Bear Hazard Assessment for Pemberton Meadows, British Columbia, Canada

Supporting Grizzly Bear Recovery and Connectivity between the South Chilcotin and Squamish-Lillooet Grizzly Bear Population Units

©Bryce Ronayne. Male grizzly bear foraging on a cow that died of an unknown cause on a Mowich Creek farmland property, 2016. This bear originates from the Upper Lillooet study area as identified through DNA.

THE COAST TO CASCADES GRIZZLY BEAR INITIATIVE
7752-C Meadows Road
Pemberton, BC, V0N 2L2

&

THE GRIZZLY BEAR FOUNDATION
#310 - 1529 W 6th Avenue
Vancouver, BC, V6J 1R1

With generous support by the BC Ministry of Agriculture

Prepared by:
Lana M. Ciarniello, Ph.D., RPBio
Aklak Wildlife Consulting
3021 Jody Lynne Way
Campbell River, BC, V9H 1N3
Email: aklak@telus.net

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Executive Summary

This document presents a community specific Bear Hazard Assessment (BHA) for Pemberton Meadows, British Columbia (BC), Canada. The work was commissioned by the Coast to Cascades Grizzly Bear Initiative[1] and the Grizzly Bear Foundation[2] with support from the BC Ministry of Agriculture. As defined by the province of BC, a BHA is an area-specific profile related to bears, humans, and human-bear conflicts. The focus of this BHA is to support the recovery, increase the connectivity, and proactively manage for potential Human-Bear Conflicts (HBC) with grizzly bears between the South Chilcotin and Squamish-Lillooet Grizzly Bear Population Units. This BHA does not address the Village of Pemberton and focuses only the Pemberton Meadows area (hereafter Meadows) because this is where grizzly bears are more commonly sighted as they begin to recover and expand their current range. The Meadows is within the traditional territory of the Lil'wat Nation but does not contain any federally registered Indian Reserve Lands. The meadows are contained within the Agricultural Land Reserve (ALR) and there are restrictions on the types of land use that can occur on farm land. Commercial agriculture production is the priority for land contained within the ALR.

The Lillooet River divides the Meadows area and its mid-to-lower portion generally forms the boundary between two threatened Grizzly Bear Population Units (GBPU): the South Chilcotin (SC) and the Squamish-Lillooet (SL). In the mid-upper Meadows area, ~2.5 km west of the closed Coast Mountain Outdoor School, the Lillooet River begins to divide forming a series of small islands; at this point the GBPU boundary crosses the River and ascends up Camel Back ridge and follows the mountain top alpine terrain of Mount Morrison. The SC and SL GBPUs are within a pocket of threatened and extirpated GBPUs in southwest BC and recovery of grizzly bears in these units has international significance.

There were two separate grizzly bear research projects that had GPS collared bears that used the meadows area: one in the SL, and, one in the SC. Both research projects reported an expanding grizzly bear population in part of their study areas: female bears in the Ryan River drainage for the SL project, and the McGillivray Mountains area for the SC project. Both projects also concluded that grizzly bears, particularly females, may be hesitant to cross the Meadows (i.e., GBPU boundary). Habitat loss due to human occupation, agricultural activities, resource extraction, and increasingly expanding recreational activities, are significant threats to grizzly bear population persistence within this area. Currently, the Meadows area is acting as a fracture between these two units.

Based on the situational analysis, the Bear Hazard Assessment for Pemberton Meadows had the following goals: (1) to foster the safe movement of grizzly bears across the Meadows/Lillooet River to increase connectivity between the SC and SL GBPUs; (2) to proactively prevent human-bear conflicts that may be anticipated to arise due to expanding grizzly bear populations; (3) to gauge the current practices and attitudes of residents towards

[1] https://www.coasttocascades.org/
[2] https://grizzlybearfoundation.com/

grizzly bear recovery; (4) to maximize resident safety by identifying the agents of past and current bear-human conflicts with the goal of managing for potential areas and causes of future conflict including reducing property and/or crop damage; and, (5) to provide recommendations to reduce bear occurrence reports and bears destroyed.

To achieve the objectives, the Meadow's area was evaluated for the connectivity to high-quality bear habitat, amount of security cover present, amount and season(s) of bear foods present, and historic and present bear reports and mortality events. Areas where bears were reported were evaluated for their seasonal habitat potential, travel route capability, cover/visibility/sensory attributes, and accessibility of non-natural attractants.

The assessment took into account the past, current and future potential of the area. Grizzly and black bears were part of the history of the Meadows and settler accounts recall what appeared to be a much greater number of grizzly bears using the Meadows than today. The land was cleared for commercial agricultural production, particularly bovine livestock, potatoes (seed and fresh market), grains and hay. At the time of this assessment, high-quality wildlife habitat in the Pemberton Valley had been sold and developed. Many wetlands have been negatively affected and a number of farms manage water levels for commercial agricultural production. Augmenting habitat loss and alteration is recreational spill over from the Resort Municipality of Whistler.

The issues with bears differed considerable between the mid-upper Pemberton Meadow's area and the lower meadow area. Urbanization was making its way up the Meadows from the Village of Pemberton. Black bears were more commonly reported in the lower meadows area and four of the five black bears destroyed were in the lower Meadows; chickens were the primary attractant for black bears, followed by garbage and fruit trees. In the lower Meadows only issues with improper management of residential and commercial garbage were noted and some unkempt fruit trees were recorded. There were no grizzly bear PWOR reports in the lower Meadows area. Farm land development is controlled to some extent by the Agricultural Land Reserve, but more residential development is taking place as farm land is sold to new owners who are allowed to build a residence on their land.

The mid-upper Meadows area primarily remained as large farmlands and residents had a deeply-rooted history of living with bears. No issues with residential or commercial garbage were noted; residents knew bears would develop problem behaviours if they accessed garbage and all arms of bins checked were locked in place. There were only three reports of grizzly bears in the PWOR database: one related to killing chickens, one feeding on dead bovine livestock, and a sighting of a family unit. A site-specific bear occurrence and damage survey was developed and aimed at filling in the gaps in the PWOR reports by determining past, current, and future use and attitudes regarding the residents' willingness to coexist with grizzly bears.

The majority of those surveyed were using the Meadows to produce products for commercial sales (75%). The primary agricultural product produced was seed and fresh market potatoes followed by cattle, hay, and mixed vegetables. Black bears occurred on all properties surveyed. The primary issue with black bears on farms was with planted grain, particularly oats, followed

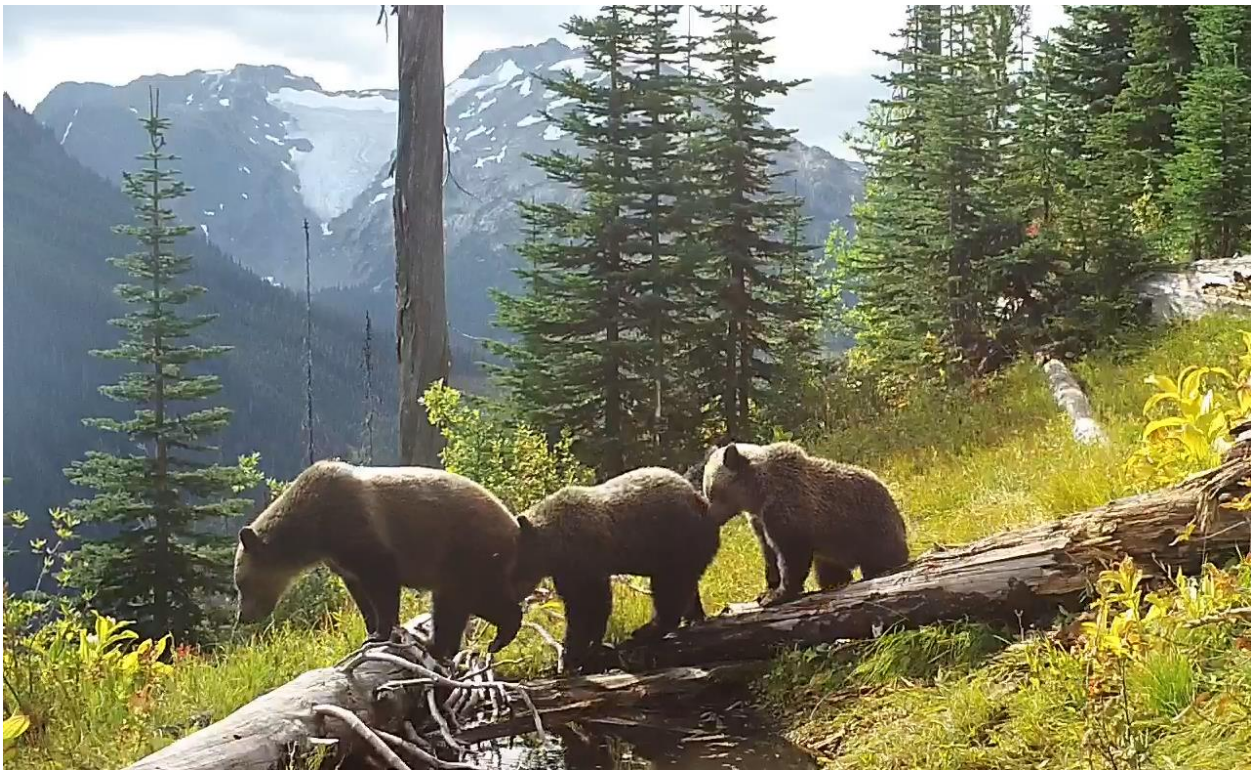
by stored grain for livestock, and then fruit trees. Grizzly bears were reported to use 69% of respondents' properties although it was primarily grizzly bear sign (tracks). The majority of respondents stated that they did not have any conflicts with grizzly bears; when conflicts did occur with grizzly bears it was damage to root crops, particularly carrots, and lettuce. Overall, the challenges with grizzly bears varied according to what palatable product the farm was producing. Potatoes were not consumed by bears and bear damage to potato crops was minimal. The primary method used by residents to deter bear access to an attractant was electric fencing, but none was in place at the time of the survey; people appeared to wait for a bear problem to occur before they used a deterrent method even if the set-up was in place (e.g., insulators and ground rods in place but no wire). The overall attitude towards grizzly bear recovery was that conserving wildlife was the right thing to do regardless of whether the farmer benefitted financially.

The linkage section of this report recommends property purchases and easements that together allow bears secure movement across the Meadows, which is required for them to access critical habitat types according to their season of bear use. One linkage design, named the Oxbow Corridor, cuts across the meadows at the Lillooet Forest Service Road. The design builds upon a band of habitat already contained within the Pemberton Wetland Wildlife Management Area. The second linkage design presented focuses on establishing Conservation Easements along the back of a number of farm properties running along the low elevation ridgeline of Camel's Back ridge. The Camel's Back Corridor is thought to favour female bears, particularly those with cubs using the Ryan River drainage, as they may be reluctant to cross mid-meadow. Both designs make maximum use of the existing grizzly bear and spotted owl Wildlife Habitat Areas. Planning a linkage design around these important habitat types enlarges the conservation area and increases the probability of their use by bears. Conservation of the proposed properties promotes area biodiversity, aquatic habitat protection and conservation of At-Risk species including grizzly bears, spotted owls, salmon and several species of birds and amphibians.

The results of the bear occurrence and mortality reports, resident survey, site visits and grizzly bear location data were used to formulate area-specific recommendations for the Meadows (Phase II of the Bear Smart requirements and Section Two of this document). The residential and commercial management of garbage was excellent in the mid-upper meadows area. Further, residents were in support of grizzly bear recovery within the Meadows; however, the actual implementation of Bear Smart mitigation methods to protect poultry coops, gardens, apiaries and the like was extremely retroactive - residents did not appear to put any measures into place until a 'problem' had occurred. The recommendations focus on proactive management, or dissuading conflicts before they occur. Dissuading conflicts is important preparation for a recovering bear population because increasing or persistent bear conflicts can result in negative attitudes towards bears and hinder conservation efforts.

During the first field assessment in August and a return to the Meadows in October a large property/farm in the mid-upper Meadows was deforested to the edge of the Pemberton Meadow's road and a large house was being constructed. The time to act on conserving

habitats and implementing Bear Smart recommendations is now while the bear populations are just beginning to expand and the habitat remains available. Fulfillment of the recommendations will require partnerships between a number of organizations, such as, the Squamish-Lillooet Regional District, the Village of Pemberton, Lil'wat Nation, the Pemberton Wildlife Association, the Conservation Officer Service, and a number of the BC Government Ministries, such as FLNRORD, MOE, MOF, ECCC, and AGRI.



Grizzly bear mother with two cubs. Curtsey of the South Chilcotin Grizzly Bear Research Project. ©M. McLellan.

Acknowledgements

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Glossary of Abbreviations

AGRI	-	BC Ministry of Agriculture
ALR	-	Agricultural Land Reserve
BC	-	British Columbia
BEC	-	Biogeoclimatic Zone
BHA	-	Bear Hazard Assessment
CDC	-	Conservation Data Centre
CI	-	Compulsory Inspection
COS	-	Conservation Officer Service
COSEWIC	-	Committee on the Status of Endangered Wildlife in Canada
COY	-	Cub of the Year
CWH	-	Coastal Western Hemlock
DFO	-	Department of Fisheries and Oceans
DNA	-	Deoxyribonucleic acid
ECCC	-	Environment and Climate Change Canada
FLNRO	-	Ministry of Forests, Lands and Natural Resource Operations
FSR	-	Forest Service Road
GBPU	-	Grizzly Bear Population Unit
GBRP	-	Grizzly Bear Research Project
GIS	-	Geographic Information System
GPS	-	Global Positioning System
IDF	-	Interior Douglas-fir
IUCN	-	International Union for the Conservation of Nature
IR	-	Indian Reserve
LEH	-	Limited Entry Hunt
LR	-	Lillooet River
LRMP	-	Land Resource Management Plan
MOE	-	Ministry of Environment
MOF	-	Ministry of Forests
MM	-	McGillivray Mountains, South Chilcotin Ranges
MU	-	Management Unit
NCC	-	Nature Conservancy Canada
PM	-	Pemberton Meadows

PWA	-	Pemberton Wildlife Association
PWOR	-	Problem Wildlife Occurrence Report
RMOW	-	Resort Municipality of Whistler
SARA	-	Species at Risk Act
SC	-	South Chilcotin Ranges
SL	-	Squamish-Lillooet
SLRD	-	Squamish-Lillooet Regional District
S2S	-	Sea-to-Sky highway corridor
UTM	-	Universal Transverse Mercator
VOP	-	Village of Pemberton
VRI	-	Vegetation Resource Inventory
WMA	-	Wetland Management Area
WMU	-	Wildlife Management Unit

Disclaimer

This document was prepared exclusively for The Coast to Cascades Grizzly Bear Initiative and the Grizzly Bear Foundation by Aklak Wildlife Consulting. The quality of information, conclusions and recommendations contained herein are based on: i) information available at the time of preparation; ii) field visits to Pemberton Meadows; iii) personal communications with residents and experts; and iv) the assumptions, conditions and qualifications set forth in this report.

This document uses expert knowledge, available data, personal interviews, field visits and a review of literature to identify and provide recommendations to manage for potential human-bear conflicts in Pemberton Meadows, BC. Any other use or reliance on this report by any third party is at that party's sole risk. Bears are wild animals that can cause considerable harm and the author assumes no liability with respect to use and application of the information contained herein.

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PHASE ONE: BEAR HAZARD ASSESSMENTS

1.0 Situational Analysis - Identifying Site-Specific Issues for Pemberton Meadows

The Coast to Cascades Grizzly Bear Initiative (C2C) and the Grizzly Bear Foundation (GBF) identified the need for a Bear Hazard Assessment (BHA) for Pemberton Meadows, located in the southern Coast Mountains of British Columbia (BC), Canada (Figure 1). A BHA identifies "the current and potential agents of human-bear conflict that occur within the community" and requires establishing an area-specific profile related to bears, humans, and human-bear conflicts (Davis et al. 2002:21).

Pemberton Meadows (hereafter Meadows) is within the traditional territory of the Lil'wat Nation (Mount Currie), which is part of the St'át'imc Interior Salish First Nation people. The Meadows are outside of the established Lil'wat Indian Reserve (IR) Lands and are managed by the Squamish-Lillooet Regional District (SLRD). In regard to bear management, the Village of Pemberton (VOP) works cooperatively with Lil'wat Nation, the SLRD, and the Province of BC. This assessment does not include the VOP itself and is focused solely on Pemberton Meadows. Provincially, grizzly bears are managed by the Ministry of Forests, Lands and Natural Resource Operations (FLNRO) and the BC Ministry of Environment and Climate Change Strategy (MOE). The Meadows are within the Agricultural Land Reserve and as such commercial agricultural production is maximized and land unavailable for agricultural production is minimized (AGRI 2009).

Key wildlife habitat in the Pemberton Valley has already been sold and developed and it was apparent that the urban agricultural-farm lifestyle was making its way up the meadows. The lower meadows area substantially differed from the mid-to-upper meadows areas in the types of residential developments, bear species use of the area, and bear complaints. The lower meadows area was more residential-farm oriented and was comprised of smaller hobby farms that produced products for personal use or local sale. There was also a trailer park and some single unit housing. Black bears were commonly sighted whereas grizzly bears reports were extremely rare.

Conversely, the mid-to-upper meadows part of the study area was primarily comprised of large-scale agricultural farming operations that produce products for commercial and local sale. Residents in the mid-to-upper meadows tended to have deeply rooted family histories within the valley that spanned generations. A number of farmers leased land from other residents for agricultural purposes. Over time, many of the wetlands have been negatively affected and a number of farms currently manage water levels for commercial agricultural production. Irrigation was historically restricted to potato crops, but has become more common to increase productivity of other forage crops (AGRI 2009).

Augmenting habitat loss and alteration is the extreme recreational spill over from the Sea-to-Sky (S2S) highway corridor and the Resort Municipality of Whistler (RMOW). Mid-meadows

there was a popular beer establishment, The Beer Farmer's, where tourists could enjoy locally grown and crafted lagers and ales on the family property. The Miller family established roots in the valley in 1895, and the Beer Farm is a "4th generation organic family farm." There were also two busy organic farm operations that provided boxes of vegetables and fruits for local sales.

In the mid-upper meadows area, at the Upper Lillooet River Forest Service Road's (LR-FSR) bridge, there was an active heli-mountain biking tourism operation. The cyclists would drive to the pick-up point and this has resulted in increased vehicle traffic. The helicopter operation was based in the RMOW and its flight path went over part of the Wetland Management Area (WMA) leading from Oxbow Lake (i.e., high quality bear habitat). It would then land on a property in the Meadows (Lot 813-B) to pick up the cyclists and to take them to the alpine; from the alpine, riders would mountain bike down the hiking/horse trail that is maintained by the Pemberton Wildlife Association (PWA) to their vehicle parked at the LR-FSR bridge in the Meadows.

1.1 Grizzly Bear Population Units for Pemberton Meadows

Pemberton Meadows lies at boundary of two Threatened Grizzly Bear Population Units (GBPU): the South Chilcotin (SC) and the Squamish-Lillooet (SL). The Lillooet River runs through the Meadows area (Figure 1). The mid-to-lower portion of the GBPU boundary follows the river west until it reaches the upper Meadows area, ~2.5 km west of the closed Coast Mountain Outdoor School bordering Oxbow Lake. Here, the Lillooet River begins to divide forming a series of small islands at which point the GBPU boundary crosses the River and ascends up Camel Back Ridge ultimately following the alpine ridgeline of Mount Morrison.

The South Chilcotin (SC) GBPU has an estimated population of 203 grizzly bears within 15,220 km^2 area of useable habitat (13 grizzly bears/1,000 km^2; MOF 2012). The Threatened Squamish-Lillooet GBPU has an estimated 59 grizzly bears within 5,019 km^2 of useable habitat (12 grizzly bears/1,000 km^2; MOF 2012). The SC and SL GBPUs are within a pocket of Threatened, Critically Endangered and Extirpated GBPUs that occur in southwest BC (Figure 2; MOF 2012, McLellan et al. 2017). Both the SC and the SL populations have been the focus of intense research efforts to understand the drivers limiting the populations of grizzly bears and to support recovery efforts.

There are two Grizzly Bear Research Projects (GBRP) that have part of their study areas encompassing the Meadows area: The South Chilcotin Grizzly Bear Research Project (Michelle & Bruce McLellan; SC-GBRP); and, the Squamish-Lillooet Research Project (Clayton Apps, Steve Rochetta & Bruce McLellan; SL-GBRP). Both research projects focus on population monitoring and use DNA analysis and data gathered from Global Positioning System (GPS) telemetry collars placed on grizzly bears to examine several aspects of grizzly bear ecology, including genetics, habitat use, movements, reproduction and survival of study bears. The SC-GBRP also uses stable isotope analysis acquired from grizzly bear hair to obtain bear diet profiles.

The studies have reported two main finding applicable to this Bear Hazard Assessment:

- From 2006-2017, the South Chilcotin GBRP monitored the grizzly bear population in the SC GBPU (M & B McLellan). That research found that the population of grizzly bears in the SC McGillvary Mountain's area (Management Units 3-33 and 2-11) was growing (M. McLellan et al. 2019).
- The Squamish-Lillooet grizzly bear population has been monitored continuously since 2004. The SL-GBRP project found that the grizzly bear population in the Ryan River area also appeared to be growing (Apps et al. 2014, Rochetta pers. comm.).

As the grizzly bears began to expand their range their movement data showed that the Meadows area was acting as a semi-fracture between these two units; bears were experiencing difficulty moving from one side to the other. Research conducted by the Squamish-Lillooet study has shown that grizzly bears, particularly females, may be reluctant to cross the extensively cleared agricultural fields (Apps et al. 2014). In the past, two male bears that used this area were drawn to unsecured attractants, including livestock carcasses and poultry coops. Ultimately, these bears were destroyed for displaying "problem" bear behaviour that developed from their access to those attractants. Habitat loss due to human occupation, agricultural activities, resource extraction, and increasingly expanding recreational activities, are considerable threats to grizzly bear population persistence within the Meadows and this negatively affects the adjacent areas.

This BHA focuses on land-use planning and proposes the acquisition of key pieces of lands to maintain and reconnect formerly contiguous crossings for bears. It also identifies some potential "ecological traps" that simply defined are high-risk food-rich habitats that attract individuals and can serve as local population sinks (Delibes et al. 2001). To be effective, recovery and conservation efforts require the support of the surrounding community. A survey was developed to assess the attitudes and current practices of landowners and managers operating within the Meadows. *The key to successful grizzly bear conservation and recovery programs is to provide the knowledge and tools to reduce risks of conflicts and encounters*.

1.2 What Does a Bear Hazard Assessment Entail?

The overall objective of a Phase 1 Bear Hazard Assessment as stated by the Provincial Bear Smart program is to identify "the current and potential agents of human-bear conflict that occur within the community" (Davis et al. 2002:21). There are 5 main criteria required to a Prepare a Phase 1 Bear Hazard Assessment[3]:

1. Identify high-use bear habitat by species (grizzly or black) in the community and surrounding area (travel corridors, natural food sources such as berry patches and salmon streams, breeding areas, denning areas, etcetera.)
2. Map non-natural attractants within the community and surrounding area that attract and/or are accessible to bears such as landfills, transfer stations, park and highway pull-out litter barrels, orchards, residential garbage collection routes, and dumpsters.

[3] Adapted from Davis et al. 2002

3. Review and map patterns of historic human-bear conflicts based on complaint records to assist with the identification of bear hazards.
4. Map human-use areas that may conflict with bear habitat such as school yards and residential areas located adjacent to heavy bush, walking trails that pass through berry patches, etcetera.
5. Using the above information, identify and map existing and potential bear hazards. The hazards should be mapped with a ranking scheme of high/moderate/low.

1.3 Specific Objectives of the Pemberton Meadows BHA

Based on the situational analysis, the Bear Hazard Assessment for Pemberton Meadows has the following main goals:

(1) To foster the safe and secure movement of grizzly bears across the Meadows/Lillooet River to increase connectivity between the SC and SL GBPUs;

(2) To proactively prevent human-bear conflicts that may arise due to expanding SC and SL grizzly bear populations;

(3) To gauge the current practices and attitudes of residents towards grizzly bear recovery;

(4) To maximize resident safety by identifying the agents of past and current bear-human conflicts with the goal of managing for potential areas and causes of future conflict including reducing property and/or crop damage; and,

(5) To provide recommendations to reduce bear occurrence reports and bears destroyed.

Figure 1. Pemberton Meadows lies in the valley between the South Chilcotin and Coastal Mountain Ranges, British Columbia, Canada. The blue line is the boundary of the Grizzly Bear Population Unit, which follows Mount Morrison, Camel Back Ridge and the Lillooet River.

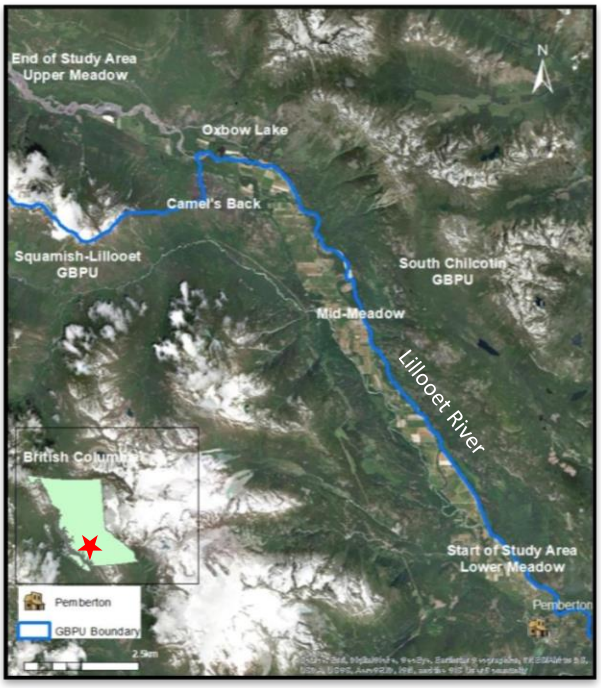
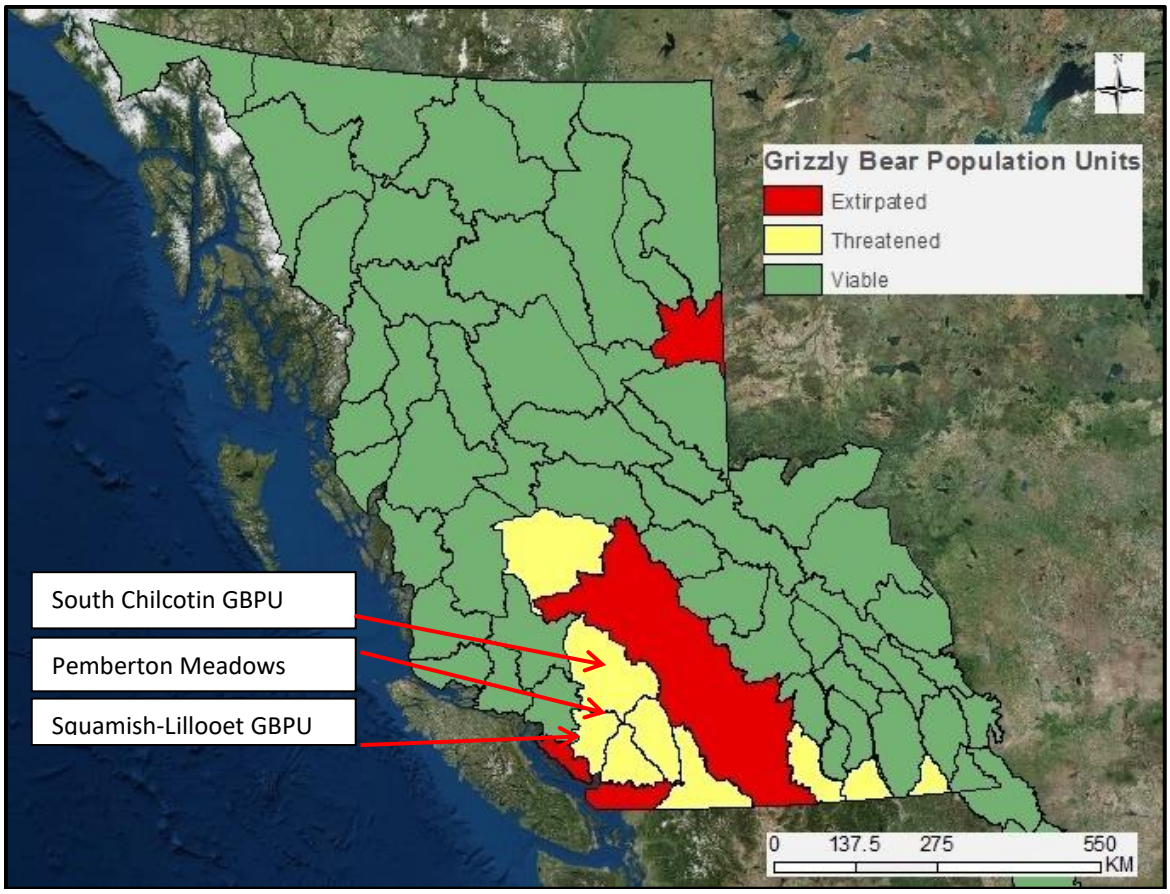


Figure 2. Grizzly Bear Population Units as designated by the province of BC. There are 56 GBPUs in the province. The South Chilcotin and Squamish-Lillooet GBPUs form part of a pocket of units designated as Threatened or Extirpated.



1.4 Biogeoclimatic Zones and Natural High-Quality Grizzly Bear Foods

The majority of Pemberton Meadows is within the Coastal Western Hemlock Dry Submaritime subzone (CWHds1). The forests of the CWHds1 zone are predominately Western hemlock (*Tsuga heterophylla*) and Douglas fir (*Pseudotsuga menziesii*). The CWHds1 is defined as an ecosystem with infrequent stand-initiating events (NDT2, Green and Klinka 1994).

The infrequent stand-initiating events are in part due to the higher site moisture associated with the NDT2 disturbance regime. The majority of the Meadow's habitat was influenced by a high water table and there were numerous wetlands, seepage habitats, forested swamps and riparian areas. The high water table is primarily the result of "surface water runoff on the mountain sides that supply gravity fed systems" (AGRI 2009:30). The majority of land not available for agriculture is within wetlands "and serve a riparian and bank stabilization function" (AGRI 2009:23). These habitat complexes are known to be high quality for grizzly bears, particularly in spring as the grasses (*Poaceae* spp.), sedges (*Carex* spp.), forbs (e.g.,

common horsetail (*Equisetum arvense*), wild celery (*Angelica* sp.), and later, cow parsnip *(Heracleum lanatum)* emerge. These low elevation wetland complexes are particularly important in years where the snow pack remains into spring, delaying the emergence of subalpine vegetation.

Grizzly bears are known to fish for adult salmon (*Oncorhynchus* spp.) in the Lillooet River albeit considerably less than in the past (M. McLellan pers. comm.). The mid-to-upper Meadow's area contained critical salmon spawning and rearing habitat within diverse wetland habitat complexes. The South Chilcotin Grizzly Bear Research Project (SC-GBRP) found that grizzly bear diet profiles had 14-30% salmon in the early 1900's, while current preliminary diet profiles reveal only 0-1% salmon in the average diet for the population; however, a few males have signatures up to 10% (M. McLellan pers. comm.). Therefore, although spawning salmon are available, they do not appear to be a critical food for these populations any longer. However, salmon runs in this system have significantly deteriorated over time and researchers think that grizzly bears would use salmon resources more if more were available (Rochetta pers. comm.).

Some of the research bears that were using Pemberton Meadows were indeed feeding on salmon. In the Lillooet River grizzly bears are accessing salmon in multiple locations (e.g., Samson creek, Rohb creek and several tributaries of the main river; Rochetta pers. comm.). The SL-GBRP has data that reveals annual use of salmon by multiple mature radio-collared females as well as non-collared females with cubs; some bears, even females with cubs, remained out until mid-December feeding on the fall Coho run (Rochetta pers. comm.). The upper Lillooet has had up to 9 grizzly bears utilizing the river during the salmon spawning period, including three mature females with cubs; the fall motorized closure dates (Sept 15- Nov 30) for the upper Pemberton Meadow's road was based on grizzly bear preferred habitat use of the upper Lillooet River to reduce the potential for human-bear conflict (Rochetta pers. comm.). The decline in salmon in grizzly bear diet is likely attributed to the general deterioration of salmon stocks; the importance of salmon to grizzly bears in the upper Lillooet should not be understated and use would be higher if the runs were healthy (Rochetta pers. comm.). Maintaining secure access to areas where bears can fish is of utmost importance, as is the restoration of critical salmonid habitat, especially as the grizzly bear population expands.

The Interior Douglas-fir Wet Warm (IDFww) biogeoclimatic zone begins on the upper portion of Oxbow Lake and encompasses the lower slopes of Wolverine Creek and Johnny Sandy Creek. The IDFww is an ecosystem with frequent stand-maintaining fires (NDT4; Green and Klinka 1994). Fire is important for the productivity of some key bear foods in these units, particularly huckleberry (*Vaccinium membranaceum;* Picture 1), Saskatoon berry (*Amelanchier alnifola*), and buffaloberry (*Shepherdia Canadensis)*.

Both the SC and SL research projects monitored bears that used the Tenquille berry patch in late summer and fall. The SL project monitored bears that crossed the Meadows into the SC-GBPU to feed on the huckleberries that were productive on the north aspect. The primary berry species consumed by bears in the SC-GBPU MM area were huckleberries (41%), followed by Saskatoon berries (27.5%; McLellan 2007). North slopes tend to be cooler and hold the

snowpack longer, which result in prolonged melting/moisture and increased berry productivity and longevity on hot summer days than those growing on the dryer southern exposure; north and east aspects appear to be where the fruit does not dry out (McLellan pers. comm.).

Picture 1. Glacier lily meadow (left) and huckleberry bush (right) with abundant fruit are high-quality grizzly bear foods.

A field of glacier lily and Western spring beauty lines the subalpine bowls of Tenquille Mountain.

Black huckleberry (pictured) and Cascade blueberry (V. deliciosum) are high-quality grizzly bear foods.

A mother grizzly bear and her 3 cubs fish and gorge on salmon. Where river systems and salmonid runs are healthy fish are a critical food source for bears.

2.0 Methods for Phase 1 Hazard Assessment

2.1 Conservation Officer Service Problem Wildlife Occurrence Reports

Problem Wildlife Occurrence Reports (PWOR) are sightings or complaints of bears made by the public to the Conservation Officer Service (COS) and/or the police. The reader is cautioned that bear occurrence reports represent those areas where bears are reported sighted and are not necessarily representative of bear use. For example, during this assessment black bears were using the mid and upper Meadow's areas but residents noted that they were used to living with black bears and tended not to report them.

Bear occurrence reports should not be used to estimate the number of bears using an area; a bear may be sighted multiple times by multiple people resulting in more than one report of the same animal. Alternatively, bears may be sighted and not reported. PWORs provide insight into the root causes of conflicts with bears and the locations of neighbourhoods' that have a higher probability of creating human-bear conflicts.

PWORs reports for Pemberton Meadows, 2004-2019, were obtained from the BC MOE, COS (Badry and Rochetta pers. comm.). Reports were provided for grizzly and black bears. The description of each report was read, including any repeat calls relating to the same event and/or any follow-up reports. Repeat and follow-up reports were removed leaving only one call per caller event. A reporting category was assigned to the event based on the report description(s). Nine reporting categories were used (Table 1).

The COS response to the report was also recorded and a category was assigned: advice provided; bear destroyed; bear sent to rehab; electric fence installed; fine/violation; no response; not recorded/unknown (Table 1). The category was further classified as an attractant/bear hazard or 'other' (i.e., sighting, injured, not recorded).

Table 1. PWOR Reporting Categories for Pemberton Meadows, 2004-2019

Reporting Category	Bear Category
Agricultural Activities	Attractant
Apiary	Attractant
Bird Feeder	Attractant
Compost	Attractant
Fruits	Attractant
Garbage & human food	Attractant
Injured	Injured
Sighting	Sighted, no conflict
Not recorded	Insufficient information

COS Response
Advise Provided
Bear Destroyed
Bear to Rehab
Electric Fence Installed
Fine/Violation
No response
Not recorded/unknown

Reports were assigned a Universal Transverse Mercator location (UTM) based on the location description provided by the reporting party. Reports were spatially plotted on LandSat™ World Imagery using GIS in ArcMap™ (ESRI Inc., ArcGIS version 10.5.1, Environmental Systems

Research Institute Inc., Redlands, California). The spatial data were also used to determine residents and areas experiencing multiple bear reports.

ArcMap™ was used to produce georeferenced maps of the PWOR reports by species. Georeferenced maps were imported into Avenza Maps® (Avenza Systems Inc., version 3.5.1, Toronto, Ontario) using an IPad (MS Apple Inc.). Avenza Maps was used to track our location and ensure all location 'hotspots' (i.e., moderate to high reporting areas) were visited.

2.1.1 Mortality Data

Grizzly bear mortality data was obtained from the Limited Entry Hunt (LEH) Compulsory Inspection (CI) database held by the BC COS (Badry and Rochetta pers. comm.). Those data spanned 1975-2016, and included Resident and Non-Resident Hunter Kill (HK), Animal Control (AC), and Illegal Kill (IK). Due to the Threatened status of grizzly bears in this area the LEH hunt has been closed in Management Unit 2-11 since at least 1975 (MacIver pers. comm.). The hunt in MU 3-33 was closed in 2000 (M. McLellan pers. comm.).

The location of bear mortalities were plotted on LandSat™ World Imagery also using GIS in ArcMap™ and duplicate entries were removed. Grizzly bear mortality locations within the meadows were visited and where possible the incident was discussed with resident(s). PWOR mortality outcomes were combined with the CI data to produce one database of bear mortality locations by species.

2.2 Site Visits

Site visits were conducted by Allen McEwan, from the Coast to Cascades Conflict Prevention team and generational resident of the Meadows, and L.M. Ciarniello, PhD, RPBio, from 18-24 August, 2019, and 5 October 2019. Senior Ecosystem Biologist and Research Biologist for the Squamish-Lillooet GBRS, Steve Rochetta, provided a guided tour of the Meadows on 19 August.

2.3 Community Bear Occurrence and Damage Survey

A survey was developed specific to Pemberton Meadows and the objectives of this BHA. Some of the survey questions were adapted from a survey put out by the Western Landowners Alliance. The Meadow's survey was aimed at filling in the gaps in the PWOR reports and determining past, current, and future attitudes regarding the residents' willingness to coexist with grizzly bears. The 29 question survey was structured into 6 main topics:

(1) Resident Information, including history of the area and the products produced;

(2) Wildlife and their property, determining wildlife species and seasons of use;

(3) Bear-human interactions, including any conflicts with black or grizzly bears by species;

(4) Financial Information, including gains and losses to their operation from wildlife;

(5) Mitigation methods used to deter conflicts and their success or failure; and,

(6) Resident attitudes, towards: bears, various mitigation techniques, perceptions on conservation and conservation of habitat.

The survey was delivered to all available/willing landowners or managers.

2.4 Grizzly Bear Locations in Pemberton Meadows

Grizzly bears in the southern Coast Range of British Columbia occur in small, relatively isolated populations (Apps et al. 2014, McLellan et al. 2017). Two separate research projects were initiated within the SC and SL GBPUs in an attempt to determine what was limiting these bears: the South Chilcotin Grizzly Bear Research Project led by Michelle and Bruce McLellan (hereafter SC-GBRP; Picture 2); and, the Squamish-Lillooet Grizzly Bear Research Project led by Steve Rochetta, Clayton Apps and Bruce McLellan (hereafter SL-GBRP).

In 2006, GPS-collars were placed on grizzly bears in the McGillivray Mountains (MM) in the South Chilcotin GBPU as part of a PhD research project through Victoria University of Wellington in New Zealand. The Principal Investigator of this part of the SC-GBRP Project was M. McLellan with help from B. McLellan. M. McLellan's dissertation examines the difference in population trends between two adjacent grizzly bear subpopulations: McGillvary Mountains in the South Chilcotin Range GBPU, and the Stein Nahatlatch, which is not discussed in this BHA.

In 2004, the SL-GBRP was initiated, and in 2007, a GPS collaring component was added led by C. Apps, B. McLellan and S. Rochetta. The objective of this part of the Squamish study was to address grizzly bear movements and response to habitat and human activity. The SL-GBRP found that some grizzly bears used the Meadows and also crossed the valley to access Ryan Creek to the south and Tenquille Creek to the north. S. Rochetta (pers. comm.) stated that female grizzly bears were beginning to expand from the Ryan River area.

From 2010-2014, three adult females and two adult males were located within the upper Pemberton Meadows, resulting in 2,341 GPS locations (*n* = 1,500F:841M). The locations of these bears were generously provided by M. McLellan and S. Rochetta and were used to formulate the landscape linkage connectivity plan for the Pemberton Meadows area (refer to Section 3.3). The data are the property of those projects.

Picture 2. Grizzly bear being fitted for a GPS tracking collar on the South Chilcotin Grizzly Bear Research Project

Bruce McLellan fits a grizzly bear with a GPS collar on the South Chilcotin Grizzly Bear Research Project

3.0 Results of the Pemberton Meadows Bear Hazard Assessment

3.1 Wildlife Occurrence Reports (PWOR)

From 2004-2018, the COS recorded 89 PWOR reports for the Pemberton Meadows area. Repeat entries were removed leaving 46 reports (Table 2). Bear Occurrence Reports were spatially separated; grizzly bears were only reported in the upper Pemberton Meadows area (Figure 3).

For both species, there was a lack of reports in the mid-meadows area. All reports in the lower meadows were of black bears. Fourteen (30.5%) of the reports were calls from the same residence but in different years, indicating that they had not adequately addressed attractant issues on their property.

Table 2. Number of black and grizzly bear reports as recorded by the COS (PWOR database) for Pemberton Meadows, 2004-2018. The subset of grizzly bear reports are provided in brackets.

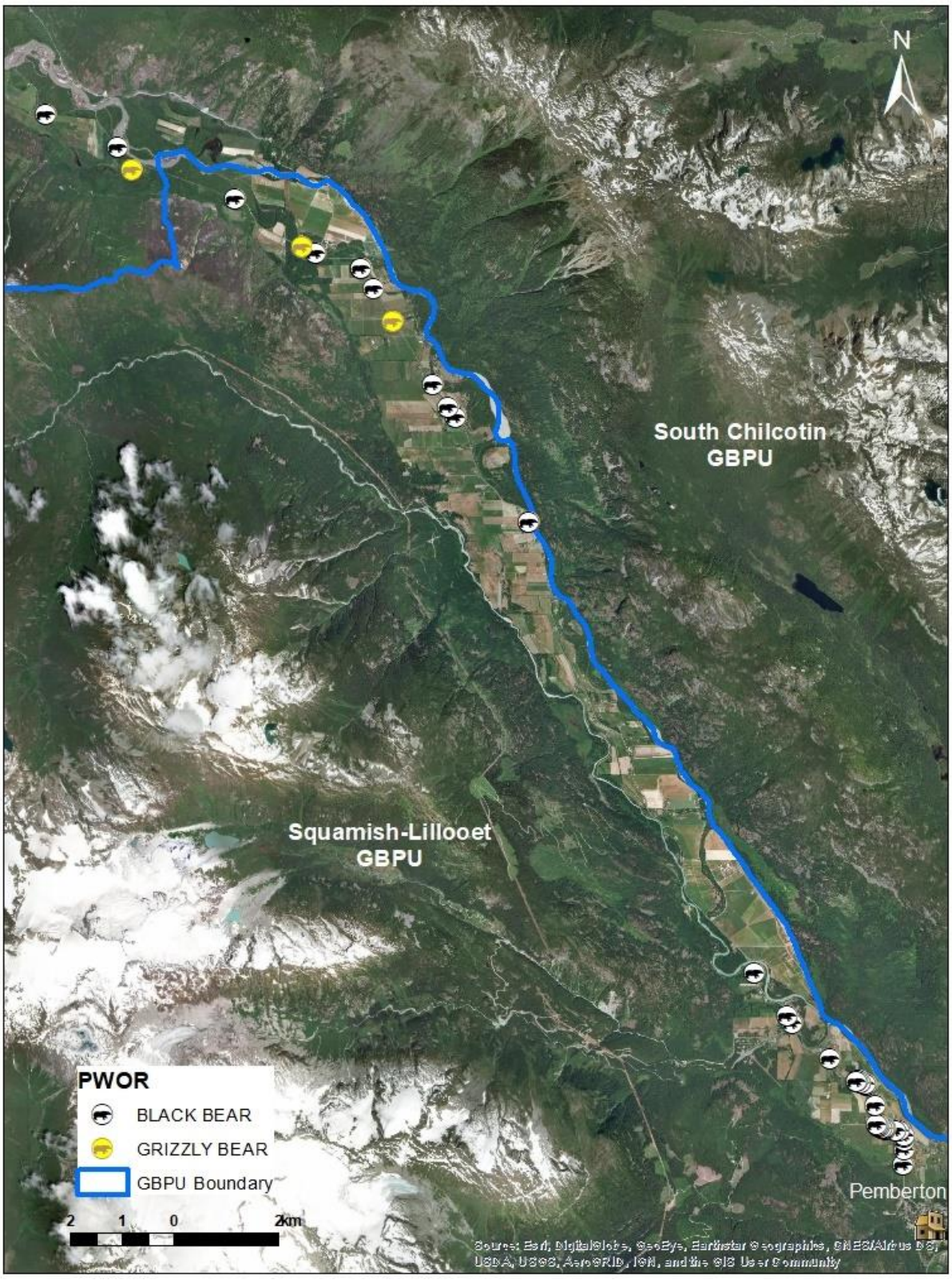
Year	No. Complaints
2004	3
2006	1
2007	4 (1 GB)
2008	4
2009	1
2010	4
2011	1 (GB)
2012	2
2015	8
2016	4
2017	8 (1 GB)
2018	6
Total	**46**

Grizzly bear with a chicken (credit: www)

Chickens were the primary attractant for black bears in Pemberton Meadows

In 1999, a grizzly bear was shot in defence of life and property in the meadow for killing turkeys

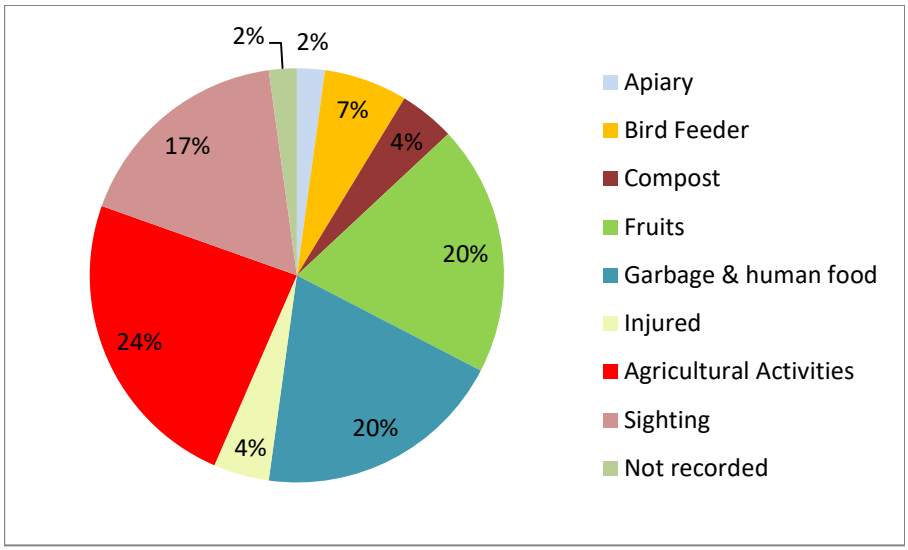
Figure 3. Grizzly and black bear COS occurrence reports for Pemberton Meadows, BC, 2004-2019. Reports of grizzly bears are the yellow circles. Black bear reports are the white circles.



Black bears represented 93.5% (*n*=43) of all reports, with 6.5% (*n*=3) being reports of grizzly bears. For both species combined, the primary reason for the call was agriculturally related (24%, *n*=12), followed by garbage & human food (20%, *n*=8) and fruit/nut bearing trees (20%, *n*=8)(Table 3, pie chart). These three attractant categories represented 64% of the calls to the COS.

Table 3. Number of PWOR reports and primary conflict type reported by residents for black and grizzly bears in Pemberton Meadows, BC, 2004-2018.

BLACK BEAR	*n*
Apiary	1
Bear on porch	2
Bird Feeder	1
Compost	2
[1]Human Food	1
[2]Fruit Tree	8
[1]Garbage	8
Injured	2
Agricultural Activities	9
Not recorded	1
Sighting	7
[2]Strawberries	1
Total BB	**43**
GRIZZLY BEAR	***n***
Livestock	2
Sighting	1
Total GB	**3**
Grand Total	**46**



[1]Garbage & human food were combined to make the pie chart
[2]Fruit trees & strawberries were combined to make the pie chart

3.1.1 Black Bear Reports

For black bears, 9 of the 43 reports (21%) were related to agricultural activities. Chickens were the primary attractant for black bears representing 7 of 9 (78%) agricultural complaints, 1 (11%) was related to sheep, and 1 (11%) grain stored for livestock. Eight reports (19%) were due to black bears accessing garbage and in one instance a black bear accessed improperly stored human food (combined 21%). Black bears feeding on fruit/nut bearing trees also accounted for 8 reports, while one bear fed on strawberries in a garden (combined 9/43, 21%). The most commonly fed on fruit was apples (4/8, 50%) followed by walnuts (3/8, 37.5%). Other fruit trees that attracted bears were cherry (planted) and mountain ash (natural).

3.1.2 Grizzly Bear Reports

Only three of the reports were grizzly bears (6.5% of overall reporting); two of the reports were related to livestock-bear conflicts and one was a sighting (Table 4). The sighting was of a radio-collared adult female and her yearling cub. These bears did not get into any attractants and the resident was reporting the bear for information purposes only.

In 2007, a grizzly bear broke into a chicken coop and killed approximately 30 chickens. The residents reported that the bear had been 'up the road for the past week.' The night before the chickens were killed they had attempted to scare the bear away from their property. The resident requested to the COS that the bear be removed or killed. In this same year these callers also reported a black bear to have killed their meat chickens. In both incidents the chicken coop was not electric fenced and no other bear deterrent methods were in place.

In the fall of 2016, a male grizzly bear fed on two cows. The cause of death of the cows was unknown but the bear was sighted feeding on the carcasses.

In spring 2017, a farmer found a 2 day old calf that he reported was killed by a grizzly bear. The farmer reported that there had been numerous grizzly bear tracks on the property for "the past month or longer." There was some question as to whether the calf had been killed by the bear or by a wolverine. At this time, the farmer also noted that a horse had been killed the previous year, but the cause of death remained unknown. Fences were fixed and fortified so the newborn calves could not wander off into the woods unattended. An interview was conducted with this family and they have not had problems since securing their livestock.

Table 4. Primary conflict type reported by residents for grizzly bears in Pemberton Meadows, BC, 2004-2018.

Year	Report	Bear Description
2007	Chickens	Juvenile grizzly bear
2011	Sighting	Adult female, 1 yearling
2017	Calf killed	Tracks only, no sighting

Unsecured or improperly secured chickens and their coops are contributing to bear problems within Pemberton Meadows.

3.1.3 COS Response to PWOR including destructions and Compulsory Inspections

The majority of calls to the COS resulted in no response (33%; e.g., sightings) or the COS providing advice on attractant management (Table 5, 30%). In two cases, electric fencing was installed, and in one instance a violation was issued. No grizzly bears were destroyed as a result of public calls to the COS.

Table 5. COS response to occurrence reports for Pemberton Meadows, 2004-2018

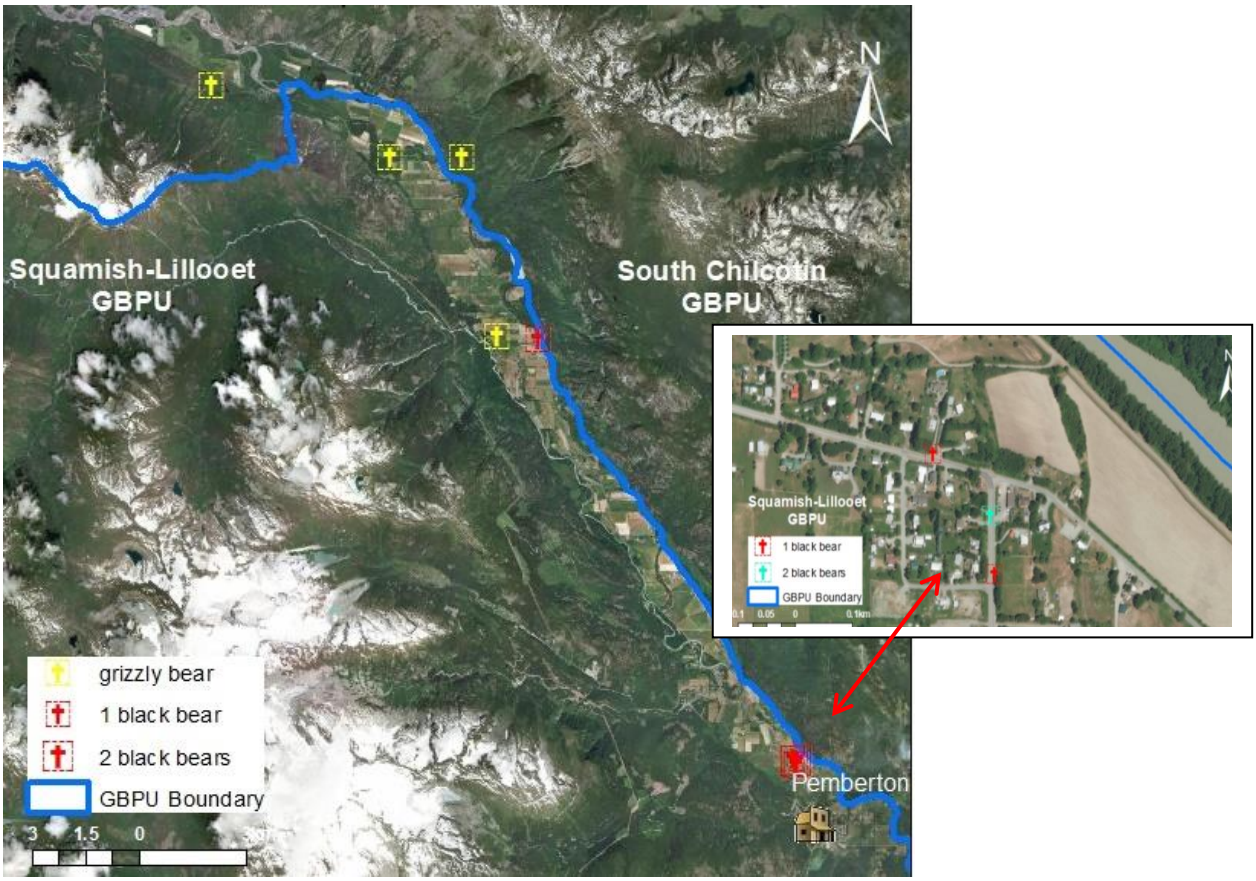
COS Response	*n*	*%*	*Attractant*
No response	15 (1 GB)	33	
Advice provided	14 (1 GB)	30	
Destroyed (5 black bears, 4 reports):	4	9	
Destroyed, 1 Ad F			Garbage
Destroyed, 1 Ad F			Not recorded
Destroyed, 1 ylng male			Chickens
Destroyed, 1 male, 1 female			Fruit trees
Electric fence	2	4	
HWCR issued	1	2	
Rehab (orphaned cub)	1	2	
Not recorded	7 (1 GB)	15	
Unknown	2	4	
Total	**46 (3 GB)**	**100**	

From 2004-2018, four of 43 (9%) calls regarding black bears resulted in the destruction of the bear (Table 5). Two of the bears destroyed were adult females; one was a lone subadult male; and, one of the calls resulted in the death of 2 bears, a male-female sibling pair, for a total of 5 black bears killed by authorities in a 14 year period (0.36/year). The number of bears killed does not take into account the legal hunt.

The issues with bears significantly differed between the mid-upper Pemberton Meadow's area and the lower meadow area. Bear reports and destructions were more common in the lower meadows. Four of the five black bears destroyed were in the lower meadow area (Figure 4). The mid-upper Meadows primarily consisted of large farmland, whereas the lower meadow area was mainly small hobby farms or semi-rural properties (Picture 3). The cluster of black bear reports and mortalities in the lower Meadows area were associated with fruit trees (destroyed 1 male, 1 female), chickens (destroyed, 1 yr old male), and garbage (1 adult female).

Grizzly bear hunting has been closed in MU-2-11 since at least 1975 (MacIver pers. comm.). The CI database had only one grizzly bear killed from 2004-2018 within the meadows area; that bear was a 16 year old male that was illegally killed at the Hurley FSR turn off in November 2011. Prior to 2004, three additional kills were recorded in the Meadows and all were Animal Control destructions: One 25 year old male on 17 May 1989; one 2 year old female on 30 October 1990; and, one 4 year old male on 24 July 1992. The CI database does not provide information on attractant type.

Figure 4. Grizzly and black bear mortalities for Pemberton Meadows as recorded in the PWOR (2004-18) and CI (1975-2018) databases.



Picture 3. Example of a small hobby farm operation in the lower Pemberton Meadows area

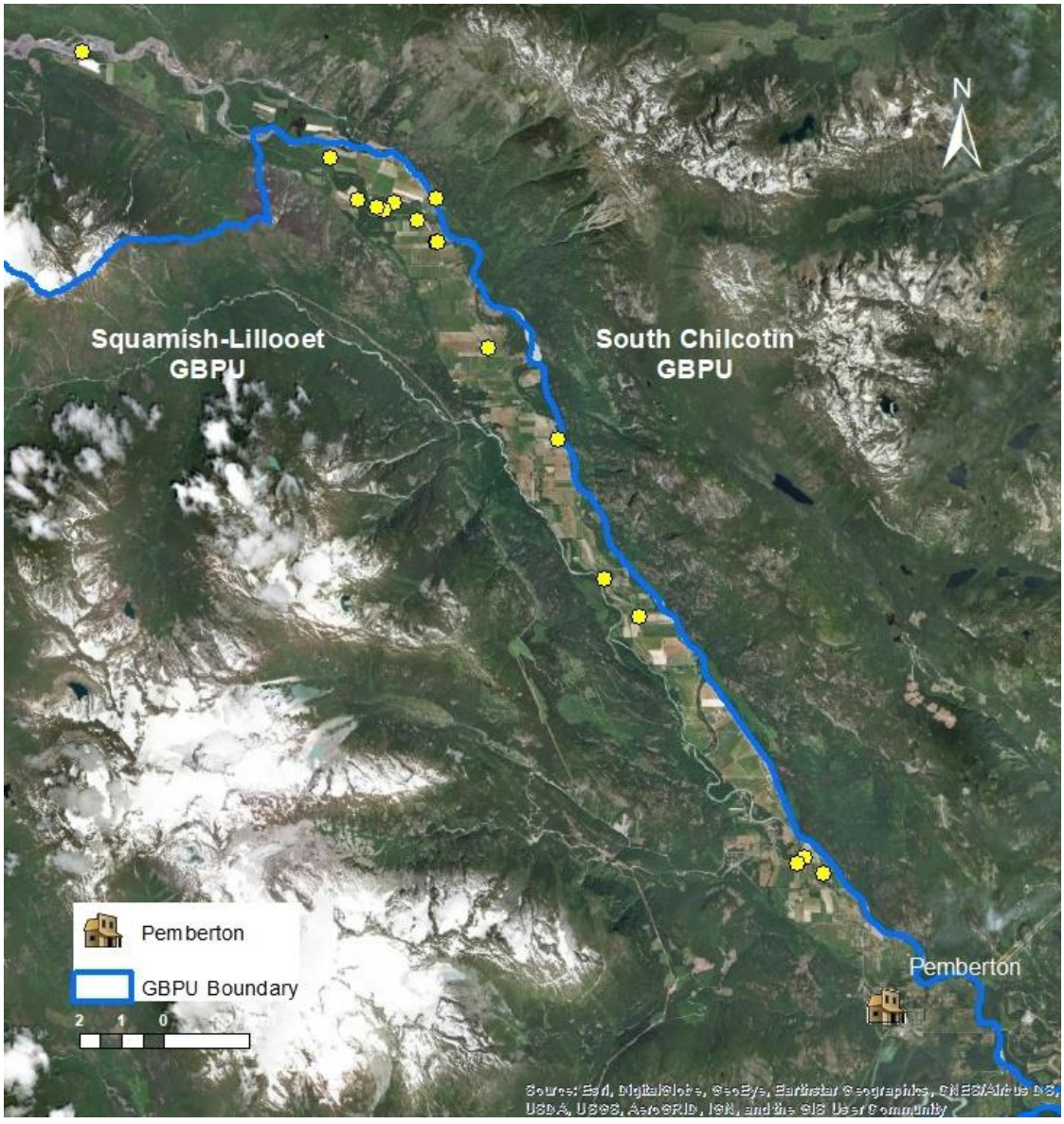
Electric fencing was not being used and the fences were inadequate to deter bears

This small hobby farm was located adjacent to a trailer park with some unlatched garbage cans. The residential area also contained a number of unkempt fruit trees. This is the neighbourhood where the cluster of black bear mortalities occurred (Fig.4).

3.2 Community Bear Occurrence and Damage Survey Results

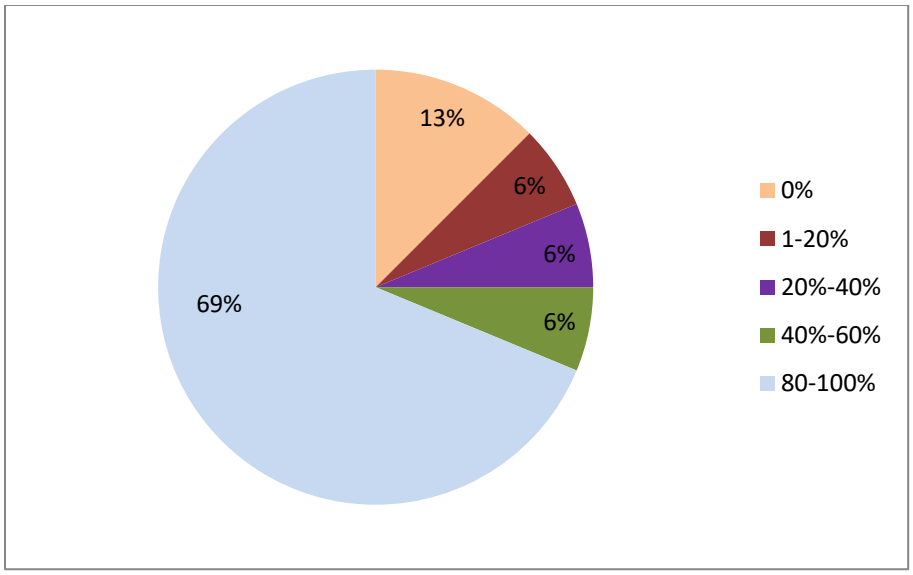
Sixteen surveys were administered to Pemberton Meadows landowners or managers covering the majority of the agricultural lands in the mid-to-upper Pemberton Meadows area (Figure 5). Most surveyed were family farms and typically more than one respondent participated in the survey. Survey participants had family history in the Meadows ranging from 3 to 116 years (median = 37.5 yrs, $\bar{x}$ = 48.37), with 87.5% residing in the meadows year-round.

Figure 5. Location of the community bear occurrence and damage survey participants. Each yellow dot represents the larger Lot of farmland area.



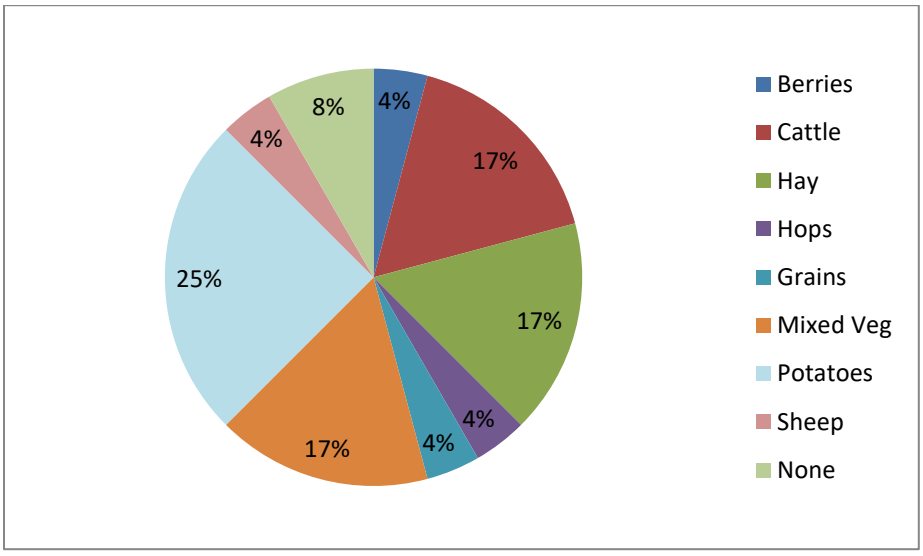
Sixty-nine percent of survey participants managed their land for agriculture purposes, including livestock grazing (Figure 6). Only 2 participants did not manage at least a portion of their land for agricultural purposes; one lived in the very upper meadows and one in the lower meadows.

Figure 6. Percentage of farm-land managed for agriculture (including livestock grazing)



Seventy-five percent of those interviewed produced products for commercial sales, while 19% produced products for local sales, and 6% for personal use. The primary agricultural product produced was potatoes (25%, seed and fresh market) followed by cattle, hay, and mixed vegetables (17% each; Figure 7). All participants interviewed noted that grizzly and black bears were not interested in potatoes and damage by bears to potatoes crops was none to minimal.

Figure 7. Primary agricultural product produced in Pemberton Meadows, BC.



When asked how they would characterize wildlife use of their property 44% said moderate use, 37.5% thought wildlife use was high, and 19% felt use of their property by wildlife was low. Black bears occurred on all properties, followed by coyotes (Table 6). Grizzly bears ranked third being reported by 11 of the 16 respondents (Table 1). Since this contradicts the PWOR reports, this finding suggests that the majority of grizzly bear sightings are not reported to the COS.

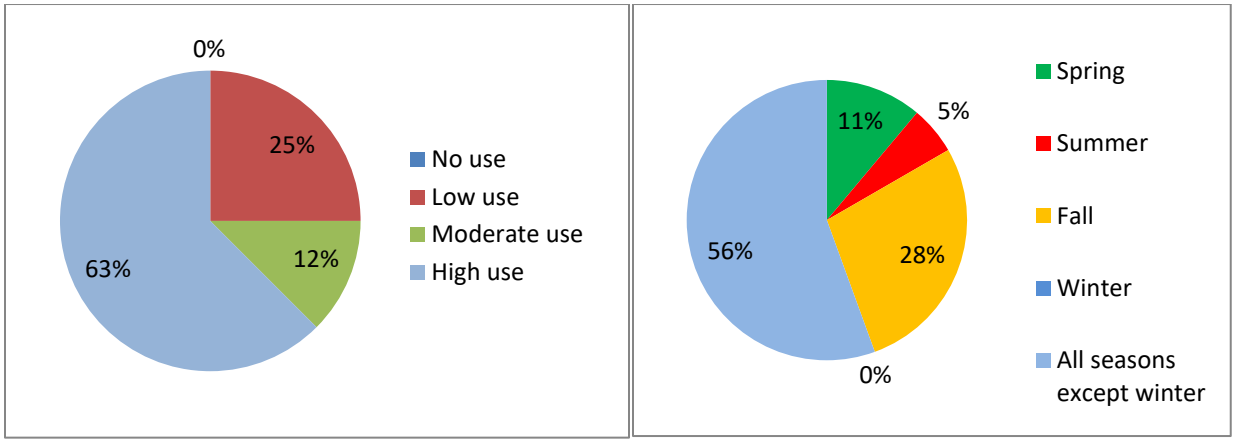
Picture 4. Remote camera installed by the landowner to monitor wildlife on a farm in Pemberton Meadows.

Table 6. Species of wildlife reported to be using the respondent's farmland

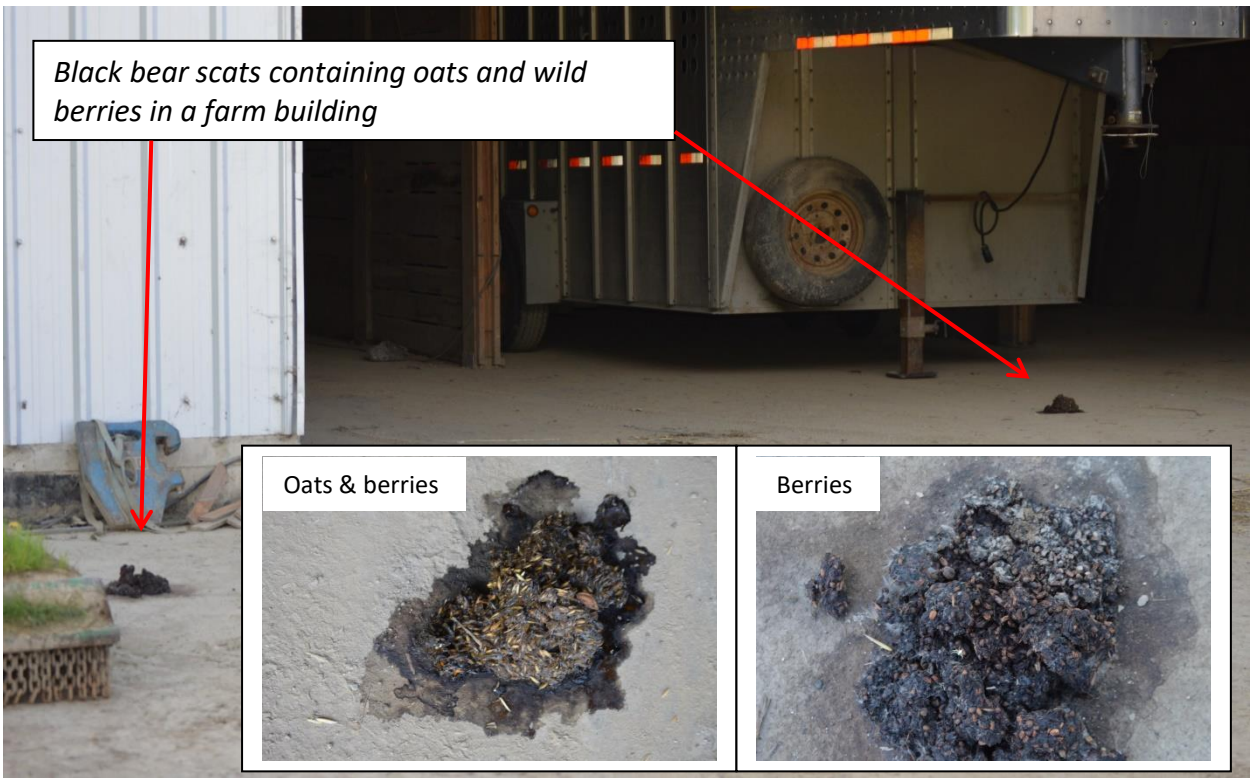
Wildlife Species	*n*	*%*
Black bear	16	100
Coyotes	13	81
Grizzly bear	11	69
Wolves	10	63
Waterfowl	9	56
Bobcat	7	44
Cougar	6	38
Wolverine	3	19
Elk	2	13
Beaver	1	6
Otters	1	6

Black bear use of properties was felt to be high in all seasons except winter (Figure 8). Of spring, summer or fall, black bears were most commonly sighted in fall, followed by spring. I encountered black bears and/or bear sign on a number of properties (Picture 5).

Figure 8. Resident report of black bear use of their property in Pemberton Meadows



Picture 5. Black bear scats in a farm building, upper Pemberton Meadows, 2019

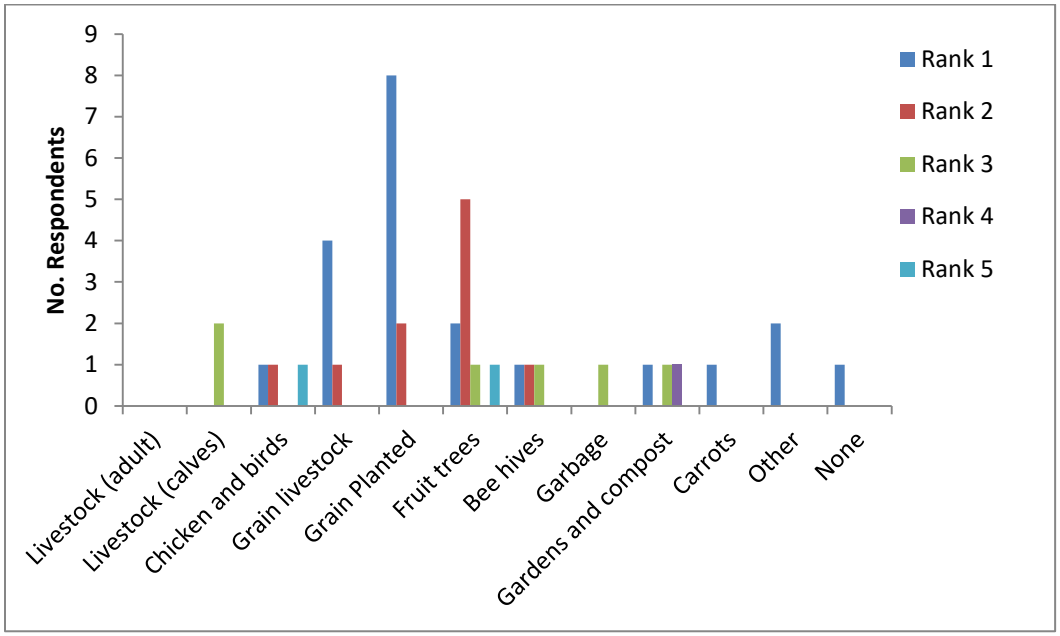


The primary issue with black bears on farms was with planted grain, particularly oats, followed by stored grain for livestock (Figure 9, Picture 6).

Fruit trees were cited as the second most common attractant on properties for black bears. Respondents that replied "other" cited natural berries, particularly dogwood (*Cornus stolonifera*) and Hawthorne (*Crataegus douglasii*), and corn as the primary attractant drawing black bears to their property.

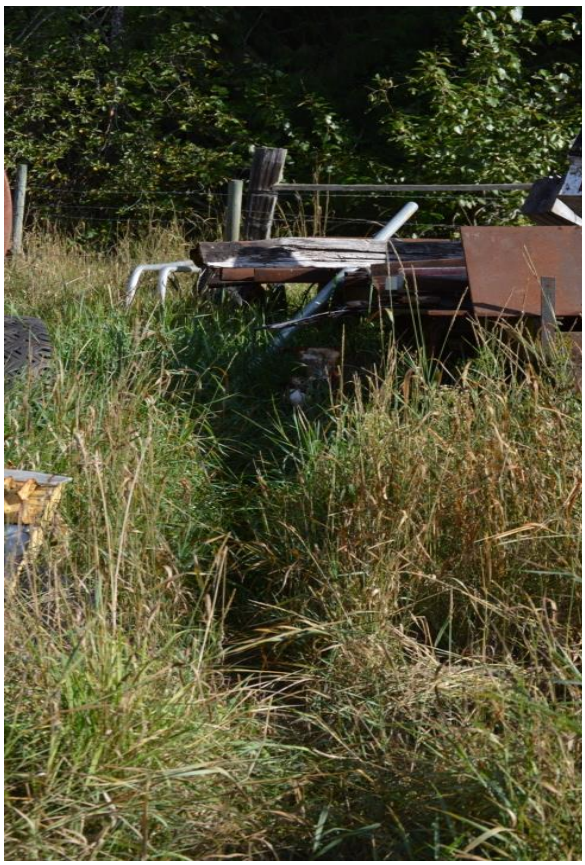
Adult livestock were not considered an issue with black bears. Two respondents ranked black bears being attracted to neonate calves as the third biggest attractant on their farms. One respondent noted that they lost a 4 day old calf to a black bear this summer.

Figure 9. Rank of attractants drawing black bears to farmlands in Pemberton Meadows



Picture 6. Adult female black bear with yearling cub feed on spilled oats on a farm in Pemberton Meadows

A significant amount of oats were spilled from the grain silos at this farm and it was apparent that the bears had been using this food source for quite some time.

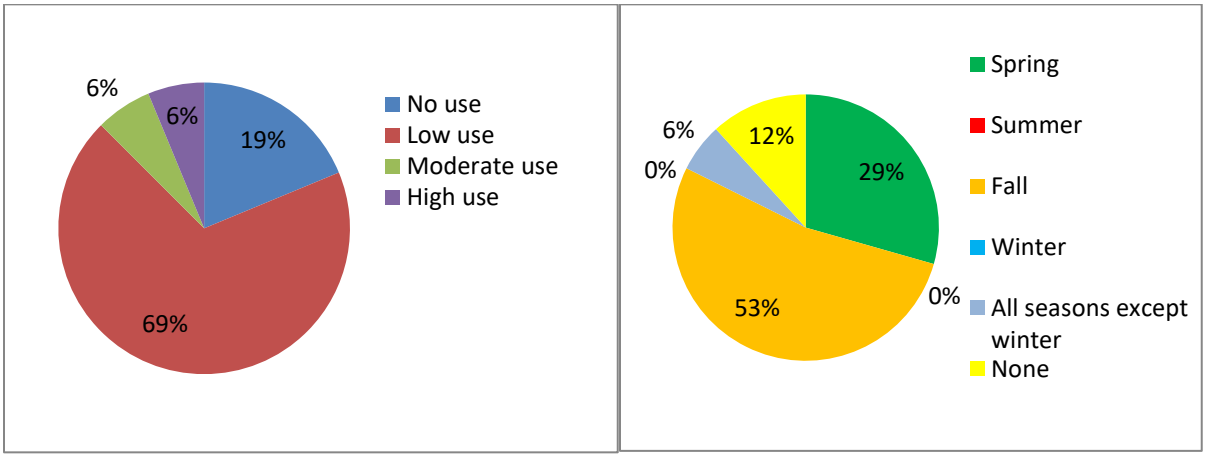


A well-used bear trail leads from the oats to the forest

Electric fencing had once been installed but was currently non-operational

Grizzly bears were reported to have low use of resident properties (Figure 10). Most often respondents reported sign of grizzly bears, particularly tracks, but rarely saw the bear. Only one resident reported high use of their property by grizzly bears. The property was a large farm in the Upper Pemberton Meadows that backed directly onto the Camel's Back route. The respondents knew the Camel Back was an active bear corridor and stated that they preferred grizzly bears over black bears because they believe they cause less damage to their farming operation. They noted that grizzly bears have eaten black bears in the corridor. In accordance with the data gathered on the SC and SL research projects, residents noted that grizzly bears were more common in the fall followed by spring (Figure 10).

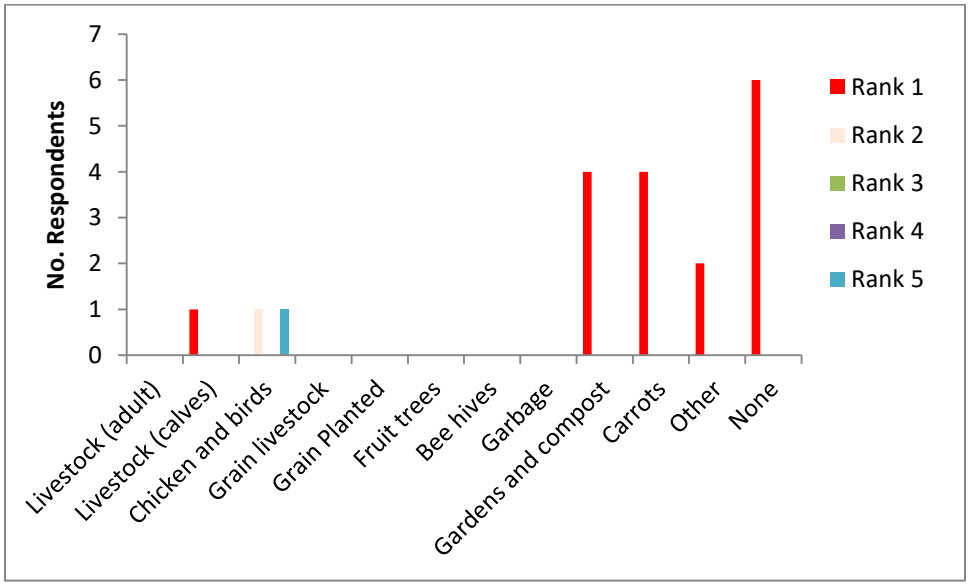
Figure 10. Resident reports of grizzly bear use of their property in Pemberton Meadows



When asked about the primary conflict types with grizzly bears six (37.5%) of the respondents stated that they did not have any conflicts with grizzly bears (i.e., rank all that apply, 1 being highest conflict type and N/A being no conflict; Figure 11). However, some of the residents that reported no conflicts also told stories about grizzly bears on their property; in one instance I was told that a grizzly bear killed 3 alpacas last year (2018), which was not in the PWOR reports.

The primary issue respondents noted with grizzly bears on farmland was damage to gardens and composts (25%) and carrot crops (25%) both for commercial and local sale; two respondents ranked both gardens and carrots as receiving the most damage by grizzly bears (Figure 11). Grizzly bears were reported to favour carrots and could do significant damage to carrot crops. Organic fertilizer made with fish guts was noted to be an extreme attractant for grizzly and black bears (other). Although the fertilizer was preferred by the farmer it was no longer used because of its ability to attract bears.

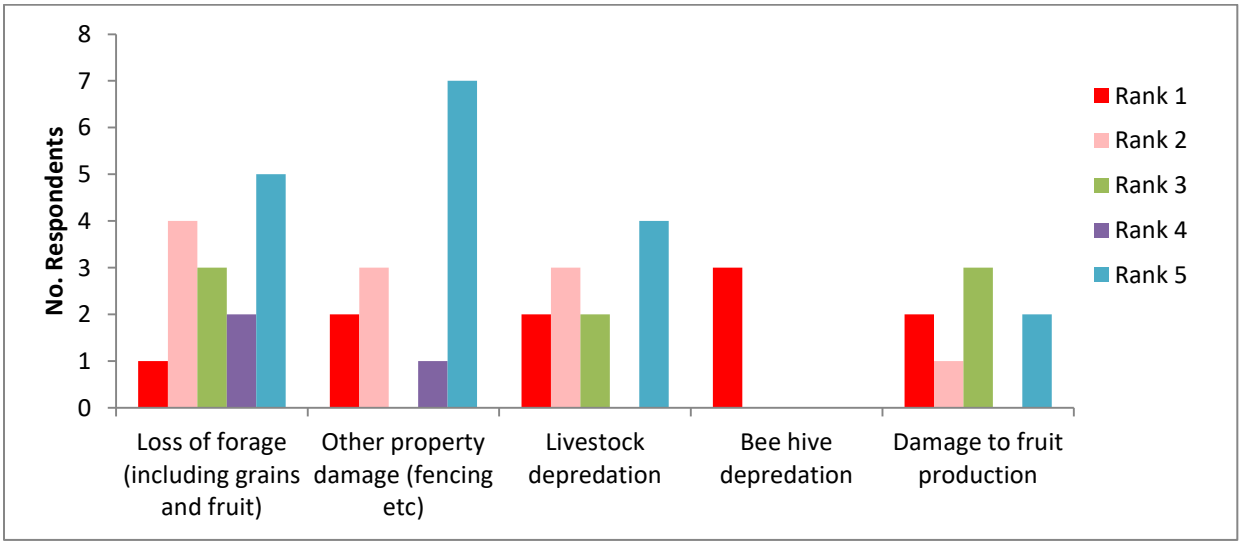
Figure 11. Rank of attractants drawing grizzly bears to farmlands in Pemberton Meadows[1].



[1]*A rank of 1 corresponds to the highest conflict type with grizzly bears, while a rank of 5 is the lowest conflict type. Not Applicable was also an option for respondents.*

Respondents were asked to rate the challenges bears create on their land, with 1 representing a "significant challenge" and 5 representing "not a challenge" (Figure 12). Different respondents experienced different challenges and the number one ranked challenge varied accordingly. For example, depredation to bee hives ranked as the biggest challenge for three of the respondents but did not rank at all for the remaining 13 surveyed, likely because they did not have apiaries. Five of the respondents felt that the loss of forage was not a challenge (rank 5), while 4 respondents ranked it as the second biggest challenge. The challenges with grizzly bears varied according to what the farm was producing.

Figure 12. Rank of the challenges bears create for farm owners in Pemberton Meadows



Challenge	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	N/A	No. Respondents
Loss of forage (including grains and fruit)	1	4	3	2	5	1	16
Other property damage	2	3		1	7	3	16
Livestock depredation	2	3	2	0	4	5	16
Bee hive depredation	3	0	0	0	0	13	16
Damage to fruit production	2	1	3	0	2	8	16

When asked whether there were negative economic impacts from the presence of wildlife on their property 56% of respondents answered 'yes' while 44% answered 'no.' Respondents were then asked to estimate the monetary loss by bear species (Table 7). Black bears were reported have caused losses up to $7,500, but the majority estimated their losses due to black bears around $1,000. For grizzly bears, the majority reported no monetary losses (69%), but one farmer that lost some cattle reported losses of >$10,000 (Table 7).

Table 7. Estimated monetary losses to resident related to black and grizzly bears

Monetary Loss	Black Bear (*n*)	Grizzly Bear (*n*)
$0	13% (2)	69% (11)
$1-$1,000	38% (6)	6% (1)
$1,001-2,500	13% (2)	6% (1)
$2,501-$5,000	25% (4)	6% (1)
$5,001-7,500	13% (2)	6% (1)
$7,501-10,000	0	0
>10,001	0	6% (1)
	100	100

Respondents were also asked about any positive economic impacts as a result of having either species of bear on their land. The majority (81%, *n* = 13) did not see any positive economic impacts from having bears on their properties; only 19% (*n* = 3) felt the presence of bears on their land had positive economic impacts.

The next part of the survey examined if conservation measures were in place within current operations and the attitudes towards various conservation initiatives. Forty-four percent (*n* = 7) surveyed reported that wildlife management and/or conservation goals were included in included in their farm plans, while 56% (*n* = 9) did not plan for wildlife or conservation. Fifty percent of respondents thought that wildlife conservation measures would be compatible with their farm, 31% were neutral (neither compatible nor incompatible), 12.5% stated they would be very compatible and 6% (*n* = 1) felt the question was not applicable to their situation since they did not operate a commercial farming operation.

I next wanted to know what, if any, deterrent methods were being used to dissuade bears from the stated attractants. The primary method used by residents to deter bear access to an attractant was electric fencing (Table 8). A common response across those that have used electric fencing was that they baited a wire with an attractant (e.g., sardines) to lure the bear to touch the wire with its tongue thereby receiving a substantial shock. Those that had baited a wire reported high success rates with electric fences. Electric fencing to exclude bear entry was reported to be used on chicken coops, grain storage areas, and gardens (Picture 7); however, during the assessment none of the fencing, except on some farms one high strand around a cattle or horse paddock to keep those animals contained, was operational.

Table 8. Bear deterrent methods used by residents of Pemberton Meadows.

Deterrent Method	Response Rate (*n*)
Electric fencing	69% (11)
Bear resistant garbage receptacles and/or storage	56% (9)
Livestock guard dogs	50% (8)
Animal husbandry	38% (6)
Bear resistant grain receptacles	38% (6)
Bear spray	25% (4)
Landscape planning planting	25% (4)
Supplementary feeding	19% (3)
Acoustic devices	6% (1)
Supplementary planting	0
None	6% (1)
Other	0

Picture 7. Electric fencing of a chicken coop on a farm in Pemberton Meadows

Although there was relatively fresh bear scat by this chicken coop at present bear problems were not occurring and the wire was not installed.

Fifty percent of respondents relied on dogs to patrol their property and deter bears (Picture 7). Very few of those dogs were breeds specific to guard livestock (Picture 8). The vast majority appeared to be mixed large breed dogs that the owners stated were good at chasing and intimidating bears. It appeared that most surveyed had more than one dog. Informal discussions revealed that none of the dogs were reported to have brought the bear back to the owner when a confrontation occurred.

I found no evidence of bears accessing garbage in the mid-upper meadows area (survey area focal point). If waste bins were present they were of the bear resistant variety and during the assessment all bins had their lids closed and arms locked in place. This is unlike the lower meadows area closest to the Village of Pemberton where the urban planning is more apparent and a number of unlocked bins were recorded at the ends of driveways. In the mid-upper areas I did not record any open or unlocked residential or commercial garbage bins.

I asked residents if they would consider using certain deterrent methods if they were not yet using them. Interestingly, the five additional respondents that were not using electric fencing said they would consider its use (Table 9). Five respondents would also consider using acoustic devices (31%). Six (38%) of respondents felt what they were currently using was adequate and they would not consider using other methods. Four respondents (25%) would like to use bear resistant grain receptacles.

Table 9. Number of residents that would consider using these bear deterrent method

Deterrent Method	Response Rate (*n*)
Electric fencing	31% (5)
Bear resistant garbage receptacles and/or storage	13% (2)
Livestock guard dogs	19% (3)
Animal husbandry	6% (1)
Bear resistant grain receptacles	25% (4)
Bear spray	13% (2)
Landscape planning planting	13% (2)
Supplementary feeding	6% (1)
Acoustic devices	31% (5)
Supplementary planting	13% (2)
None	38% (6)
Other	13% (2)

I then asked if they would recommend any conservation programs and/or deterrent methods that they have used to their neighbours. Sixty-nine percent (*n* = 11) of respondents would recommend specific deterrents or conservation tools to other landowners, 25% (*n* = 4) would not, and 6% (*n* = 1) had no opinion. I did not formally record what deterrent method was most recommended but it appeared to be electric fencing and guard dogs.

Picture 8. Karelian Bear dogs at the Hops Farm

The Hops Farm lies adjacent to the Salmon Slough and runs along the Lillooet River. It uses a well-known breed of bear dog to protect the property and people, the Karelian bear dog.

Respondents were asked what conservation tools they had used within the last 10 years. Sixty-three percent (*n* = 10) had not used any of the programs available to them (Table 10). Five respondents (31%) had, or were in the process of achieving, an Environmental Farm Plan. One farmer, on their own initiative, fences their cattle out of water sources.

Table 10. Resident use of conservation tools that are available to farmers in Pemberton Meadows, BC.

Programs	Response Rate (*n*)
None	63% (10)
Environmental farm plan	31% (5)
Technical assistance/ conservation officer	13% (2)
Grant	6% (1)
Conservation easement	0
Direct compensation payments	0
NGO conservation program	0
Private investment	0
Provincial program (e.g., BCCF)	0
Federal program	0
Other – fenced cattle out of water sources	6% (10)

The final question was aimed at determining resident attitudes towards wildlife conservation. The overall attitude appeared to be that conserving wildlife was the right thing to do regardless of whether or not the farmer benefitted financially. Interestingly, the respondents that did not think wildlife conservation was a priority for them still felt that it was the right thing to do.

Table 11. Resident values in regards to wildlife conservation in Pemberton Meadows

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	*n*
Wildlife conservation is economically good for me	19% (3)	31% (5)	37.5% (6)	0	12.5% (2)	16
Wildlife conservation is the right thing to do	69% (11)	31% (5)	0	0	0	16
Wildlife conservation is an important part of being a good neighbour	37.5% (6)	62.5% (10)	0	0	0	16
Wildlife conservation is a high priority for me	50% (8)	25% (4)	12.5% (2)	12.5% (2)	0	16

The number of respondents is provided in brackets

3.2.1 Bear Reports by Landowners/Managers

The lack of PWOR reports for grizzly bears meant that grizzly bears had largely been displaced from the meadows or that residents were not reporting grizzly bear sightings. Survey respondents told many stories of grizzly bears. Historically, grizzly bears were considerably more common in the meadow area than today. For example, in 1960, a grizzly bear family unit was shot because they were feeding on cattle and their pelts marketed (Pic. 9, B. Miller pers. comm.); during this time, there was no conservation concern for the grizzly bear population.

Picture 9. Hides of an adult female grizzly bear and her two cubs hang from the barn at the Miller farm, 1960

Photo: ©B. Miller used with permission.

I examined Naylor (2012) to gain an understanding of grizzly bear use of the valley during a time when humans were still expanding their settlement. In the 1980s and 1990s, "traditional animal husbandry practices in the valley included disposing of beef carcasses on the outlying farm areas where they were readily available to hungry bears." Grizzly bears were known to use the many beef 'bone yards' located "on the margins of farm pastures."

The following passage reveals the effect of the expanding human settlement on the SL and SC grizzly bears:

> In the 4 years from 1988 to 1991, nine grizzlies in the Pemberton area were killed or relocated. Grizzlies had become increasingly habituated to farm life (for reasons already stated) and the local farm community was demanding action or the bears would be at the mercy of local vigilantes. Bear raids on root crops and especially Michael and Julia Ross's carrots as well as scavenging of beef carcasses were common. Whether the bears were actually preying on live animals is still a matter of some local debate (Naylor 2012:3).

One story that was particularly popular among residents was of and adult male grizzly bear named "Winston[4]". On 28 Oct 1991, snares were set near a calf carcass that was thought to have been killed by a bear. Trapping resulted in the capture of two bears, a ~300 lb female and a ~800 lb male. The male bear was named Winston and estimated to be 15 years old. An incredible story of relocations and homing (returning to the meadows) developed around Winston[2] and he was even translocated to a "western tributary of the Fraser River, 20 km north of Boston Bar, 220 air/km west of Pemberton." Winston continued to return to the Meadows and in 1999 an old male believed to be Winston was destroyed for killing turkeys on a farm in Pemberton Meadows (Naylor 2012). Interestingly, *there are no reports in the PWOR or CI databases regarding a grizzly bear killed within the meadows in 1999*.

Reports indicate that grizzly bears were historically more common in the meadows than today; however, at present the SL Ryan River and SC MM populations are expanding. The cover photo of this report is a remote camera picture of a grizzly bear foraging on a cow on a Mowich Creek farmland property, 2016 (Picture 10). This male grizzly bear originates from the Upper Lillooet study area as identified through DNA (Rochetta pers. comm.).

Picture 10. 2016 remote camera image of a grizzly bear feeding on a bovine carcass, Pemberton Meadows.

Photo: ©Bryce Ronayne used with permission.

[4] For a full account of Winston's story, please refer to Nayler 2012.

Although not reflected in the PWOR database, grizzly bear sightings are becoming more common in the meadow area. Grizzly bear sightings and/or grizzly bear sign (tracks) were noted by a number of the survey respondents. I was told of an adult female grizzly and cubs that used the Oxbow Lake area the spring of this assessment (2019).

In late August 2019, one respondent informed me that "their" grizzly bear has made his annual appearance and had been "in the carrot patch for the past four evenings." The resident gathered a hair sample that was submitted to the SL-GBRP for DNA analysis.

In the fall of 2019 (Nov) hikers reported sighting a grizzly bear in the lower Samon Creek area. They noted fresh excavations in the ground and bear scat. The sighting falls within the Samson Creek 2 Grizzly Bear Wildlife Habitat Area, which is also part of the proposed linkage plan.

3.3 Linkage Results

3.3.1 How Grizzly Bears are Using Pemberton Meadows

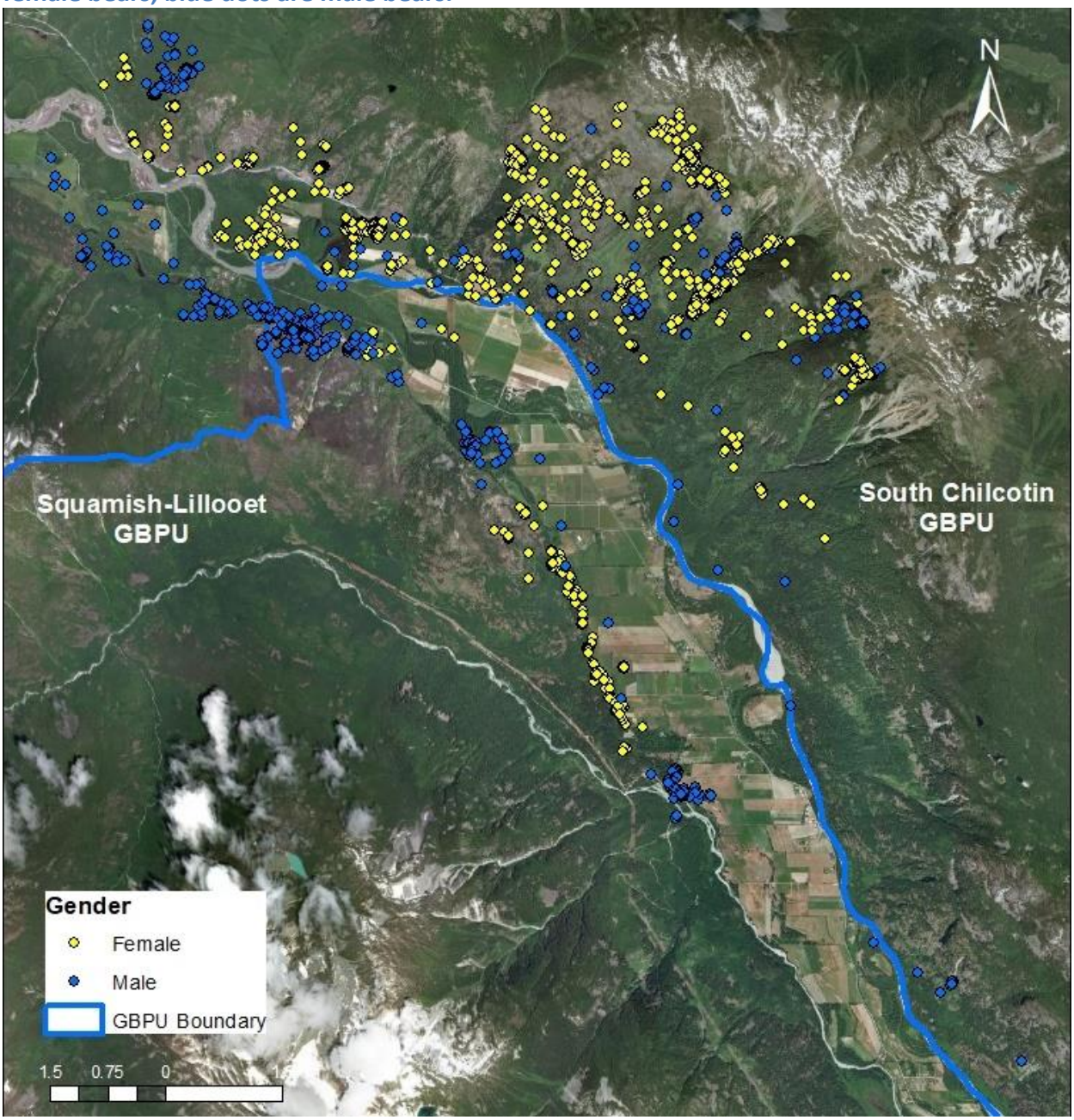
The Squamish-Lillooet grizzly bear research project (SL-GBRP; Rochetta pers. comm., Apps et al. 2014), and the South Chilcotin grizzly bear research project (SC-GBRP; McLellan 2007), monitored GPS-collared grizzly bears that used the Pemberton Meadows area (Figure 13). The location data presented is provided courtesy of those research projects and was used to examine the movement of bears in and around the Meadows.

The SL-GBRP monitored an adult female with two yearlings that descended the Ryan River drainage to the base of the agricultural lands in the Meadows in spring 2011. This family unit primarily remained within the band of forested habitat located at the base of Mount Ross and Camel's Back Mountain (i.e., back edge of the agricultural properties); they did not appear to venture far from the base of the mountains or into the agricultural areas. In fall, they again used the Ryan River area, primarily sticking to the forested edge of the lower Camel's Back / agricultural areas, eventually crossing Pemberton Meadow around the Wetland Management Area (i.e., Oxbow Lake corridor), and crossed the Lillooet River to the Oxbow Lake area. From the Lillooet/south meadows, grizzly bears appear to cross the valley to access Ryan Creek to the south and Tenquille Creek to the north. Tenquille Creek contains huckleberries, which is a critical food source for grizzly bears in the fall. Maintaining safe access to these different habitat types is important for bears because they provide high-quality forage according to the season. What's apparent from the SL-GBRP location data is that adult females did not appear to venture out into the cleared agricultural areas of the meadows. Instead, the family unit using the south side of the Lillooet stuck close to the lower ridge line following the base of Mount Ross and the Camel's Back. Male bears also relied heavily on the forested areas of the lower ridges; however, they were bolder and occasionally ventured into the open agricultural fields.

Originating from the SC/north meadows, the GBRPs monitored four adult grizzly bears that used the Meadows: two males and two females. The two adult females were located in the Pemberton Meadows area primarily in spring (mostly May); whereas the two male bears

primarily used the Meadow area in the fall (mostly Nov), followed by spring (May). The females used the Wolverine drainage to access the Oxbow Lake area. Both of the males and one female were thought to have been using the area for fishing (Rochetta pers. comm.).

Figure 13. Grizzly Bear GPS Locations in the Pemberton Meadows area courtesy of the South Chilcotin and Squamish-Lillooet Grizzly Bear Research Projects, 2010-2012. Yellow dots are female bears, blue dots are male bears.



Data courtesy of M. McLellan and S. Rochetta

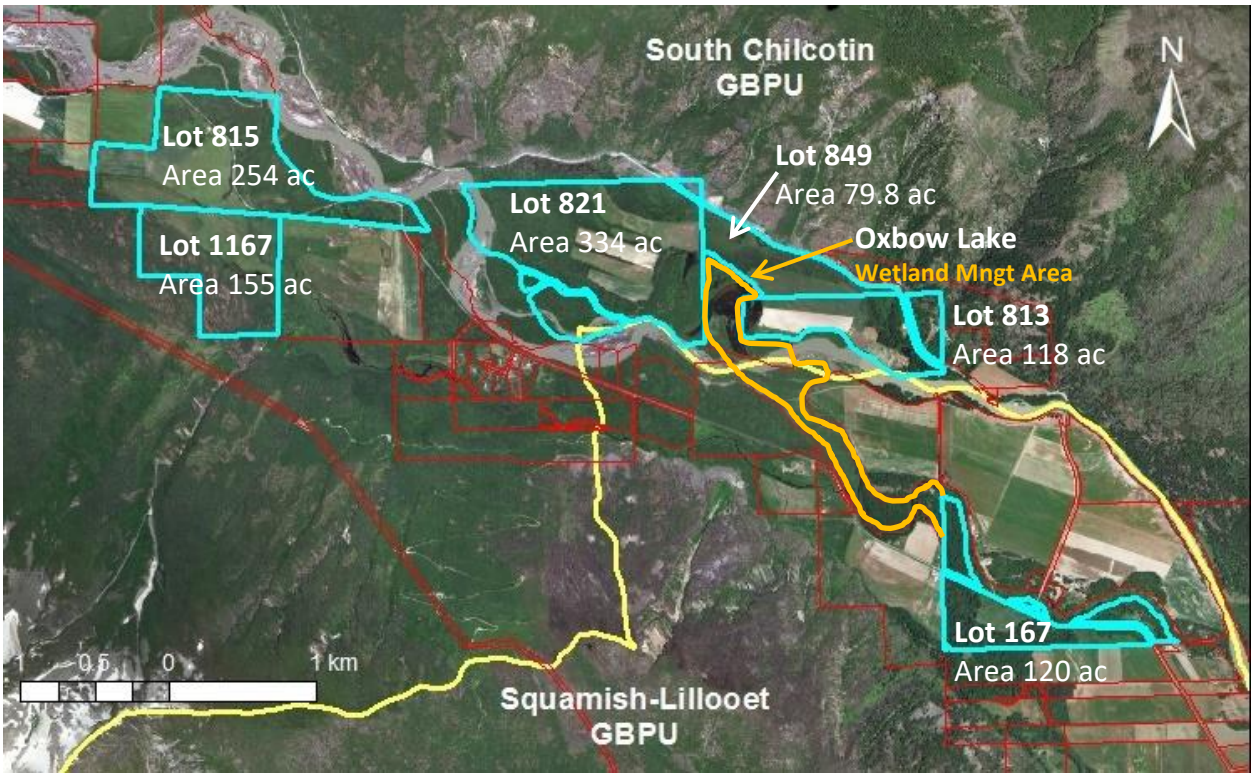
Notice how the locations on the south-west side of the Lillooet River largely stick to the mountain ridgeline, while the locations on the north-northeast side are in the alpine/subalpine and descend down the drainages to the Lillooet River.

3.3.2 Recommended Properties and Conservation Agreements to form a Linkage Zone

To enhance grizzly bear movement across Pemberton Meadows, and therefore across the SC and SL GBPUs, I recommend a *combination of Property Purchases and Conservation Easement/Agreements.*

The 4 properties for consideration of purchase are: Lot 167; Lot 821; Lot 1167; and, Lot 815 (Figure 14). Lot 821 is on the north side of the Lillooet River, while Lots 167, 1167 and 815 are on the south side.

Figure 14. Recommended properties to form a Conservation Linkage Zone for the purpose of augmenting grizzly bear movement across the SC and SL GBPUs



A Conservation Agreement is a voluntary agreement where certain types of developments, whether they be recreational, resource extraction, industrial and/or real estate are restricted. In a conservation agreement the "landowner agrees to limit some uses of a piece of land to protect its natural features and the species that live there. In return, the landowner is paid or receipted for placing the agreement on their land" (NCC website).

Two separate Conservation Agreements are recommended: one is for Lots 849 and 813 on the north side of the river that are owned by the School Board; and, one for a 150-200 m easement that runs along the base of Camel's Back Ridge on the south side of the Lillooet River and involves a number of properties.

3.3.3 Oxbow Lake Corridor

North Side of the Lillooet River

The alpine habitats of Wolverine Creek contain extensive avalanche paths and provide good spring forage, such as glacier lilies (*Erythronium grandiflorum*; Picture 11); however, when snow packs persist into late spring grizzly bears may be forced to lower elevations to forage, increasing the importance of the Oxbow Lake habitat. In the South Chilcotin-GBRP, grizzly bears used the south side of Wolverine Creek to access the valley bottom. This area also contains a well-used game trail leading to the lower elevation habitats (McEwan pers. comm.).

Picture 11.Subalpine habitat important to grizzly bears in the upper Wolverine Creek drainage

Glacier lily bulbs at a grizzly bear dig site

On the north side of the Lillooet River the linkage design presented forms a connected band of properties that focus on conserving the wetland complexes leading into and surrounding Oxbow Lake. Oxbow Lake is recognized for its sensitive habitat and importance to house a diversity of species. Both grizzly bear research studies had a number of grizzly bear locations in the Oxbow Lake area, particularly in spring and fall. In the proposed linkage design, Oxbow Lake links to the Pemberton Wetland Wildlife Management Area (WMA) that continues on the south side of the Lillooet River. Cottonwood Creek runs through Lot 813 and is important salmon, trout and char habitat (Figure 14, Picture 12). Planning a linkage design around these important habitat types enlarges the conservation area and increases the probability of their use by bears.

Picture 12. Oxbow Lake and Cottonwood Creek (Lot 813), Pemberton Meadows

Oxbow Lake is high-quality habitat for grizzly bears and fish. It links to salmon bearing streams, such as Cottonwood Creek, and the Lillooet River

Lots 813 and 849 are owned by the School District and provide a buffer for the north and east sides of Oxbow Lake. The School District does not want to sell these properties, but will accept proposals for consideration for use of the land (McEwan pers. comm.). These properties encompass the bottom of the Wolverine Creek drainage and protect important Coho rearing habitat leading to Oxbow Lake. **A conservation agreement is recommeneded for Lots 813 and 849.**

- Lots 849 and 813 provide maximum conservation value by restoring and protecting a Coho spawning stream and wetland riparian complex that surrounds Oxbow Lake. Purchasing the surrounding lots would enlarge and further protect this high quality habitat on the north side of the river.
- Lot 813 protects the lower drainage of Wolverine Creek extending to Oxbow Lake.
- The C2C should partner with NCC to develop a Conservation Agreement.
    - The School Board is willing to consider proposals for the properties.
    - The Outdoor School and Heritage Village are part of these lots. These lots have multiple buildings on them which were part of the original Outdoor School.
    - The potential for habitat degradation, including fish bearing habitat, is high if thoughtful use of these lands is not considered.

Lot 821 buffers the western boundary of Oxbow Lake and provides expansive access to Lillooet River front. Lot 821 is privately owned and was recently extensively logged thereby decreasing its current value to grizzly bears. Prior to harvesting, both the SC and SL Grizzly Bear Research Studies had a number of grizzly bear locations within Lot 821, particularly surrounding the forested edge of the closed Outdoor School. Lot 821 borders Oxbow Lake, and links up the suggested Conservation Zone starting from the base on Wolverine Creek drainage extending up

the north side of the valley bottom. Lot 821 would benefit from reforestation to increase its habitat value for grizzly bears by returning the land-base to pre-harvesting conditions.

Moving towards the Lillooet River there are bands of retained cottonwoods that run adjacent to the hay fields (Picture 13). Those cottonwood habitat complexes extend to the River's edge and then occurr again on the other side of the Lillooet River. These retention bands offer bears security within quality grizzly bear habitat. Conserving these areas would also protect the high quality grizzly bear habitat that extends from ~4.5-to-6 km along the Lillooet FSR (Rochetta pers. comm.).

Picture 13. A retention patch of cottonwood extends from the north side (left) and across the Lillooet River (right) providing security cover and high-quality habitat for grizzly bears.

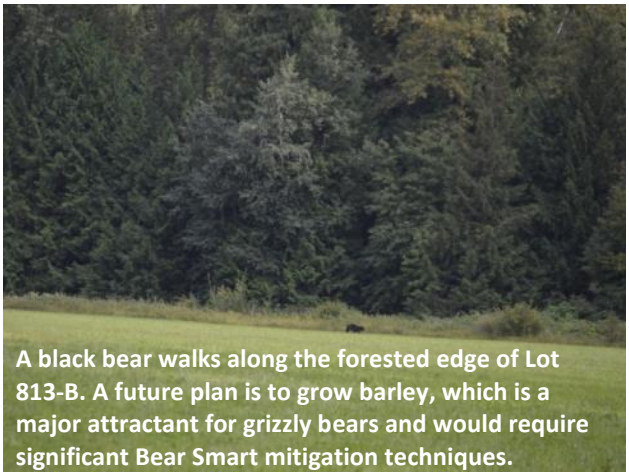
South Side of the Lillooet River

Lot 167 is on the south side of the Lillooet River. The Salmon Slough runs through Lot 167 and is a productive Coho salmon spawning and rearing stream (Picture 14). Locals refer to the Salmon Slough as the "most productive Coho salmon stream in the valley" (McEwan pers. comm.). The Lot contains extensive wetlands and is important habitat for grizzly bears, black bears, mule deer, fish and amphibians.

- Lot 167 contains critical Coho rearing salmon habitat.
- Lots 168,169 2721 and 2722 sold and are now a fully operational hops farm. The Hops farm has plans for the construction of a pub, which would increase traffic in this area.
- Lot 813-b is also owned by the Hops farm. A future plan for Lot 813-b is to grow barley for the proposed brewery. Barley is a major attractant for grizzly bears and this would require significant Bear Smart mitigation techniques. An alternate crop that does not attract bears, such as potatoes or hops, should be considered instead.
- Male bears are more likely to cross the Salmon Slough than females, particularly due to the increased traffic accessing the Lillooet FSR.
- Purchasing Lot 167 would increase the size of the Wetland Management Area providing bears a more secure travel route across the Meadow.

Picture 14. The Salmon Slough is a productive Coho salmon rearing stream

The Salmon Slough is within the Pemberton Wetland Wildlife Management Area and is productive salmonid habitat. It follows the south boundary of Lot 167 and the Hops Farm (right photo).

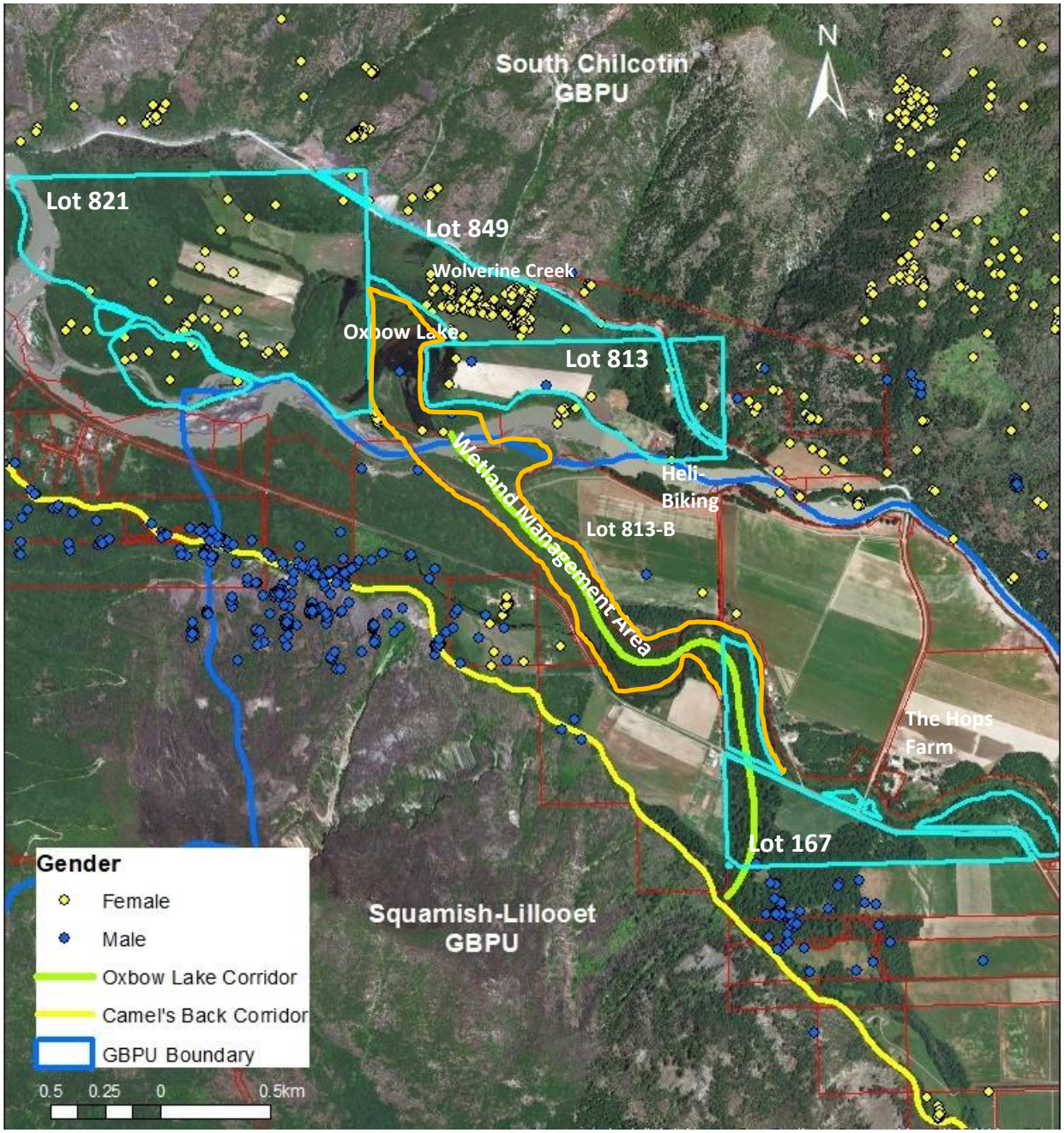


A black bear walks along the forested edge of Lot 813-B. A future plan is to grow barley, which is a major attractant for grizzly bears and would require significant Bear Smart mitigation techniques.

The design concept for the Oxbow Lake corridor, linking Tenquille Mountain (picture 15) and Tenquille Creek to the Salmon Slough, is presented in Figure 15.

Picture 15. Critical subalpine and alpine spring grizzly bear habitat with abundant glacier lily and western springbeauty on Tenquille Mountain.

Figure 15. Concept for the design of the Oxbow Lake corridor with grizzly bear GPS locations.



**GPS location data provided courtesy of M. McLellan (South Chilcotin) and S. Rochetta (Squamish-Lillooet) Research Projects.*

To utilize the Oxbow Lake Corridor bears must move directly across Pemberton Meadows in somewhat close proximity to the Lillooet FSR. The traffic accessing the Lillooet FSR is increasing; there was an active helicopter based mountain biking operation occurring within Lot 813-B, and there are plans for a pub to be constructed at the hops farm. The telemetry data gathered by the Squamish-Lillooet project already shows that some bears, particularly females, may be wary

to cross these areas at the current levels of human use and therefore a **second corridor, The Camel's Back Corridor, is recommended.**

3.3.4 The Camel's Back Corridor

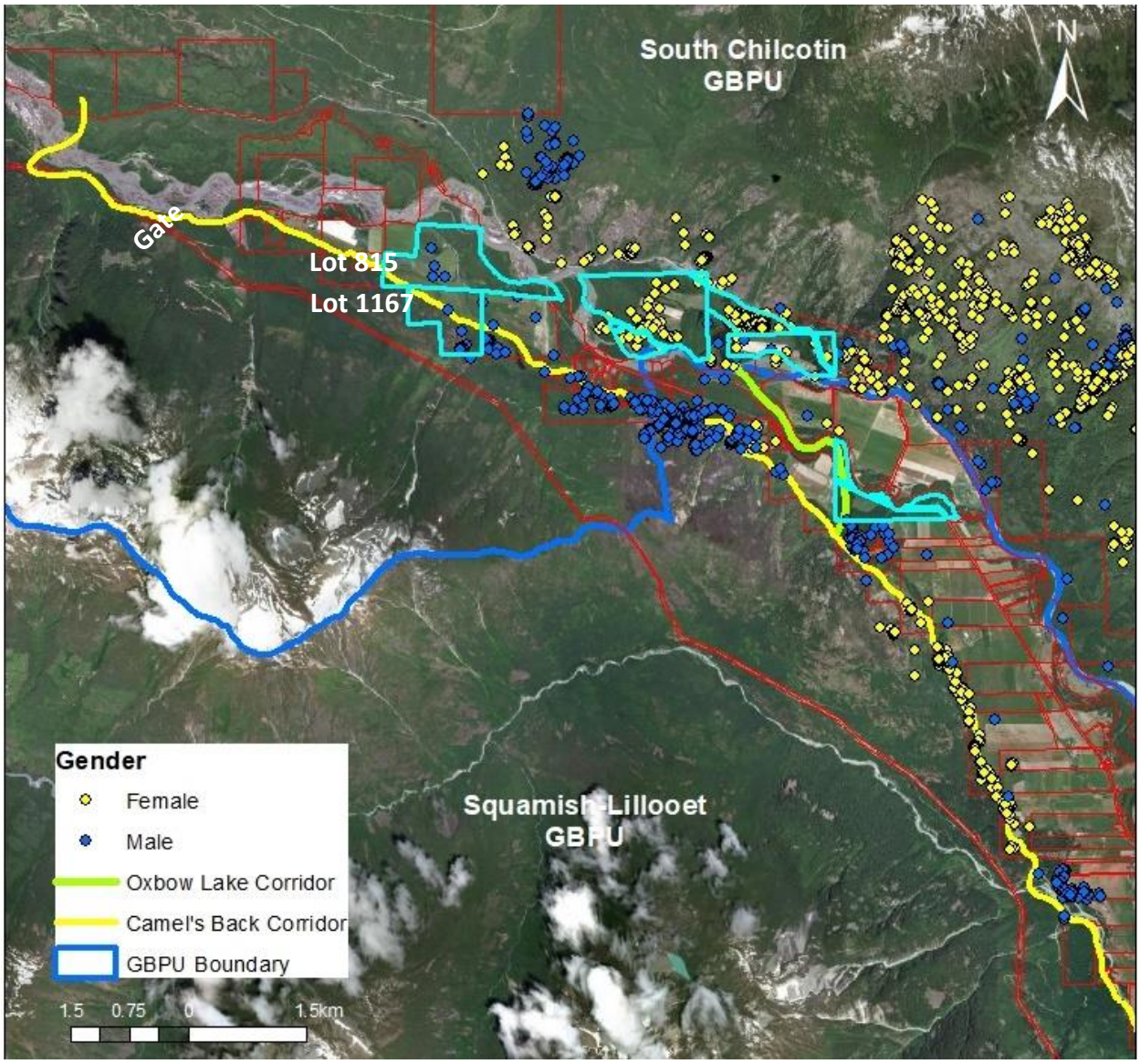
The Camel's Back corridor runs along the base of the Camel's Back Ridge and allows more wary bears a way to cross the Lillooet River by use of the Upper meadows area, where they can pass the access gate at end of Pemberton Meadow's road (Figure 16, Picture 19). The gate was installed to limit motorized human access to Mount Meager and closure dates were founded on science-based management from the Squamish-Lillooet research project (Rochetta pers. comm.). The gate is locked in spring from April 01 to 15 June, and in the fall from September 15 to November 30, when bears have a higher probability of using this area.

This design intentionally favours females with cubs by providing them access to important wetland and salmon-bearing habitat in an area that limits human use during spring and fall - the seasons when the SL-GBRP has determined that bears have a higher probability of use of those areas.

The back of multiple properties run along the Camel's Back and therefore a Conservation Agreement with landowners is recommended to preserve this natural corridor. An old forestry access road, that became a recreational x-country ski trail where in the past races were held, runs along the base of the Camel's Back and provides easy travel for bears (Picture 16). Recommended corridor width varies according to a number of site specific factors including habitat type and human use levels; some recommend a width of 100 m while others are ≥1 kilometre (Bond 2003). Highway overpasses that are designed to foster connectivity of wildlife, are known to be used by grizzly bears in Banff National Park (Ford et al. 2017); they tend to be ~60 m wide. To foster connectivity it is generally accepted that wider corridors are better than narrower ones. The conservation agreement is recommended to protect an approximately 150-200 meter width band of forested habitat along the base of the mountains. The old road has brushed-in and motorized and recreational access is no longer possible.

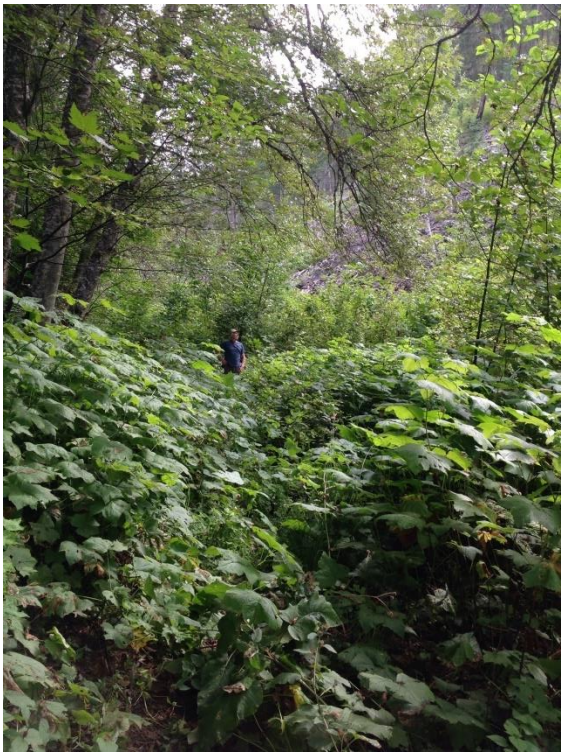
The Squamish-Lillooet research project found that female grizzly bears are expanding from the Ryan River Drainage (Rochetta pers. comm.). *The largest conservation and linkage benefit would be to establish a Conservation Agreement extending from the Ryan River at Pemberton Meadows, travelling along the base of the mountains and past the gate at the Upper Pemberton Meadows Road* (Figure 16). However, the design is flexible and benefits would be accrued even if the corridor began just south of where the Oxbow corridor meets the Camel's Back, thereby linking the mid-upper Pemberton Meadows area.

Figure 16. The proposed Camel's Back Corridor linked to the proposed Oxbow Lake Corridor. A Conservation Agreement would need to be set in place with property owners.



A short walk along part of the Camel's Back Corridor revealed the ease of travel for bears (Picture 16) and abundant bear sign (Picture 17).

Picture 16. Ease of movement & well used wildlife trail along the Camel's Back corridor



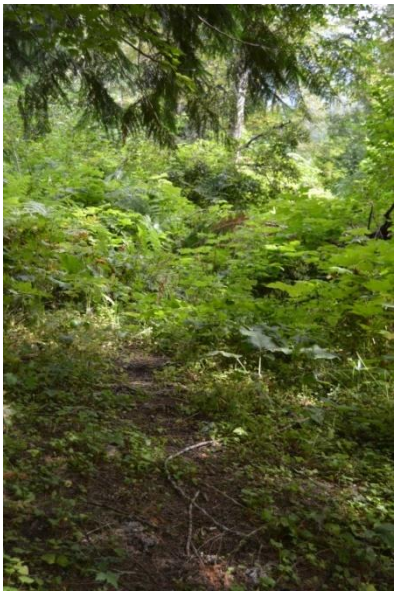
Allen McEwan stands along a bear travel route

The back fence of a farm property backing onto the Camel's Back corridor (upper). The barbwire contained clumps of what is thought to be bear hair (lower).

Picture 17. Examples of the abundant bear sign located along the Camel's Back Corridor

Black bear paw prints

Claw marks



Wildlife Trail

One of many bear mark trees located along the Camel's Back corridor. Note the brown coloured bear hair.

Evidence of a bear foraging for ants and ant larvae in a rotting log.

Possible black bear den site high up in a cottonwood tree.

Bear bed with scat. Bears rest in the circular depression

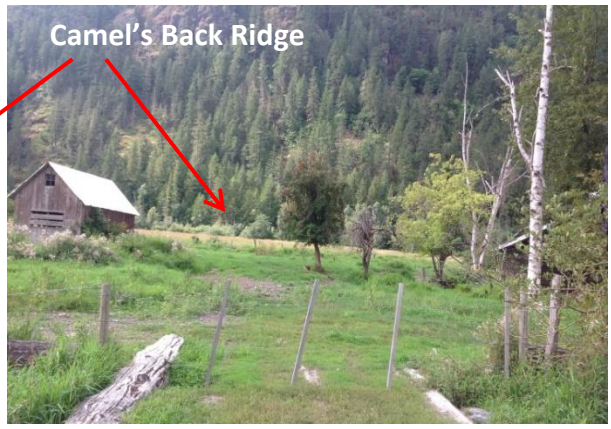
Scats are often associated with beds

During the site visit there were two Lots listed for sale: Lot 1167 and Lot 815 (Figure 16, Picture 18). The two lots are owned by one family and together these lots form “Echo Ranch” (aka Legacy Ranch). The Lots extend from the base of the Camel’s Back ridge, which is a natural movement corridor for grizzly bears, across Pemberton Meadows Road, and provide access to extensive River front via Lot 815. In their current state these Lots are largely deforested and are used for cattle grazing and hay production. There are some retained cottonwood stands but these would need to be reconnected and overall the Lots would benefit from reforestation and rehabilitation of wetland habitats.

- Lot 1167 and Lot 815 are currently for sale. Their placement in a more rural part of the upper Meadows offers linkage options for bears that may be wary of crossing at the busier Oxbow Lake crossing.

Picture 18. The Echo Ranch property extends from the base of Camel’s Back Ridge, across Pemberton Meadow’s road, to the Lillooet River.

Cows lick a salt block under a crab apple tree heavy with fruit near the edge of Camel’s Back Ridge on Echo Ranch



The river front portion of Lot 815 had a moderately steep bank down to the river (pictured below). Although bears could cross at this location the probability of crossing is lower because there are easier places for them to cross further up the valley.

The islands of retained cottonwoods provide good security cover and habitat for bears.

The area selected for a higher probability of a grizzly bear crossing the Lillooet River is ~1.4 km after the gate where the river bank slopes gently to the river front (Picture 20). On the south side of the River it crosses the beginning of a 248.2 ha, Lillooet #3, Grizzly Bear WHA that is listed as a no harvest zone (Figure 18). The crossing point itself is a braided channel offering some islands of treed and secured habitat. The grizzly bear WHA on the north side of the river is Samson #1, which is a 479.8 ha no harvest zone. Lot 813 also extends to the Lillooet River front and is immediately adjacent to the Samson Creek #2 Grizzly Bear WHA, which is a 157.9 ha no harvest zone. The Oxbow Lake / Wolverine Creek area borders a 3,215 ha Spotted Owl Wildlife Habitat Area and contained a number of GPS locations obtained by the South Chilcotin GBRP. The location of the WHAs compliment the Oxbow Lake and Camel's Back corridor design.

On the north side of the river a ~28 year old burn on Tenquille Creek has regenerated into productive and abundant huckleberry habitat. The Tenquille Creek gate is closed to block motorized access during berry season (15 July-30 Oct) thereby making the area more secure for bears to use the north slopes to forage on berries.

The proposed design capitalizes on linking two areas that use gates to control motorised access: the South Lillooet FSR and Tenquille Creek. Both are science-based management closures with the dates corresponding to higher probabilities of grizzly bear use.

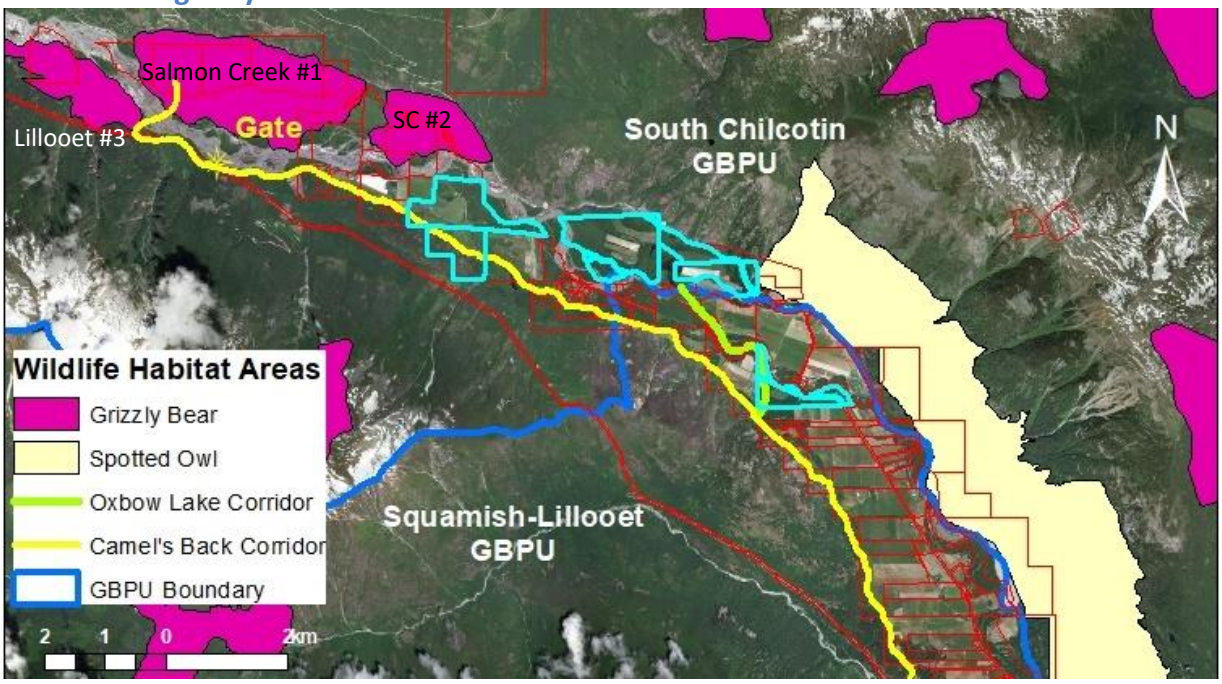
Picture 19. Gate at upper Pemberton Meadows road that is used to control motorised access to Mount Meager

During closure the boulders on either side of the gate discourage people with motorized vehicles from going around the gate.

Picture 20. Potential crossing point of the Lillooet River for grizzly bears

The gently sloping bank, lower water levels, braided channels and patches of retained forested habitat are all features that make this area favourable to grizzly bear crossing.

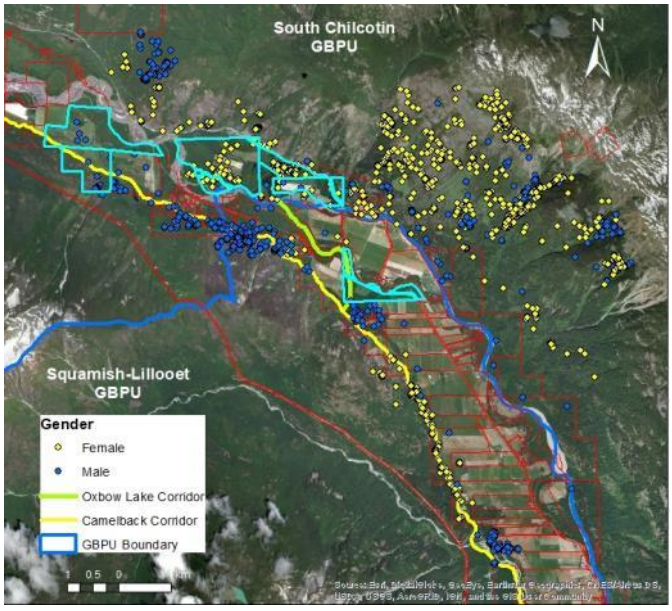
Figure 17. The location of designated Wildlife Habitat Areas increases the secure habitat available for grizzly bears.



The Upper Pemberton Meadows area is more secure for grizzly bears due to the low human resident population and the Mount Meager access closure gate. The dates of closure are specific to grizzly bears and are science-based (Rochetta pers. comm.).

The proposed linkage design fits nicely with the telemetry locations gathered by the South Chilcotin (M. McLellan) and Squamish-Lillooet Grizzly Bear Research Studies (Figure 19).

Figure 18.Grizzly bear GPS locations in relation to recommended property purchases and conservation agreements.



3.3.5 The Landscape Scale Conservation Linkage Plan

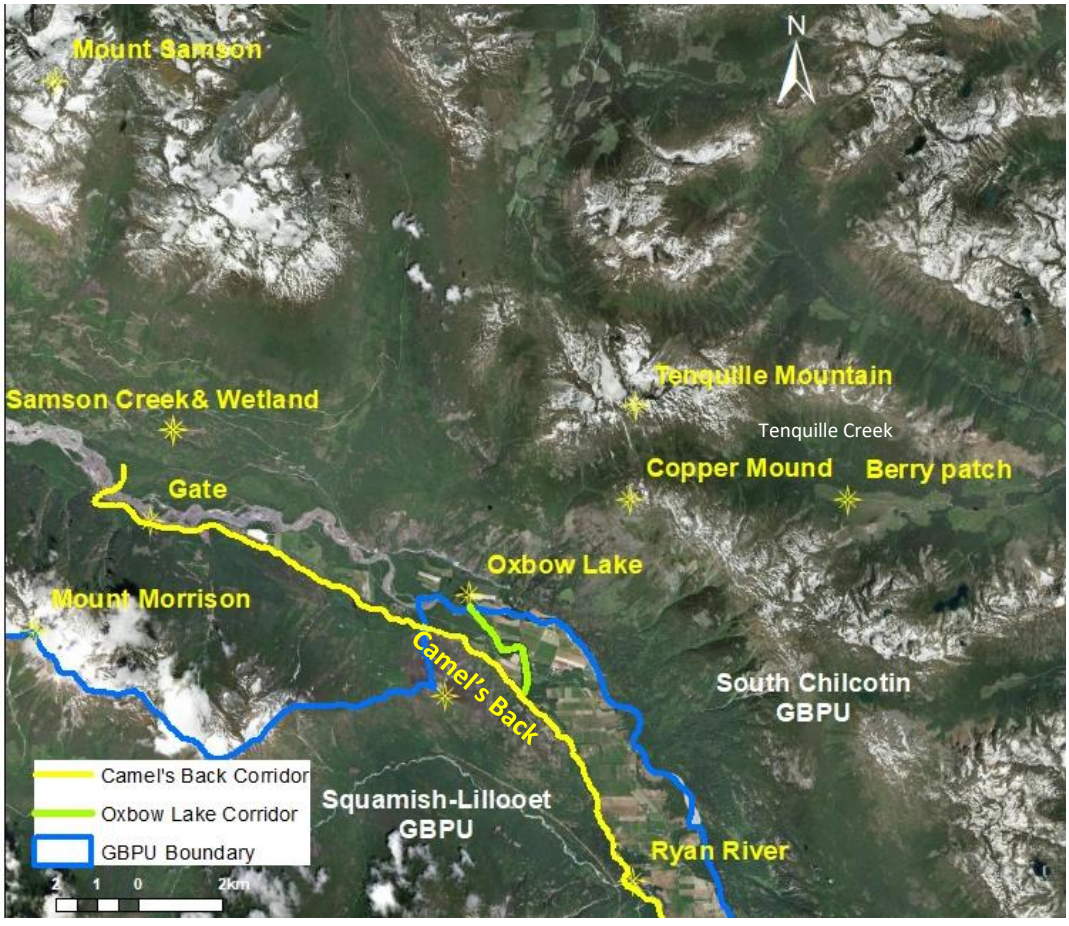
Upper Pemberton Meadows Crossing

The Camel's Back corridor allows bears access to critical habitat types to the north (Samson area), east (Tenquille area) and west (Morrison & Meager) surrounding mountains. The Camel's Back corridor provides a Ryan River-Tenquille linkage zone ~1.4 km northwest of the upper Pemberton Meadow's road gate (Figure 19); bears may then remain west to access Mount Meager or cross from the south side to the north side of the Lillooet River. The Tenquille area contains high elevation, high quality spring habitat (e.g., glacier lily) as well as abundant fall huckleberries, which are critical food source for these populations (Rochetta & M. McLellan pers. comm). Bears may also cross the Lillooet River to access the productive Samson wetlands.

Mid-Pemberton Meadows Crossing

The Camel's Back corridor also links to the Oxbow Corridor; this provides bears with more options to safely use habitats and to cross GBPU boundaries. Samson Creek forms a wetland-riparian habitat complex and those habitats are selected for by bears (Picture 21). On a larger landscape scale this design allows for bear movement North-South via Tenquille Mountain – Tenquille Creek - Samson Creek – Oxbow Lake and cross the Lillooet River using the productive sockeye and Coho wetland habitat.

Figure 19. Tenquille Mountain to Ryan River Corridor concept design



Picture 21. Samson Creek's productive wetland habitat encompasses Samson Creek #2 Grizzly Bear Wildlife Habitat Area

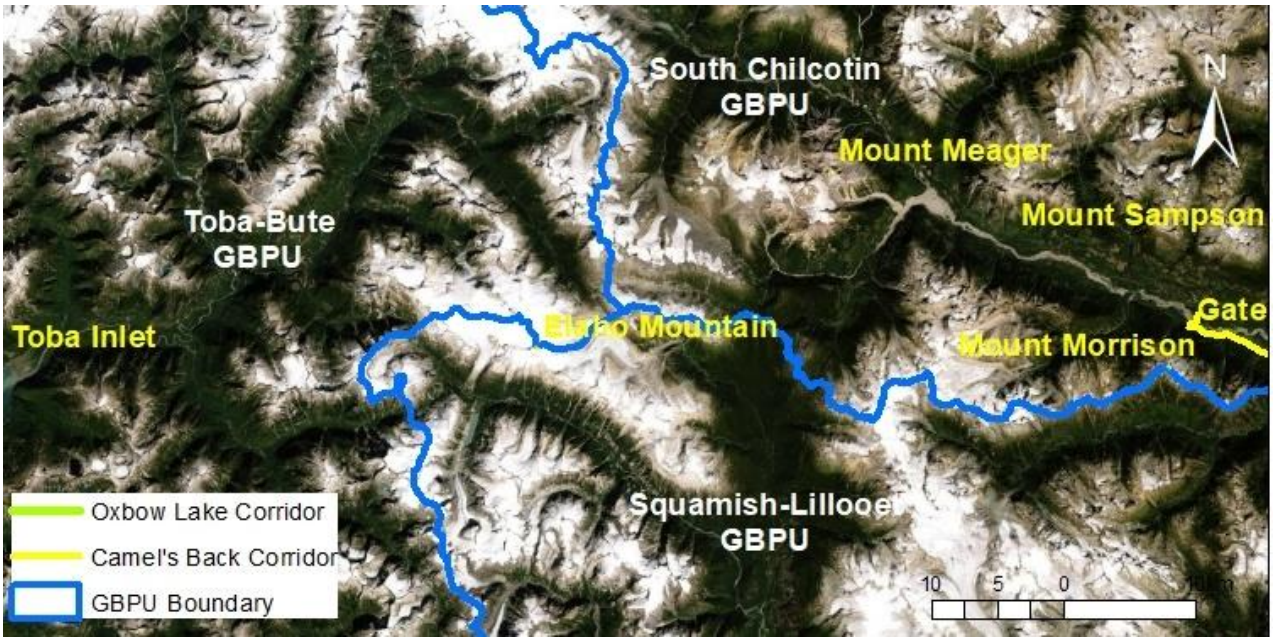
The proposed design allows bears to remain on the south side of the Lillooet River using the Camel's Back to pass the access closure gate where the bear then has the ability to continue to travel west or it can cross the Lillooet River to utilize habitat to the east (Ryan-Tenquille).

Picture 22. Looking down on the Camel's Back with Ryan River in the background

Toba-Bute Access

If bears remain on the west side of the Lillooet River, the corridor allows for connectivity to flow between Mount Meager, connecting southwest to Elaho Mountain and Valley, and ultimately it could provide a linkage zone to Toba Inlet within the Toba-Bute GBPU (Figure 21). This is biologically important for grizzly bears in this area because the Toba-Bute GBPU is Viable and those bears may help support the grizzly bears in the bordering SL and SC GBPUs.

Figure 20. The end of the Camel Back's corridor is northwest of the access gate that has spring and fall closure dates based on results of the Squamish-Lillooet grizzly bear study. This allows bears to utilize larger-scale linkages such as, the Mount Meager - Elaho Valley - Toba Inlet areas.



3.3.6 Re-stablishing the Link and Restoring Movements across the Valley

A number of properties within the mid-to-upper Pemberton Meadows area contain highly sensitive habitats, including riparian benchlands, wetland marsh, and wetland shallow water habitat types. These wetland-riparian complex habitats are known to produce high-quality bear forage items and, when healthy and functional, are able to house a diversity of species, such as amphibians, reptiles, birds and invertebrates.

- The location of these properties provide animals with key refugia habitats, that is, the negative effects of disturbance in the valley would be lower in these areas than the surrounding area thereby affording safer travel.
- Animals could move with increased security crossing the Lillooet River in both directions offering at least two points of safer passage.

- The habitats put forward are already selected for by a number of species, including grizzly bears.
- The habitats suggested contain an abundance of wetlands and sloughs and are rearing grounds for salmonids. Habitat restoration would be beneficial for salmonid stocks.
- The Camel's Back corridor should offer female grizzly bears, particularly those with cubs, security to move up and down the meadow as well as to cross GBPU boundary at a safer/less human influence area past the Upper Meadow's gated access.
- Conservation of the proposed properties promotes area biodiversity, aquatic habitat protection and conservation of At-Risk species including grizzly bears, spotted owls, Coho and several species of birds and amphibians. Black bears and mule deer also use these properties. Mountain goats may be commonly spotted. The purchase of these properties would hold significant conservation value for the entire Pemberton Meadows valley.

In October 2020, M. McLellan will be conducting a quantitative linkage analysis by modelling the grizzly bear location data gathered on both the SC and SL GBRP. That work will elaborate on grizzly bear habitat use and movements across the SC and SL GBPUs.

3.4 Ecological Bear Traps Noted for Pemberton Meadows

Grizzly bears are beginning to expand their range from the Ryan River drainage in the SL-GBPU and the McGillivray Mountains in the SC-GBPU. This Bear Hazard Assessment supports that expansion and proposes a design that attempts to foster bear movement in certain key, secure habitat areas – that is, along the mountain ridgeline on the west side of the Lillooet River (The Camel's Back, Ryan-Tenquille linkage) and directly across the mid-upper meadow area (Oxbow Lake linkage). The focus of this section is to identify the ecological traps for bears that exist in the Meadows in order to implement mitigation measures. Mitigation measures should be in place before grizzly bear use of the Meadows increases because the intention is to dissuade the development of "problem" bear behaviour before it occurs.

As previously mentioned, the primary conflict type(s) differs between the lower meadow area that is closest to the Village of Pemberton and the mid-to-upper meadows. For example, the mid-upper meadows did not have issues with residential or commercial garbage maintenance; however, in the lower meadows, where urbanization was making its way up the valley from the VOP, issues with residential and commercial garbage management and unkempt fruit trees were noted.

The mid-upper meadows area has a mix of grizzly bear and black bear reports, while in the lower meadows more black bears are reported and grizzly bear reports are rare. The mid-upper Pemberton Meadows is an agriculturally oriented community and the conflict history for grizzly bears appears to be related to the disposal of cattle carcasses, the production of digestible vegetables (particularly carrots and lettuce), chickens, and increasingly apiary operations.

3.4.1 Livestock - Bovine

On the west side of the Lillooet River, there were quite a few places where cows roamed large acreages and a number of those lots backed onto the Camel's Back ridgeline (Pictures 22, 23). AGRI (2009) states that due to soil quality, available water, climatic condition, and easy distance to markets, agricultural activities "should not de-intensify" in the Meadows. The Camel's Back corridor design utilizes a band of largely forested habitat that runs along the base of the mountains; however, the crops will back onto the corridor. In the Meadows, agricultural crops are often rotated with "potatoes in year 1, cereal crop (usually oats) with grass-legume mix as an understory in year 2, grass-legume mix for pasture and hay in years 3, 4, and possibly 5, then back to potatoes. Cattle are grazed on land that has been harvested for potatoes (as they will eat the waste potatoes lying on the ground), grazed on land that has been harvested for cereals, and grazed on the grass-legume mix" (AGRI 2009:13).

Protection of all crops, with the expectation of potatoes and hops, is required for coexistence of bears and farmers. Electric fencing running along the back end of the properties along the ridgeline is an option to keep bears on the chosen path and from venturing into farmlands; however, to be done properly it would require fencing an extensive length line of 5-strand e-fencing and that would be difficult to maintain. The fencing would need to be regularly checked for shortages along its entire length.

Bear Smart animal husbandry practices, such as keeping calving areas closer to human settlements, not allowing calves to roam freely near or within forested areas, and proper disposal of livestock carcasses, may be more realistically operational. *I recommend making Bear Smart practices a requirement during the establishment of any covenants/conservation agreements with landowners.*

Picture 23. Cows free-range throughout a large pasture in Pemberton Meadows

3.4.2 Livestock – Lamas, Chickens, Pigs

Small scale livestock operations also occurred throughout the meadow, particularly chickens, although I also recorded lamas and pigs within the meadows area. Electric fencing works well to protect these smaller scale livestock operations. Electric fencing is discussed in its own section due to its importance as a mitigation technique for the meadows area. None of the farms I surveyed were using fencing, electric or otherwise, in an adequate design as to deter bears (Picture 24).

Picture 24. An example of a small scale hobby farm in mid-Pemberton Meadows

The fencing protecting these lamas will not exclude a grizzly bear. Also, the paddocks back onto an expanse of forested habitat

3.4.3 Apiaries

There was one apiary operation that was for commercial production. The operator noted that previously he had brought the hives to the Upper Lillooet so the bees could access fireweed, however, the electric fencing failed and the hives were destroyed by a grizzly bear.

There were a few hives that were for personal/local use (Picture 28). None of the apiaries I visited were protected by electric fencing. Further, apiaries were often placed backing onto forested habitat rather than being out in the open.

Picture 25. Example of apiaries on residential farms in Pemberton Meadows

These apiaries back onto forested habitat and are not protected by electric fencing

3.4.4 Berry Production

A new establishment to the valley was the commercial production of cranberries, blueberries and honey (Picture 26). Cranberries - whether bog cranberry (*Vaccinium oxycoccos*) or highbush cranberry (*Viburnum edule*) – honey and blueberries are all known to be preferred foods of black and grizzly bears. The farmer had not had any issues with bears and there were no Bear Smart mitigation methods in use for the apiaries, blueberries or cranberries at the time of the survey. However, the operation was new and issues with bears are anticipated. It is recommended that Bear Smart mitigation measures be put into place before issues with bears occur. Electric fencing would be an effective tool to protect this operation especially when combing with properly trained livestock protection dogs.

Picture 26. Cranberries float on the water waiting for harvest, Pemberton Meadows

3.4.5 Fruit Exchange Program

There were personal fruit trees noted in the mid-upper meadows and bears were reported to use them, however, none of the residents considered it a bear problem/issue. The majority of those residents stated that they picked the fruit early and did not allow it to fall from the tree.

The lower portion of Pemberton Meadows towards the VOP had unkempt fruit trees and COS reports were more common. The VOP has a fruit exchange program and annually gleans trees on Collins road and Taylor road, however, the program does not officially extend to the Meadows area (Geisler pers. comm.).

The Pemberton Fruit Tree program noted a challenge with getting volunteers to a harvest and back and noted that to include the Meadows area they required more funding to cover transportation costs (Geisler pers. comm.). In addition, harvesting a tree takes between 30 minutes and 2 hours, and adding a drive of 30 or 45 minutes each way may be significant for volunteers.

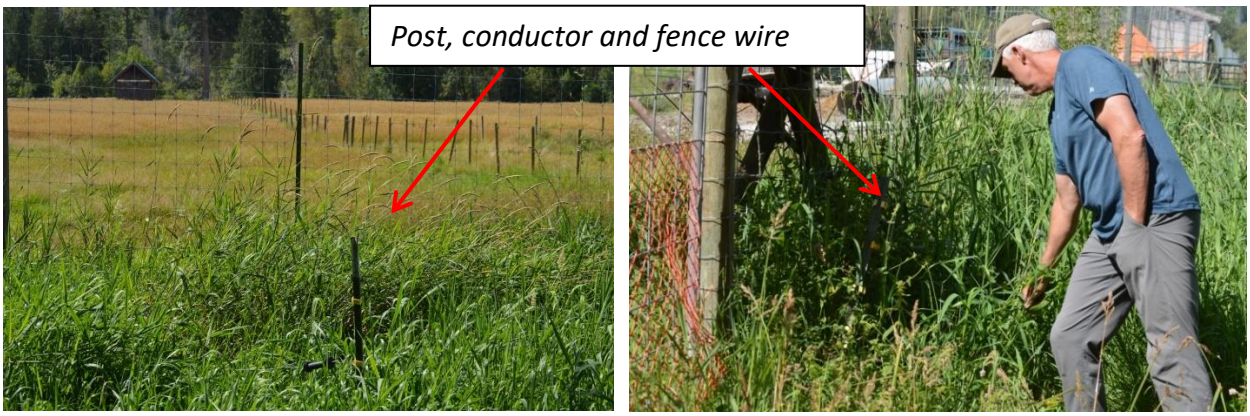
A fruit exchange program should occur in the lower portion of the meadows, particularly around the trailer park where black bear destructions due to attraction to fruit have already occurred.

3.4.6 Electric Fencing

A number of the farms had a string of electric fencing around livestock paddocks with the intention of keeping their livestock contained. However, on many occasions I noted that the electric fencing was no longer operational (Picture 27). *It commonly appeared that residents*

used electric fencing after a bear had come into conflict rather than keeping the fencing operational and dissuading a conflict before it occurs. Reacting to bear issues after they occurred was common in the lower, mid and upper meadow areas.

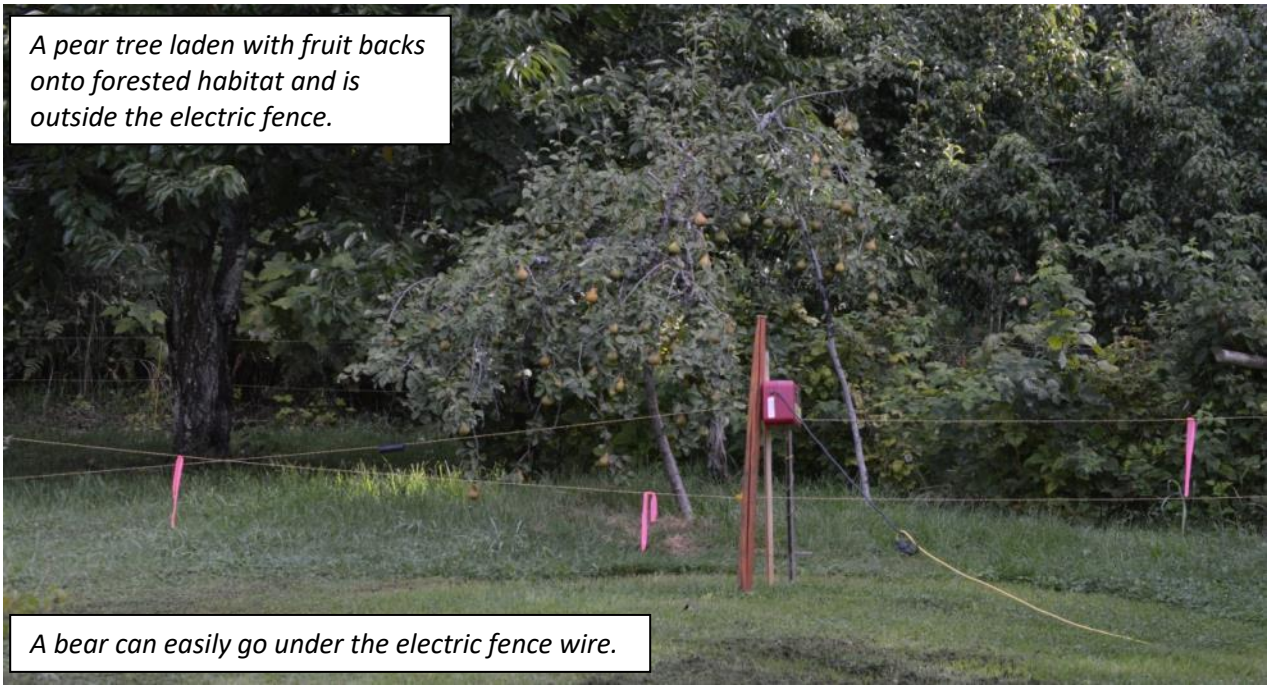
Picture 27. Electric Fencing examples of use and issues in Pemberton Meadows



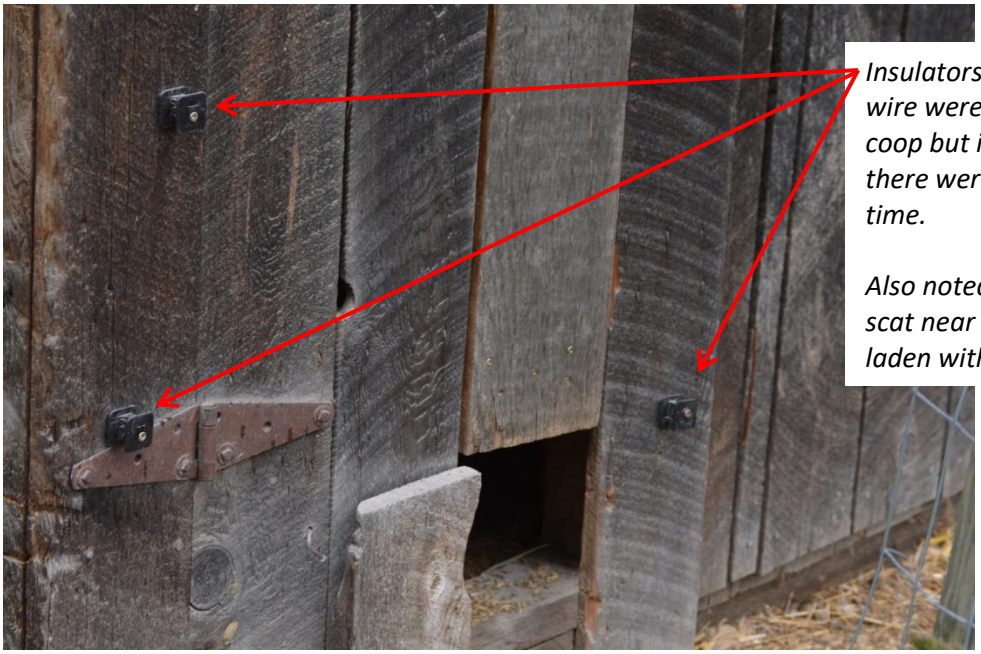
Electric fencing needs to be kept clear of vegetation so it does not short.

Farms that were using electric fencing to deter damage by wildlife did not have it set-up to adequately deter bears. Fencing to deter bears should use 14 gauge wire, an energizer of ≥0.7 joules or greater, and a 6-foot ground rod. There should be at least 5 strands of e-fencing with the first strand being no more than 12 inches (i.e., nose height) from the ground.

An example of an electric fencing set-up on a small hobby farm



The electric fence design is not adequate to deter a bear.



Insulators for the placement of electric wire were in place around this chicken coop but it was not operational since there were no issues with bears at the time.

Also noted at this site was fresh bear scat near the coop and a fruit tree laden with fruit.

3.4.7 Garbage Receptacles

Garbage management in the mid to upper Pemberton Meadows area was excellent and bear access to garbage was not determined to be an issue. All residents acknowledged that allowing bear access to garbage creates greater conflicts with bears and all farms and commercial operations appeared to store their garbage in a bear-resistant location (Picture 28).

Picture 28. Bear resistant garbage bins with locked lids, Pemberton Meadows

These Carney garbage bins are located on two different farms. The arms of both bins are locked down so bears cannot gain access to the bin.

The latching bar on this Carney garbage receptacle worked well as evidenced in the picture on the right. The lid had been bent but the bar did not allow the bear access to the contents.

The Heritage Village is currently non-operational. However, the school board does accept proposals for potential use of the property. Each of the cabins had a garbage bin outside the entrance (Picture 29). If Heritage Village was to become operational it would need these bins replaced with a bear-resistant bin. This was the only garbage issue identified for the mid-to-upper meadows area.

Picture 29. Garbage receptacle at Heritage Village

Heritage Village backs onto the Wolverine drainage and is a recommended to form part of the proposed Oxbow Lake corridor

Lower Pemberton Meadows

Residents of Pemberton Meadows used the Carney Waste Management System for their garbage disposal. The type of residential bins used were approved bear-resistant (CWS 35 SH 140L and CWS 65 SH 260L); however, the system requires the user to lock the lid of the bin in place. In the lower meadows I noted houses with unlocked bins. Further, some bins had the corner of the lid bent likely by an animal attempting to access the bin (Picture 30). In the lower

meadows, residential bins were often adjacent to other bear attractants, particularly fruit trees, and kept outside often at the end of driveways.

Picture 30. Residential and commercial garbage containment in the lower Pemberton Meadows area

The lid on this Carney system bin has been bent likely by a bear.

The lids of these bins are locked closed with a carabiner type system. Some of the garbage bins in this trailer park did not have their lids locked down.

This Carney garbage receptacle was associated with a commercial business.

The lid had been so badly damaged it did not close down onto the main receptacle body.

3.4.8 Roadside Fruit and Vegetable Stands

Roadside stands selling consumable goods from berries to corn, zucchini, squash and herbs were common in the lower-mid meadows area (Picture 31). There were no incidents in the PWOR that specifically related to farm stands, possibly this is because the goods were removed at night when bears would be more likely to access them. There were many incidences of bears accessing the gardens, but not the stands themselves. However, M. McLellan (pers. comm.) reported seeing a black bear feeding at a roadside stand in the larger area along Portage Road.

Picture 31. Roadside fruit and vegetable stands in Lower Pemberton Meadows

3.5 Heli-Mountain Biking

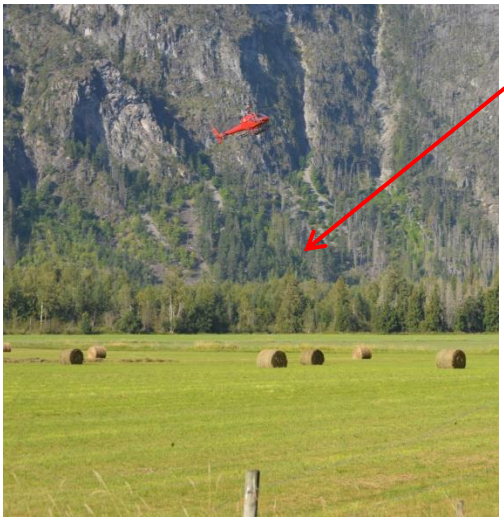
There is an active heli-biking operation that operates within the meadows at the Lillooet RSF bridge, just east of Lot 813 (Pictures 32). This operation represents recreational spill-over from the Resort Municipality of Whistler, where the helicopter company is based. Mountain bikers drive to the east side of the Lillooet Forest Service Road where vehicles are parked. The helicopter pick up point is within Lot 813-b.

Bikes are loaded onto the side of the helicopter. The helicopter then ascends up the side of the Wolverine Creek/Copper Dome Mountain in a zig-zag pattern. Mountain bikers are dropped off in the alpine habitat of Mt. Barbour. The bikers follow historic horse trails to Tenquille Lake where they ascend over the pass and down the south east side of Wolverine Creek. The final descent is down the Tenquille Lake trail, which ends within 50 meters of the Lillooet FSR bridge.

There are many concerns with a heli-biking operation within the meadows and in a Threatened GBPU in general:

- The operation brings increased vehicle traffic into the meadows. This affects the entire meadow area to the pick-up point.
- The helicopter's flight path from Whistler goes over the Wetland Management Area that leads from Oxbow Lake to Lot 167.
- The helicopter zig-zags up the mountain ranges - and the way it ascends sticking close to the mountain side likely has a negative effect on the wildlife, particularly the Mountain goats on Mt. Pauline (Picture 33).
- The subalpine and alpine habitats of Tenquille Mountain are critical spring (e.g., glacier lilly, western spring beauty) and Tenquille Creek is fall (*Vaccinium* sp.) foraging habitats for grizzly bears.
- The increased access into a formerly difficult area to access results in a reduction in secure habitat for bears.
- Mountain biking is a high-speed activity where the rider must focus on the path rather than their surroundings and this increases the likelihood of a negative human-bear encounter.
- High speeds, quiet movements and a focus on the track limit the reaction time for both bears and humans.
- Grizzly bears are more likely to attack when they first become aware of a human presence at distances of less than 50 meters (55 yds, Herrero and Herrero 2000, *n*=33)
- 85% of bicyclists were unaware of the bear's presence until within 50 meters (Schmor 1999, *n*=41)
- In 12% of encounters (4/33), bicyclists were injured by a grizzly bear (Herrero and Herrero 2000). Three of the 4 injuries were serious and required hospital stays more than 24 hours (Herrero and Herrero 2000).
- In a negative human-bear encounter, it is often the bear that is removed
- Pemberton Meadows is within the ALR and is a provincial land use zone. Agriculture is the priority use, farming is encouraged, and non-agricultural uses are controlled (AGRI 2009). During the administration of the bear occurrence survey more than one farmer noted that they were more concerned about the weeds that were being introduced to their fields by the increase in tourist vehicle traffic than grizzly bears. AGRI (2009) recognizes that "some types of non-farm uses can have the unintended impact of making it more difficult to run a farm business ….recreation and leisure development can effectively cause the surrounding farm uses to be of lower intensity and possibly also of lower economic value to accommodate a perceived or real threat of nuisance complaints…the Farm Industry Review Board has determined that farmers should show reasonable consideration for their neighbours. Encouraging more recreation and leisure uses of farmland may not be in the best long-term economic interest of agriculture in the region" (AGRI 2009:24).

Picture 32. Heli-Mountain biking operation at the Lillooet RSF, Pemberton Meadows



The helicopter approaches over the Wetland Management Area adjacent to Lot 813-b

Bikes are loaded on the side of the helicopter and it ascends cross-crossing the mountain side

Bikers are dropped off at Mount Barbour and riders follow historic horse trails to Tenquille Lake

Picture 33. Mountain goats rest on Mount Pauline, which is along the flight path for the heli-mountain biking tourism operation.

3.5.1 Other Recreational Activities

The heli-biking operation was discussed in-depth because it occurred within the Meadows and directly affects the proposed Oxbow Corridor. Keyhole Falls Hotsprings is northwest of the Meadows but due to bears accessing food and garbage left by visitors, and then displaying aggressive behaviour towards humans, it is now closed from April 15th to Nov 15th each year (Schmunk 2017). No change of those closure dates were expected (McCrone pers. comm.).

PIs for the SC and SL grizzly bear research projects noted that there are many types of recreational activities occurring in the larger area and most seem to be increasing; heli-hiking, heli-fishing, and heli-sightseeing are also very popular helicopter activities. Heli-golfing and alpine yoga occur on Mount Currie. Other recreational activities that appear to be increasing include hiking, hunting, climbing, dirt-biking, and horseback riding. Recreational activities, particularly those that occur without proper planning to avoid critical grizzly bear habitat either spatially and/or temporally, could displace bears forcing them to use lesser quality habitat (McLellan and Shackleton 1989). Also, when bears flee they use energy; it is possible that unregulated recreational activities could affect overall fitness by increasing energy output, forcing bears to use poorer quality habitat, and/or increasing HBC. Recreational activities,

particularly those involving people recreating with firearms, could kill bears directly (Ciarniello et al. 2009).

Generally, the relative impacts of various recreational activities, with the exception of hunting (ungulate), on bears are poorly understood and it would be beneficial to explore what is occurring within these Threatened GBPUs. The Sea-to-Sky Land Resource Management Plan (LRMP 2008) lists 4 main issues that must be considered in the management of grizzly bears in the S2S planning area (LRMP 2008:73). These issues are:

1) Availability of functional grizzly bear habitat, including denning areas and critical forage areas.
2) Ability for grizzly bears to migrate throughout their range, ensuring genetic flow.
3) Grizzly bear mortality associated with roaded access and human-bear interactions.
4) Habituation of grizzly bears to humans.

The 5 goals of the LRMP for grizzly bears are (2008:73):

5) Achieve and maintain a Viable status for each of the four Grizzly Bear Population Units that overlap the Plan Area.
6) Conserve critical bear habitat, including movement corridors;
7) Reduce mortality of bears due to bear-human interaction;
8) Reduce incidence of grizzly bear mortality within, and displacement from, critical habitats; and,
9) Reduce incidence of displacement of grizzly bears due to recreational activities.

It appeared that consideration for whether or not recreational activities should occur in a given area is at best minimally occurring, and at present it is inadequate to meet the goals of the LRMP. Recreational activities should be planned to minimize potential negative impact on grizzly bears and take into account grizzly bear habitat use.

4.0 Inter-Provincial and/or International Issues

A Provincial objective for bear hazard assessments is to identify "regional, inter-provincial and/or international issues in areas outside the community that may affect the effectiveness of the "Bear Smart" program" (Davis et al. 2002:22). The following issues have been identified and resolving them will require partnerships between the Landowners, AGRI, the Village of Pemberton, Stewardship Pemberton Society, Lil'wait Nation, the Resort Municipality of Whistler, the School Board, FLNRORD, Helicopter-based tourism, the Hops Farm, and the Conservation Officer Service:

1. This Bear Hazard Report and the accompanying Bear Management Plan were initiatives of the Coast to Cascades Grizzly Bear Recovery Initiative (C2C) and the Grizzly Bear Foundation (GBF). The C2C and/or GBF do not have the authority to develop, legalize, or enforce any Bear Smart initiatives. The VOP, AGRI, and FLNRORD must be partners

and extend Bear Smart Initiatives (e.g., Pemberton Fruit program) and enforcement (e.g., bylaws) to the Meadows area.

2. There is significant tourism growth throughout the Sea-to-Sky corridor and those recreational activities are infiltrating the Meadows area. There was an active heli-biking operation that was frequently taking visitors from the meadows into subalpine grizzly bear habitat. There appeared to be little forethought regarding the impacts of heli-biking on the wildlife in the area. At a minimum flight paths should be reviewed to avoid critical wildlife habitat. Recreational trail use and placement should be evaluated for mountain biking versus the trail's intended use, hiking and horseback riding. The current heli-biking operation is thought to negatively affect grizzly bear habitat use and stress levels, as well as the other wildlife using the area, such as mountain goats. There are also a heli-hiking, heli-golf and heli-yoga tourism operations (M. McLellan pers. comm.).

3. There is excessive growth of unregulated trails and campgrounds within the Threatened SL-GBPU and with little supervision by the province. Expanding human use further into the subalpine and alpine areas via the increased recreational trail networks negatively impacts recovery of the SL-GBPU population. Grizzly bears require relatively undisturbed habitat to thrive and survive. The expansion of recreational activities onto Crown Land should only occur with consultation of an Advisory Board that contains members from the various stakeholder groups, including government, First Nations and NGOs.

4. There is a need to support the recovery of grizzly bears in the Ryan River drainage. The Sea-to-Sky LRMP (2008:77) recognizes that the "Ryan River watershed contains high habitat values for grizzly bear" and recommends that recreational access to the Ryan be restricted year round (LRMP 2009:39). Research suggests that grizzly bears are expanding from the Ryan River drainage into the meadows and within the SL-GBPU. A C2C grizzly bear recovery committee should be formed and specifically address whether visitor use and recreational trails should be increased in high quality bear habitat. *The grizzly bear research data from both the SL-GBRP and the SC-GBRP should be quantitatively modelled and used to inform landscape planning and management.*

5. The SC and the SL Grizzly Bear Population Units are provincially classified as Threatened. Adjacent to the SC-GBPU is the Stein-Nahatlatch GBPU which in 2016 was further classified as Critically Endangered by the International Union for the Conservation of Nature (IUCN; McLellan et al. 2017). The Stein-Nahatlatch GBPU has an estimated density of 3 grizzly bears/1,000 km^2 (24 bears for 7,510 km^2 of useable grizzly bear habitat; MOF 2012) and research shows that this population is declining (M. McLellan pers. comm.). Adjacent to the SL GBPU is the Garibaldi-Pitt GBPU. The RMOW is located within the Garibaldi-Pitt GBPU; the density of grizzly bears is <1 grizzly bear/1,000 km^2 for a population estimate of 2 bears in 6,031-km^2 of useable habitat (MOF 2012). There is global conservation concern to maintain the population of bears in these Threatened and Critically Endangered GBPUs (McLellan et al. 2017).

6. This Bear Hazard Assessment does not include the Village of Pemberton. The VOP should conduct its own BHA and develop an associated management plan for the larger area. The VOP has Bear Smart bylaws and uses approved bear resistant waste bins, with appropriate signage, throughout the village. The Bear Smart initiatives that focus on agriculturally related practices should be develop and extended into the Meadows area.

5.0 Potential Data Limitations

A BHA must present the potential data limitations. The data presented contains the following potential limitations:

1. I was unable to obtain the actual grizzly bear location data from FLRNORD until late February 2020. Had I been able to obtain those data earlier I could have modelled the movement of the bears, which would have allowed me to verify/validate the land purchases put forward in this report. Instead, I used hard copies of the locations provided in Apps et al.'s (2014) report to develop the linkage plan. Regardless, the location data will be modelled by M. McLellan in fall 2020.

2. There were very few bear occurrence reports and some did not contain some vital information:
    - UTM Locations were generalized from street names and occurrence information. Reports that did not contain this information were omitted from the database.
    - Areas were selected based on professional opinion, occurrence reports, and number of bears destroyed. A potential area may have been mistakenly omitted.
    - There were known omissions of grizzly bear reports within the meadow area, such as the Mowich Creek grizzly bear.
    - There was an overall paucity of grizzly bear reports.
    - There was a lack of reports for the mid-meadows area.

To address those limitations I designed the bear occurrence and damage survey, which specifically addressed grizzly and black bear sightings within the Meadows area.

3. Due to funding limitations large tracks of green spaces were not able to be assessed and their value was inferred based on professional opinion.
    - To address this limitation extensive and frequent exchanges with the grizzly bear research project's PI were conducted and they reviewed a draft of this report.

4. A number of properties were for sale or had recently sold and the human footprint was continually expanding:

    - As habitat changes due to human developments and forested areas are decreased, wildlife also shifts habitat use in response to development. This could change what is presented in this report.

5. Hazard assessments are largely based on informed, but subjective, professional opinions of biologists:
    - Bears are wild animals and can be anywhere at any time. Although the most up-to-date data available was used for this report any area could have a bear present.

Partnerships and a commitment to move forward with pursing Bear Smart initiatives are required by a number of stakeholders in order to carry the program forward and promote/support recovery.

Picture 34. Looking onto Pemberton Meadows from the Wolverine Creek burn. Note the huckleberries beginning to rejuvenate in the understory.

6.0 PHASE TWO: Hazard Ratings & Recommendations

The hazard ratings for the mid-upper Pemberton Meadows:

Bear Hazard	Hazard Rating Mid-Upper Meadows
Livestock - Poultry (chickens, turkeys, ducks, etc.)	High-Extreme
Oats - planted	High-Extreme
Heli-biking	High
Livestock - grain storage	High
Gardens vegetables - carrots, root crops, lettuce (consumable without cooking; includes organic commercial operations)	High
Blueberries	High
Apiaries	High
Sunflowers	Moderate-High
Cranberries	Moderate-High
Corn	Moderate
Fruit Trees	Moderate
Livestock - Bovine neonate and calves	Moderate
Livestock - Bovine Adults	Low
Potatoes (seed and fresh market)	Low
Hay	Low
Waste Containment - residential	Low
Waste Containment - commercial	Low
The Beer Farmers	Low
The Hops Farm	Low
Coast Mountain Outdoor School	Closed
Heritage Village	Closed

The Hazard Ratings for lower Pemberton Meadows are:

Bear Hazard	Hazard Rating Lower Meadows
Livestock - Poultry (chickens, turkeys, ducks, etc.)	High-Extreme
Fruit Trees	High
Gardens vegetables - carrots, root crops, lettuce (consumable without cooking)	High
Sunflowers	High
Blueberries	High
Apiaries	Moderate
Livestock - grain storage	Moderate
Waste Containment - residential	Moderate
Waste Containment - commercial	Moderate
Roadside fruit and vegetable stands	Low-moderate
Livestock - Bovine neonate and calves	Low
Livestock - Bovine Adults	Low
Potatoes (seed and fresh market)	Low
Hay	Low
Oats - planted	Low

7.0 Recommendations

Land use decisions within the GBPU affect the recovery of grizzly bears throughout the Meadow's area. Currently, there appears to be little forethought or planning for wildlife. Recommended is a two-pronged approach of using the science to inform planning decisions and hiring a Bear Recovery Coordinator to directly assist people with their conflict reduction efforts.

7.1 Educational and Landscape Planning Recommendations

CONTINUING EDUCATION PROGRAM: Education, Awareness, Understanding, Promoting Co-existence
Science based Recommendations:
• Form a C2C grizzly bear recovery committee to address whether visitor use and recreational trails should be increased on Crown Lands
• Quantitatively model the grizzly bear research data from both the SL-GBRP and the SC-GBRP and use this information to inform landscape planning and management (linkage analysis and habitat-quality recreational use analysis)
Public Education Recommendations:
• Support a C2C Bear Recovery Coordinator Position whose duties include public outreach - This should be a local person with ties to the Meadows
• The Bear Recovery Coordinator would liaise with residents and aid in implementing proactive management
• The Bear Recovery Coordinator would be responsible for keeping track of bear sightings
• The Bear Recovery Coordinator would work with the Pemberton Fruit Exchange Program
• Develop agricultural related human-grizzly bear educational material
• Focus material on how to prevent grizzly bears from their corrals, yards, gardens and grain fields
• Work cooperatively with the Portage Road C2C Bear Aware working group
• Support an electric fence workshop focused on large-scale agricultural activities
• Hold agriculturally related "Bear Smart" workshops – electric cattle guards, etcetera
Record Bear Data (Sightings, issues/conflict, mortalities)
• For the mid-upper meadows encourage a resident reporting of grizzly bear sightings
• Follow up on bear sightings and all conflict reports and determine the cause of the report
• Ensure attractants are secured in a Bear Smart manner

7.2 Connectivity Recommendations: Suggested Property Purchases & Conservation Agreements

The multi-spatial connectivity approach proposed in this report allows for:

- *Connectivity between GBPUs* – offering a minimum of two crossing locations: one crosses the middle of the Pemberton Meadow's area and another following the base of the Camel's Back ridge leading to a less developed crossing point just north of the gate.
- *High Potential for Species Diversity* – by protecting and restoring critical wetland habitats including spawning habitat for several species of salmon. Birds and amphibians also benefit from the protection of these habitats. Retaining or replanting to forested habitats will benefit ungulates and spotted owls. Several of these species are currently At Risk.
- *Wildlife Habitat Areas* – capitalizes on existing protected areas to enlarge the size of the overall habitat.

Recommendation: Re-establish connectivity by linking habitats parcel by parcel using a combination of Property Purchases and Conservation Easement/Agreements.
Property Purchases: Consider purchasing 4 properties: Lot 167, Lot 821, Lot 1167, and, Lot 815
Oxbow Lake Linkage Corridor *- purchase Lots 167 & 821. Conservation Agreement Lots 849 & 813*
Lot 167 (McCubbin) • Salmon Slough runs through Lot 167 and is a productive Coho salmon rearing stream
Lot 821 is privately owned and was extensively logged. • In its timbered state, both SC and SL bears used Lot 821. Reforest Lot 821.
Lot 813-b (Hops farm) • Discuss with landowners the issue with the proposed planting of barley on Lot 813-b which lies adjacent to the proposed Oxbow Lake corridor and the existing WMA. • Consider planting an alternate crop that does not attract bears, such as potatoes or hops, should be considered instead.
Camel's Back Linkage Corridor *- purchase Lots 1167 & 815 (Legacy Ranch). Conservation Agreement for multiple farms running along the ridge line for Ryan River-Tenquille linkage*
Lot 1167 (Backs onto Camel's Back) • Reforest Lot 821 • Rehabilitate wetlands • Connect bands of cottonwoods
Lot 815 (Lillooet River Front) • Establish a secure crossing for Pemberton Meadows Road

Conservation Agreements: Consider partnering with NCC to develop two separate conservation agreements
Oxbow Lake Conservation Agreement - Lots 849 & 813 • Lots 849 and Block A 813 on the north side of the river that are owned by the School Board • The school district does not want to sell the properties but will consider proposals for use of the land • C2C should provide a letter to the School Board advocating for conservation for their 2 lots
Camel's Back Conservation Agreement - Ryan-Tenquille Linkage, Multiple Properties • Multiple properties run along the base of the Ridegline and a Conservation Agreement with landowners is recommended to preserve this natural corridor • Consider a 150-200 m easement running along the base of Camel Back Ridge • Only selective logging allowed • No human recreation in spring • No human recreation in fall. Spring and fall dates could be based on the dates of the upper meadows gate closure. • Do not allow cattle to free-range in the conservation agreement area
• *Make Bear Smart practices a requirement during the establishment of any covenants/conservation agreements with landowners*
LANDSCAPE SCALE RECOMMENDATIONS: LINKAGE ZONE
• Continue to enforce spring and fall gate closures for the gate at 2 km on the south Lillooet FSR
• Using quantitative modelling, determine the amount of secure habitat available for female grizzly bears
• Calculate the amount of secure habitat by habitat quality
Salmonid Habitat Restoration
• Conduct a scientific assessment of the state of salmonid spawning and rearing habitat
• Identify and prioritize salmon habitat recovery projects
• Focus riparian and wetland restoration efforts on critical salmonid spawning and rearing habitat
• Restore natural riverine processes by reconnecting the Lillooet River with its floodplains (allow for frequent flooding)
• Conduct an assessment of culverts and bridges and remove barriers

7.3 Agricultural Based Recommendations

There is a need to switch from reactive bear management to proactive bear management throughout all of Pemberton Meadows. Bear Smart practices need to be in place to dissuade the development of problem behaviours with bears, rather than reacting once an issue has occurred.

7.3.1 Large Scale Agricultural Activities

AGRICULTURAL ACTIVITIES
• Larger lot parcels had more agricultural production and commercial sales
• Some farmers noted that the increase in tourism resulted in increased invasive weeds in their fields and felt this was a greater threat to their farming operation than an expanding grizzly bear population.
Cattle/Livestock
Electric fencing is difficult where there are large cattle operations and should be combined with Bear Smart animal husbandry deterrent techniques.
• Ensure all livestock food is contained in a bear-resistant structure
• Keep livestock calving areas close to human dwellings, well lit, and preferably within electric fenced enclosure
• Discourage calving/birthing within forested areas
• Calves should be released only when they are of sufficient size to deter predation
• Promote the use of properly trained, recognized breeds of bear dogs for protection of livestock
• Work with the government to compensate for livestock lost to grizzly bears
• Discuss with farmers the potential problems associated with attracting bears to their farm, particularly the placement of carcasses close to establishments or within cattle fields (Bear Aware coordinator)
• The disposal of animal carcasses is governed under the Codes of Agricultural Practice for Waste Management. Immediately remove carcasses from area.
Grain Silos
• Clean up grain spilled from silos
• Replace leaking silos with bear resistant grain holders

7.3.2 Small Scale Agricultural Activities

Properly installed and maintained electric fencing works very well to deter bear access to poultry houses, pig pens and apiaries.

Chicken Coops
Electric fencing works well for small livestock (poultry, pigs) enclosures
• Use properly installed, Bear Smart electric fencing methods - 14 gauge wire - an energizer of ≥0.7 joules - 6-foot ground rod. - minimum of 5 strands of e-fencing with the first strand being no more than 12 inches
• Locate livestock houses away from greenspaces
• Install automatically triggered lights
• Electric fence poultry coops during all seasons except winter
• Operate and maintain the electric fencing spring, summer and fall regardless of bear issues
• Use birthing sheds for sheep and pigs
• Promote the use of properly trained, recognized breeds of bear dogs for protection of livestock
BEE HIVES
Electric fencing works well to protect apiaries
• Electric fence all bee/apiary operations
• Prohibit the free-ranging of bees in the back country mountains
• Encourage proper placement of honeybee colonies in open areas and away from green-spaces.
• Consider raising colonies on a platform
• Support holding an electric fencing workshop
Cranberries & Blueberries – this is a large scale operation that may be difficult to protect
• Physically protect crops with electric or barrier fences
• Use guard dogs to deter bears from entering croplands
• Use hazing methods (e.g., motion or heat sensing devices that trigger alarms, strobe lights, deflectors) to deter bears from entering croplands

7.4 Fruit Trees: Increasing the Agrotourism Sector:

Consideration should be given to establishing an Agritourism sector within the meadows as it would fit nicely with the current operations. Fruit could also be sold to secondary industries, such as jams and jellies for local or commercial sale or to the beer establishments for the creation of ciders or wines.

The Northern Bear Awareness Society in Prince George raised $~7,500.00 in 2017, $4,000.00 in 2018, and $8,000 in 2019 by selling ~20,000 lbs. in 2017 and 16,000 lbs. in 2018 of fruit from the fruit exchange program. In Prince George the Northern Lights Winery accepts 30,000lbs of apples from the community to produce their Lumiere Blanche apple wine and makes a monetary donation to the Northern Bear Awareness Society for advertising and coordinating the apple drop off at the Winery. The funds are used to help run the Northern Bear Awareness Society's programs in Prince George (Bakker pers. comm.).

FRUIT TREES
Expand the Pemberton Fruit Exchange program to the lower portion of the meadows, particularly around the trailer park where black bear have been destroyed as a result of unkempt fruit trees
• Support the Pemberton Fruit Tree program
• Work with the VOP to expand the fruit exchange program to the lower Meadows area
• Seek approval to remove unwanted/untended fruit trees
Consider establishing an Agritourism sector • Promote and support secondary industries, such as juice production, wine production, etc. that could benefit from using the unkempt fruit. Use the profits generated to fund Bear Smart education programs.
• Encourage the local breweries to make a local fruit-based wine
• Encourage the local organic gardeners to consider Jams and Jellies for local or commercial sale
• Use social media to network those who have fruit with those who want it
• Consider leaving fruit trees in areas where they can hold bears out of town and areas where you don't want them to be during fruit season
• Install electric fencing to protect fruit trees
ROADSIDE FRUIT AND VEGETABLE STANDS
• Interview owners of the stands to determine any bear issues
• Develop educational material for roadside stands
• Ensure stands are only operational during daylight hours
• Ensure all goods are kept in a bear resistant location at night

7.5 Recreational Recommendations

There appears to be significant unregulated growth of the tourism industry along the Sea to Sky area and as a result of spillover from the Resort Municipalities of Whistler. This has the potential to negatively affect the recovery of grizzly bears within both the Squamish-Lillooet and South Chilcotin Threatened GBPUs.

There appeared to be little forethought regarding the impacts of heli-biking on the wildlife in the area – from the flight path of the helicopter, to the drop off in high quality habitat, through to the descent on the Tenquille Trail. The current heli-biking operation is thought to negatively affect grizzly bear habitat use and stress levels, as well as the other wildlife using the area, such as mountain goats.

> *The tourism industry should not be allowed to expand onto Crown Land without the consultation of an Advisory Board that contains members from the various stakeholder groups, including Researchers, First Nations and NGOs.*

Heli-Mountain Biking
Monitor Recreational Use
• Map and model backcountry mountain bike trails according to grizzly bear habitat quality
• Determine the type, frequency & location of helicopter-based recreation
• Review flight paths and mandate that they avoid critical wildlife habitat
• Work with the government to develop standards for heli-based recreation
• Mandate flight distances from mountain sides taking into account all wildlife, including goats
• Evaluate recreational trail use and placement for mountain biking versus its intended use, hiking
• Avoid high-speed recreational activity in high-quality grizzly bear habitat
• Use the best available science to plan trails and avoid high quality habitat
Monitor Recreational Use
• Determine the type, location, and amount of backcountry recreational use that conflicts with grizzly bear habitat
• Geographically map backcountry mountain bike trails according to grizzly bear habitat quality
• Restrict or legislatively limit helicopter based tourism operations within Threatened GBPUs
• Provide support for analysis of the Tenquille data (traffic counters and grizzly bear GPS locations) with focus on examining if bears are displaced by recreational activities when the habitat is limiting

7.6 Residential and Commercial Waste Management

The waste management system in place in Pemberton Meadows was an approved bear-resistant system. The VOP also has BYLAW No. 684, 2011, which is a bylaw to provide for the control of wildlife attractants (https://www.pemberton.ca/public/download/documents/37266). The bylaw defines a wildlife attractant as:

> "wildlife attractants" means any substance or material, with or without an odour, which attracts or is likely to attract dangerous wildlife and includes but is not limited to domestic garbage, waste, food for human consumption, restaurant grease, ash, food for animals (e.g., pet food, livestock feed, birdseed, hummingbird nectar or suet), barbecues, recyclable materials, game meat, salt, petroleum products, antifreeze, paint, outdoor refrigerators or freezers, and compost waste other than lawn clippings, leaves or branches"

MAINTAINING A BEAR-RESISTANT SOLID WASTE MANAGEMENT SYSTEM
Residential Waste Management
• Conduct a garbage audit on the lower meadows area
• Tag garbage cans that do not have their lids locked
• Discuss and educate residents that are not properly using bins
• Remove all damaged bins residential and commercial
• Ensure all commercial operations are using bear resistant bins with lids locked down
• For the upper meadows, if the Old School was to become operational bins would need to be removed and replaced with a bear-resistant can
• Enforce any repeat offenders under Pemberton's garbage bylaw

This BHA provides a plan to reduce the competition between people and bears for space on the landscape. Connectivity can be restored for bears within Pemberton Meadows, while also reducing bears being attracted to food products produced or managed by residents. To maintain the positive attitude residents currently hold towards grizzly bear recovery, it is imperative to take a proactive approach to prevent or resolve conflicts before residence tolerance for bears declines (HBCET IUCN 2019a,b).

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Bakker, Dave. President. Prince George Northern Bear Awareness Society. Prince George, BC, Canada https://www.northernbearawareness.com/

Geisler, Belinda. Feasting for change coordinator, Stewardship Pemberton society, Pemberton Fruit Tree Program. Email: pembyfruittree@gmail.com

MacIver, Stephen. Regulations and Policy Analyst, Fish & Wildlife Branch, Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, Victoria, BC, Canada.

McEwan, Allen. The Coast to Cascades Grizzly Bear Initiative Livestock Conflict Prevention Program Coordinator, Pemberton Meadows, BC, Canada.

McCrone, Alistair. Recreation Officer. Sea to Sky Recreation District. Recreation, Sites and Trails BC. Squamish, BC, Canada.

McLellan, Bruce, PhD. Retired Ministry of Forests & Researcher, South Coast Grizzly Bear Project, D'Arcy, BC, Canada.

McLellan, Michelle, PhD. South Coast Grizzly Bear Project, Nelson, BC, Canada.

Mueller, Brittany. Conservation Officer, Sea to Sky Zone –Whistler. Ministry of Environment and Climate Change Strategy.

Rochetta, Steve. Senior Ecosystem Biologist. BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development. Squamish, BC, Canada.

8.3 List of Survey Participants

I thank the following residents for taking part in the Bear Occurrence and Damage Survey:

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