Human-Grizzly Bear Interactions and Education Baseline Data for the Babine Watershed Monitoring Trust

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Executive Summary

Since 1990, records indicate that grizzly bear (*Ursus arctos* L.) mortality within the Babine watershed can be attributed to the legal hunt, illegal kills and problem wildlife kills (n = 59). The majority of grizzly bear kills within the Babine Watershed Monitoring Trust (BWMT) study area resulted from the Limited Entry Hunt (LEH, 80%) followed by 'problem' wildlife kills (10%) and illegal kills (10%). A similar number of males (n = 28) and females (n = 26) were killed during the study years, 1990-2011. We were unable to get a reliable estimate of the number of grizzly bears killed by the legal First Nations harvest or in conflicts on First Nations lands because it was not mandatory for First Nations to report grizzly bear kills in the compulsory inspection database. Similarly during interviews we heard of illegal kills of bears but could not verify those reports. Therefore, we have likely underestimated the 'true' number of kills as they relate to those sources of grizzly bear mortality.

Human-bear conflict resulting in a problem wildlife occurrence report was relatively common in areas such as Fort Babine and at the DFO fish fence due to the availability of domestic anthropogenic attractants as well as the availability of fish that pooled at the weir to bears. However, the increased implementation of non-lethal management actions such as relocation and translocation has reduced the number of animals being destroyed as 'problem bears' although the actual fate of the bear(s) moved often resulted in an LEH outside of the study area. Overall the spatial distribution of grizzly bear mortality appeared to be related to the LEH and guide outfitter territories, human settlements (Fort Babine), and road access, particularly adjacent to the only two authorized road accesses to the Babine River (upstream and downstream). We also examined if any potential causal relationships existed between grizzly bear mortality and distance to salmon bearing rivers, biogeoclimatic zone, land cover type and stand age. Identifying landscape features that may be related to bear mortality would benefit greatly from the implementation of a more statistically rigorous use-availability design than presented here as that level of advanced analysis was beyond the scope of this project.

We provided annual mortality rates and mortality rates by 5-year allocation periods. Mortality rates for this region, though limited in their application due to lack of historical population data, appeared high and resulted in the 2012 harvest allocation rates being exceeded in multiple years throughout the study period (1990-2011). We did not detect overharvest of grizzly bears in WMU 6-7 as it related to the annual mortality rate or the portion of that rate that is considered acceptable kill rate for females. For WMU 6-8 kill rates were over harvest allocation in 7 of the 22 years (32%). Annual female mortality rates were also over harvest allocation in 9 of the 22 years (41%) in WMU 6-8. The 5-year harvest allocations were also overharvest suggesting that grizzly bears are potentially being over-harvested within the BWMT study area, especially in WMU 6-8 but by 5-year allocation also in WMU 6-7. We discuss a number of explanations potentially contributing to why the harvest rate was repeatedly over the

harvest allocation. We think that the most plausible explanation is that the BWMT area was acting as a sink for grizzly bears. Interviews with local bear biologists raised concern that the weir was acting as a significant attraction to bears and may be drawing bears from unknown but large distances. If this is the case it is possible that a considerable number of bears concentrate in this area and therefore mortality rates for the larger area would actually be lower than we report, potentially resulting in a source-sink dynamic when compared with the larger Babine Grizzly Bear Population Unit (GBPU).

The grizzly bear population in the BWMT has very limited data regarding population size, status or trend. Indeed various sources indicated that the Babine Grizzly Bear Population Unit (GBPU) was the least understood of all GBPUs within the province. If the Trust is concerned with issues related to the harvest allocation it is prudent to determine the distance at which the BWMT study area is drawing bears from surrounding areas. We recommend that the Trust consider a demographic study of grizzly bears captured within the BWMT study area and subsequently monitored throughout their entire range. We recommend implementing scientific trend monitoring of the population using at a minimum a combination of non-invasive (DNA based) trend monitoring techniques but preferably in combination with outfitting some bears with GPS radio-tracking collars. We believe that management recommendations made by the Trust need to be considered at the Grizzly Bear Population Unit (GBPU) level because that is the scale at which the Provincial government manages the biological bear population. The current focus on the Trust's monitoring area is far too narrow to adequately determine population trends and therefore the influence the bear mortalities within the BWMT area are having on the larger GBPU. Mortality rates for the study area can not be adequately determined without reliable, science-based information on ecosystem-wide population trends.

We found that access to educational messages that focused on bear awareness recommendations and how to reduce undesirable interactions between humans and bears was limited in the Babine watershed and varied based on the company/organization. Although the types of Bear Smart messaging supplied by user groups within the study area tended to be somewhat similar, and were mostly accurate, they were largely too broad in content to be helpful. BC Parks staff received the most rigorous training regarding bears but it was unclear whether this information was passed on to park users because there was not a permanent ranger assigned to this park. In addition, the majority of public education on bears was located on their web site requiring park users to familiarize themselves before their trip. We found only one company, the Baine Norlakes Steelhead Camp, that had made notable and consistent efforts to ensure the safety and education of their guests in regards to bear smart practices both to reduce the potential for a bear encounter and how to respond in the event of a bear encounter. We suggest that this company may act as a role model for other operations. We were unable to contact anyone in Fort Babine despite repeated efforts. Due to the mortality of bears associated

with attractants at Fort Babine we recommend a dedicated Bear Smart outreach educator visit this area and provide seminars on attractant management. There are many useful educational resources available to educate recreationalists however it does not appear that they were being consistently utilized. We recommend the development of more consistent, site-specific and accessible bear awareness education for this area. An in-depth examination of the behavioural response by bears to humans is another research aspect that would yield information beneficial to the management of bears in this multi-use recreational area that contains an abundance of natural (i.e., fish) and non-natural attractants to grizzly bears within the larger Babine GBPU.

1.0 Introduction

Human activities have been reported as the primary factor influencing grizzly bear (*Ursus arctos* L.) density because they can result in loss of suitable habitat and increased human-caused mortality of bears (Servheen 1984, Mattson & Merrill 2002). Mortality factors for grizzly bears can result from a number of causes including but not limited to the legal hunt, First Nation kills, problem wildlife kills, in defence of life and property kills (DLP), illegal kills, and rail and road collisions. Human-caused mortality is reported as the primary cause of death for adult bears in the majority of grizzly bear populations (McLellan 1990, Mattson & Merrill 2004, Nielsen et al. 2004, Schwartz et al. 2006, Ciarniello et al. 2009). The Babine Watershed Monitoring Trust (BWMT) was interested in identifying the drivers that contribute to regulating or limiting population change of grizzly bears within their monitoring area. The resulting Babine watershed human-grizzly bear interactions and education project had two main objectives: (1) to gather, summarize and re-analyse data on grizzly bear mortality from 1990-2011; and (2) to summarize the status of current bear awareness education in Babine Watershed.

Grizzly Bear Population Units (GBPU) defined by the Provincial Ministry are used to delineate individual grizzly bear populations throughout British Columbia (Hamilton et al. 2004). GBPUs tend to follow topographic features such as height of land between watersheds or other ecologically based boundaries that act to limit immigration and emigration of bears between GBPUs. The Babine GBPU, which encompasses the BWMT study area, is considered viable "based on the difference between the current population estimate and the estimated habitat capability" (Hamilton et al. 2004). However, in a recent review of the Skeena Region, Apps (2011) identified the Babine as one of the highest priority GBPU in the province in need of a population inventory and monitoring. Land-use activities have been suggested to be negatively impacting the bear population but that level of impact remains to be quantified (Wellwood 2005). A Grizzly Bear Monitoring Index was used in the Babine from 1994-1997 and 2001-2003 to examine grizzly bear population trends but the information obtained from the 5 survey techniques employed (i.e., road, river, monitoring and incidental observations, and conflicts and bear mortalities) could not detect a trend (Hatler 1998, Wellwood 2005).

We present detailed spatial analysis of harvest and non-harvest related mortalities as well as provide clusters of mortalities ("hotspots") from all sources and by kill type. We use areas with dense clusters of grizzly bear mortalities to prioritize management recommendations, particularly as they relate to Bear Smart initiatives which are aimed at reducing "problem" kills further allowing for the conservation of bears (Davis et al. 2002). We also present the annual total human-caused mortality rates for the BWMT study area, 1990-2011, and examine those rates as a percentage of the current population estimate for 2012, and the percent of female bears represented. We accepted the Provincial allowable mortality rate of 6% of the population of which female mortality should not exceed 30%, to determine whether the mortality rate exceeded

allowable mortality levels. The legal harvest of bears can be controlled through government issuing of permits and therefore it should be more easily managed than management actions or illegal kills.

Grizzly bears may avoid areas with high human activities, preferring instead to spatially separate themselves from humans (McLellan and Shackleton 1989) or they may be attracted to areas with humans, primarily as a result of human-provided attractants (Gibeau et al. 2002). In 1994, the Babine River was proposed as a "wilderness zone" due to its significance to wildlife, particularly grizzly bears, steelhead, and salmon as well as abundant recreational opportunities. Within the BWMT study area there are world-class non-consumptive (e.g., rafting, kayaking, camping, photography) and consumptive (e.g., angling, hunting) recreational opportunities occurring within protected and non-protected areas. The abundant seasonal foraging opportunities that are critical to bears are also excellent spots for outdoor activities. Considerable runs of salmon species accumulate at the Department of Fisheries and Oceans (DFO) fish-counting weir, providing excellent angling opportunities for bears and people alike. We assess the reliability, quality and availability of information on grizzly bears offered in the BWMT area to recreationalists.

The primary goals of this study were to quantitatively and spatially examine grizzly bear mortality within the BWMT study area to provide for increased understanding of the various causes of bear mortality and to evaluate Bear Smart messaging available to residents and visitors. The study was designed to focus on the different causes of mortality, identify "hotspots" of mortalities or conflicts by type, and calculate mortality rates by comparing known/recorded grizzly bear mortalities with the annual allowable kill rate set by the Province. We think that the grizzly bear mortality information contained within this report may be beneficial to reducing the conservation risk to grizzly bears because areas of locally high mortality have been identified by the primary cause(s) thereby allowing for the formulation of site-specific management recommendations.

2.0 Study Area

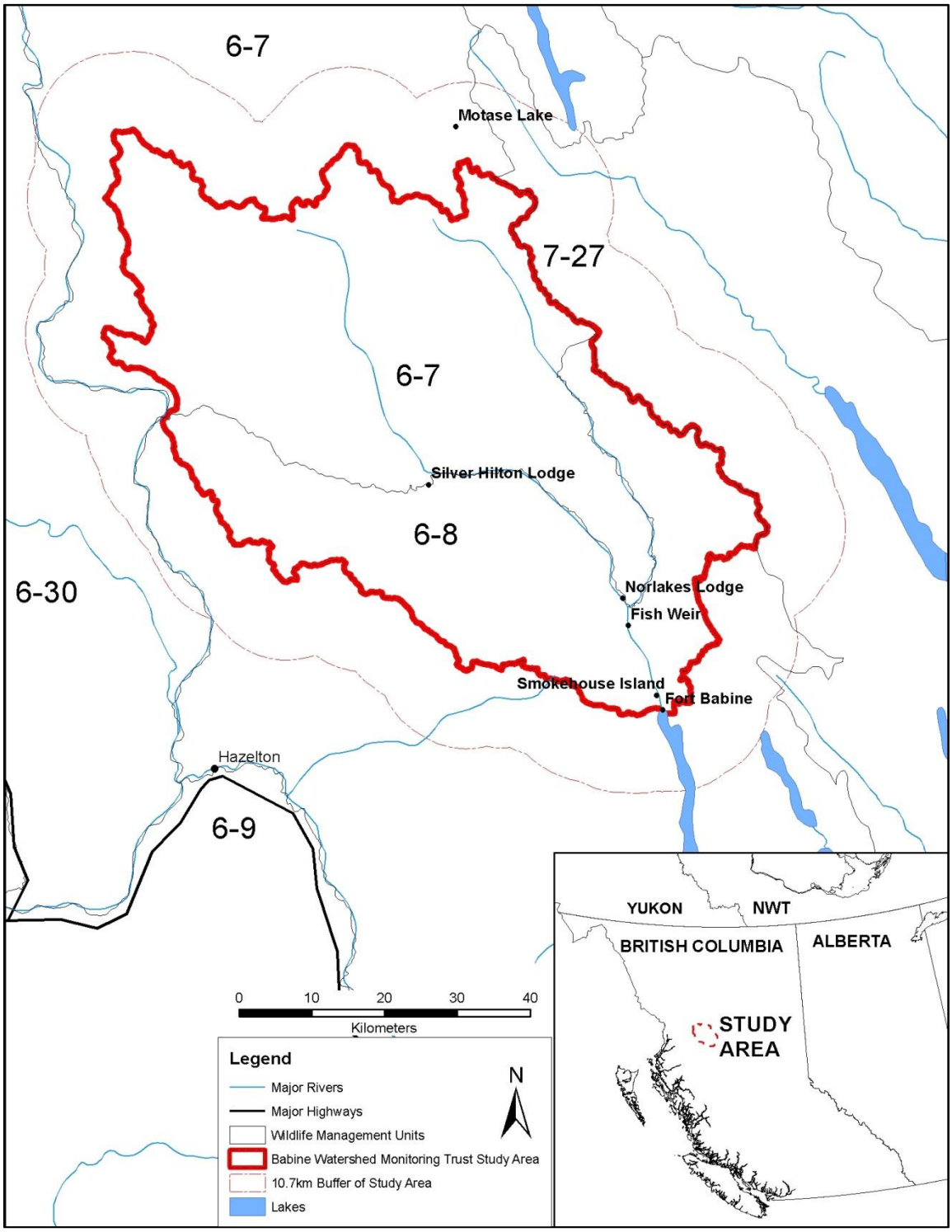
The Babine Watershed Monitoring Trust study area (BWMT) is approximately 4,022.5 km^2 located in north-western British Columbia, Canada (centroid UTM 6169928 620164, Zone 9; Fig. 1). The study area is primarily contained within two Wildlife Management Units (WMU; 6-7, 6-8) while the inclusion of the buffer encompassed four WMUs (6-7, 6-8, 6-30, and 7-27). The BWMT area comprised 29% of the larger Babine Grizzly Bear Population Unit (13,786.5 km^2, see Fig. 11). The Babine River, a tributary of the Skeena River, runs through the centre of the study area.

The eastern part of the Babine watershed is home to the Nadut'en community of Fort Babine while the western part is within Gitxsan territory. The watershed also accommodates the Babine

River Corridor Provincial Park and the fish fence (weir) belonging to the Department of Fisheries and Oceans (DFO). The area is renowned for its world-class angling opportunities attracting recreationalists from around the globe. Grizzly and black bears (*U. americanus*) are also attracted to the river for the considerable runs of wild steelhead, sockeye, Chinook, coho, and pink salmon, Dolly Varden and rainbow and bull trout. Multi-user groups such as guide outfitters, resource extraction companies, lodges providing angling opportunities and rafting companies work and recreate within the watershed.

During interviews with local experts we noted a concern that the BWMT study area did not consider ecological boundaries for bears when determining the monitoring area (D. Wellwood, pers. comm.). We investigated this concern and noted that in particular the northern and southern boundaries tended to be open, lower elevation valleys that with the addition of the Babine River may actually facilitate movement for bears; we agreed that there was no apparent limitation to immigration or emigration for bears, particularly for females and to the north-south. Due to biological closure issues we placed a 10.7-km buffer around the BWMT study area, which was meant to represent the average home range size for female grizzly bears in interior BC as determined by Ciarniello et al. (2009). The buffer was 3,734.5 km^2 and increased the BWMT area to 7,757 km^2. Aside from visual representation on the figures the results for the buffer analyses are contained within Appendix 7.1.

Figure 1. Babine Watershed Monitoring Trust Study Area used to provide the detailed spatial analyses of harvest and non-harvest related mortalities and the status of current bear awareness education in Babine Watershed, 1990-2011. The dashed, light red outer boundary represents the 10.7 km buffer (Appendix 7.1).



3.0 Methods

3.1 Meta-Database

To acquire the necessary grizzly bear data from within the Ministry of Environment for the Babine watershed a Freedom of Information and Protection of Privacy Act release form was completed. The form was submitted to A. Hamilton, Mike Badry, Kevin Nixon and Deanna Muir, and full access to the data was granted.

The final outcome (i.e., mortality, translocation, etc.) for each situation involving a grizzly bear determined how each report was allocated. We prioritized reports into one of three categories: killed bears; problem wildlife reports; or relocations. This was required in order to avoid duplication within the databases, as certain bears fit all three scenarios; for example, a bear may have been reported as a problem, subsequently trapped and moved, and then later destroyed. If a report resulted in a dead bear, either due to the LEH, an illegal kill, animal control or because it was considered problem wildlife, that animal was put into the database for destroyed bears. The next priority category was relocated and translocated bears because they potentially represented a loss (i.e., moved out of) or gain (i.e., moved into) to the local population. The final category was for bears that were reported to the COS as Problem Wildlife Occurrence Reports (PWOR) but that did not result in the bear(s) being moved or destroyed. We have provided the meta-database as a separate Excel document. The resulting meta-database from the acquired information (Bears Killed, Problem Wildlife Reports, and Bears Relocated) are each prefaced by a data dictionary that provides definitions and describes the database contents in detail.

3.2 Compulsory Inspection Data

Compulsory Inspection (CI) data were requested and received from A. Hamilton, Large Carnivore Specialist, Victoria, in December 2011. These data included information on all reported grizzly bear kills within the BWMT study area and buffer. We requested the kill date, kill year, hunting season, location in UTM, description of the location, gender of the bear, tooth and edited bear age, and skull length. The UTM coordinates provided were rounded to the nearest kilometre (i.e. 345678E, 1234567N = 346000E, 1235000N). The UTMs that we were required to determine from the location descriptions were also rounded to maintain consistency. A. Hamilton aided us in interpretation of the CI data as well as located any original CI records in cases where we required confirmation of facts. We did approach the David Suzuki Foundation for CI data however we were told that it was the same data already acquired from A. Hamilton.

3.3 Problem Wildlife Occurrence Reports

We contacted Kevin Nixon, Conservation Officer Sargent in Smithers, to obtain paper copies of the original Problem Wildlife Occurrence Reports (PWORs) dating back to 1990; PWORs were not recorded in electronic/database format until approximately 2001 at which time

only certain records/attributes were entered. The most recent PWOR binders (2009-2010) were in the local COS office, and the records from 1999-2008 were stored in the Smithers COS warehouse. For the earlier records, Deanna Muir, the Freedom of Information and Protection of Privacy Act (FoIPPA) Coordinator in Records Management was contacted. Ms. Muir provided us with the PWORs from 1990-1998, which were held in an offsite storage warehouse in the lower mainland. We had all records shipped to the Prince George COS office where they were manually sorted through for those grizzly bear reports occurring within the BWMT study area and buffer. Mike Badry, Wildlife Conflicts Prevention Coordinator, provided the 2011 PWORs in January 2012 (MS Excel) which were taken directly from the new COS call centre log. The acquisition and sorting of the PWOR data was very time consuming due to the storage of the records in multiple locations and the need to manually sort through the hard copy reports. PWORs were provided to us by year in a binder containing a PWOR ledger. Some years had multiple binders due to the high frequency of PWORs for that season. The PWOR ledger lists all of the PWORs by date, but also describes each record by species, location, occurrence and the outcome. Most ledgers were filled out by hand.

Data were collected from each PWOR that was within the Babine study area and the 10.7 km buffer zone. We began by locating the grizzly bear records and those records were then sorted by location. The following data were collected from each applicable report: the PWOR number; the date of the occurrence; all location information (including the wildlife management unit and UTMs if provided, although this was rare); the type of occurrence; the attractants available; management actions taken; and all follow up details related to the report. As per our confidentiality agreement no personal information such as names or phone numbers were recorded. All duplicate reports (i.e. two different people calling in about the same 3 bears in the same location on the same day) were removed from the database to reduce double-counting.

Up until approximately 2001, the PWORs were printed forms which were filled out by hand. After 2001, it appeared forms were partially filled out on a computer database and then printed, where addendums or updates (i.e. trap status, etc) were added by hand. Reading some of these reports, especially the details, could be arduous due to nearly illegible hand writing. Additionally, many of the forms were filled out only partially, or were not filled out at all. For example, there was a record stating that a bear was sighted in Fort Babine and the only detail provided on the report was that the bear was 'trapped and moved'. There was no further information on what the bear was doing, how the bear was trapped, or where it was moved to. There were also instances where further action was taken with an animal but there was no logical follow up within the reporting system, leaving us to piece together the situation. These types of examples indicate that the reports were not being filled out in their entirety, and that important details that should have been included were not properly recorded in some cases. We also encountered difficulty with the PWOR locations. The majority of the occurrence locations did

not provide UTM coordinates and our only landmark was general descriptions that were not meaningful for interpretation for those not familiar with the area; for example, grizzly bears reports were filled out for "Willie's cabin", "the 487 Rd' and "78 km on the Nilkitkwa FSR". Determining a fairly precise location in order to assign UTM coordinates for mapping purposes took vast amounts of time referencing road networks and talking with local experts familiar with the area and the Fort Babine community, such as Kevin Nixon and George Schultze. We obtained as much information as possible on the PWORs and it has been included in the meta-database provided with this contract.

3.4 Relocated and Translocated Bears

Relocation is defined as moving an animal from one area to another within its home range (i.e., short distance), while translocation implies the movement of an animal to an area that is outside of its home range (ICWDM 2008). For this report, animals that were moved outside of the study area or into the study area from other regions are considered translocated bears. Animals that were moved within the study area are referred to as relocated bears. To obtain accurate relocation and translocation data, George Schultze, the Wildlife Officer in Smithers, was contacted. Since the early 1990s he has been keeping a record of when and where grizzly bears were moved. His spreadsheet contains information on relocated grizzly bears within the Babine watershed dating back to 1994. This database and Mr. Schultze's intimate knowledge of the study area was very valuable in determining specific locations and in answering a number of questions that resulted from incomplete PWORs reports. For the majority of the records Mr. Schultze had information on the fate of the relocated grizzly bears following their release.

3.5 Population Density Estimates and Mortality Rate Information

Bear densities along with other factors are used by the government to determine harvest allocation within each wildlife management unit (WMU). Grizzly bear density estimates for the province of British Columbia recently went under review and were updated for 2012 (A. Hamilton, pers. comm.). We report densities provided by A. Hamilton because those densities are being used to set harvest allocations.

We used the same methods as used by the Provincial government to obtain the number of bears within the BWMT study area and buffer (A. Hamilton, pers. comm.). First we determined the amount of area of each of the WMUs contained within the BWMT study area and buffer. Next, using the same GIS layers as used by the government to identify non-bear habitat (e.g., lakes, glaciers, rock) we removed the area of non-bear habitat from each of the WMUs. We then transformed the density of bears to the number of bears based on the resulting area and similar to the provincial government we assumed that number of bears was distributed equally across the WMUs. We note that this contains the inherent assumption that bears are uniformly distributed across the different landcover types however it is based on using averages. Next, we retained

only the amount of 'bear' habitat that occurred within the WMU that was also within the BWMT study area; this was used to obtain the number of bears within that slice of WMU area that occurred within the BWMT study area or buffer. To obtain the number of bears estimated to be within the BWMT area we simply added the number of bears from the different WMUs together. Density of bears per 1,000-km^2 for the BWMT area was then obtained by converting that number into the total area it represented in km^2.

We calculated the annual kill rate by taking the number of bears we determined to die each year (or time period) over the estimated population as determined above and based on the 2012 estimates for that portion of the WMU within the BWMT study area and/or buffer. We considered the provincial standard of 6% of the overall population as acceptable, of which no more than 30% should be female (A. Hamilton, pers. comm.). The ratio of males to females was assumed to be 1:1. Since the percentage will change based on the number of bears in the population we wanted to obtain population size for each year from 1990-2011 thereby varying the denominator; however, after approaching a number of different sources we were unable to locate those numbers and we were told they had not been retained (A. Hamilton pers. comm.). Therefore, we assumed the 2012 numbers were representative of past population size. We also obtained a second set of densities, calculated using the new multiple regression modelling techniques (D. Heard, pers. comm.), and provided them in the report for comparison.

3.6 Bear Observations and Education Evaluation

Documents from BC Parks on bear observations around the DFO fish fence and the BC Parks parking area were provided by John Howard, Babine Area Supervisor, BC Parks. BC Park employees recorded their bear observations for 2005 and 2006. Scott MacMillan conducted the observations from 2007-2011.

In order to assess the availability and consistency of bear awareness education to residents and visitors entering the Babine watershed we contacted all major groups with a presence in the area and inquired as to whether they discussed bears with their visitors (Table 1). Additionally, any groups who had made calls to the Conservation Officer Service and filed a PWOR between 1990-2011 were contacted. We contacted personnel with BC Parks, Fisheries and Oceans Canada (DFO), and the Fort Babine band office. We acquired the names of the companies operating within or around the Babine River Corridor Provincial Park, and compiled a list of groups who had made calls to the COS about grizzly bears. We also contacted a number of guide outfitters, angling lodges, rafting companies and resource extraction agencies and requested or discussed the bear aware information they provided their guests. Our evaluation of the Bear Smart material was based on recommendations contained within the International Association for Bear Research and Management's endorsed bear safety video: Staying Safe in Bear Country (www.bearbiology.com).

Table 1. Groups working within the Babine watershed that were contacted to discuss bear awareness education.

Company, Organization or Group	Responded?	Contact (Position)
BC Parks	Y	John Howard (Babine Area Supervisor)
Fisheries and Oceans Canada (DFO)	Y	Mike Jakubowski (past DFO camps manager)
Fort Babine Band Office	N	-
Falcon Drilling	Y	Dan Bomford (safety supervisor)
Pacific Inland Resources (West Fraser Timber)	Y	Al Baxter (biologist)
Houston Forest Products (West Fraser Timber)	Y	Mike Dunbar (woodlands manager)
Collingwood Bros. Guides and Outfitters	Y	Reg Collingwood (owner-operator)
Babine Norlakes	Y	Pierce Clegg (owner-operator)
Silver Hilton Steelhead Lodge	N	-
Fort Babine Lodge	N	-
Skeena Valley Expeditions	Y	Hatha Callis (owner-operator)
Nahanni River Adventures	Y	Neil Hartling (owner-operator)
Aquabatics	Y	Simon Coward (owner-operator)
Stellar Descents	N	-

For the Babine River Corridor Provincial Park we contacted John Howard, the Babine Area Supervisor for BC Parks. Mr. Howard provided electronic copies of documents that included historic park attendance, park statistics and anecdotal bear observations dating from 2005 to 2011. He also supplied a list of rafting companies utilizing the Babine River in recent years. We spoke with Mike Jakubowski, DFO Babine camp manager from 1981 to 2002, about his experiences with grizzly bears and the DFO fish fence. We attempted to contact Barry Finnegan and Jason Latrace, recent DFO managers at the Babine fish fence; however, we were unable to reach them for comment. The Fort Babine band office was called several times; however we were unable to reach anyone to discuss bear awareness education in the village. Contact was attempted with eleven other companies (eight responded), most of which are involved in the tourism and recreation sector. Respondents were asked about the education provided to their clients/guests regarding bear awareness and also what kind of training staff members receive.

3.7 GIS and Mapping

Johanna Pfalz provided the Geographic Information System (GIS) layers for the BWMT Land use plan boundaries, special management zones and management units, as well as the road layers. The road layers were only available for the BWMT study area and not for the 10.7-km buffer area. Obtaining current and accurate road layers was difficult as there are no central government databases that contain such data. From the various road layers provided we classified roads into five generalized categories (active, brush, deactivated, gravel, and unknown)

based on the comments and road types described in the source databases. Using the descriptions in the GIS layers provided for roads we classified the following road types as **Active**: Active (ACT); ACT - 2 unsafe bridges at approx. 6km; ACT - brushed in edges; ACT - possibly brushed in edges; ACT – guess; bridge; private; Kisgegas road; and, road - unimproved. Roads with the following descriptions were classified as **Brush**: ACT - very brushed in edges; ACT - very brushed in; ACT – 4WD access located 9km 486 rd Nilkitwa; ACT - 4wd access located at 9km 486 rd; ACT - gated at .1km has failing box culvert at .4km; Deactivated (D) - 4WD access; D - 4WD access, very brushed in; D - 4WD or ATV access; D - ATV access; D - 2WD access; water barred; over-grown; trail; Wilderness (W) -ATV; W-ATV access; and very brushed in. Roads with the following descriptions were classified as **Deactivated**: deactivated (D), old burn; D- over grown; D - unimproved cut block access; retired; and W - temp deactivated. **Gravel** roads had the classification: road, gravel undivided. Road with descriptions of unknown, pending and unsure were classified as **unknown**. The remaining GIS layers (BEC, land cover, salmon streams) were acquired online from various sources (Table 2).

Table 2. Information on the data layers used in spatial analyses, including their source and time of most recent update.

Data Layer	Source*	Time of Last Update
Provincial Biogeoclimatic Subzone	Ministry of Forests, Lands and Natural Resource Operations	March 2008
Freshwater Atlas Stream Networks	LRDW Geographic Data Discovery Service	2008
Salmon Bearing Streams	FISS Historical Fish Distribution Maps	2006
Forest Cover Polygons	LRDW ILMB Discovery Service	2006
Landsat^{TM} images	US Geological Survey	August 2011

* For source website addresses, please see the References section.

Grizzly Bear Population Units (GBPUs) and Wildlife Management Units (WMUs) were obtained from A. Hamilton. It was assumed that the BWMT study area followed the boundaries of the wildlife management units, however due to differences in map scale, the two boundaries do not line up, which caused minor issues in the spatial analyses. Area calculations for both the GBPUs and the WMUs involved the subtraction of rivers, lakes and glaciers as provided by A. Hamilton. In this way the area calculations in this report match those used by the Ministry of Environment for calculating grizzly bear densities. Spatial analyses were performed using Analyst, Spatial Analyst and Hawths tools in ArcGIS 9.3.1., and were conducted on the BWMT

study area and the buffer independently. All statistical analyses were run using SAS 9.2 and Microsoft Excel 2010.

4.0 Results

4.1 Causes and Hotspots of Grizzly Bear Mortality (Compulsory Inspection & Problem Wildlife Occurrence Reports)

There were 59 reports of dead grizzly bears associated with the three types of kill codes within the BWMT study area, 1990-2011 (Table 3, Fig. 2). Forty-seven (80%) of those bears were destroyed legally through the limited entry hunt (LEH), six (10%) bears were killed illegally and reported to the COS, and 6 (10%) were animal control kills. Four bears destroyed as 'animal control' did not contain information on the conflict or type of domestic anthropogenic attractant while the remaining two were destroyed as 'problem' wildlife. One of those two bears did not have a corresponding CI report to match the PWOR although it was destroyed in protection of property. This was the only destroyed animal within the database that did not have a CI report. There was only one family group killed and it was a female with three cubs (illegal kill).

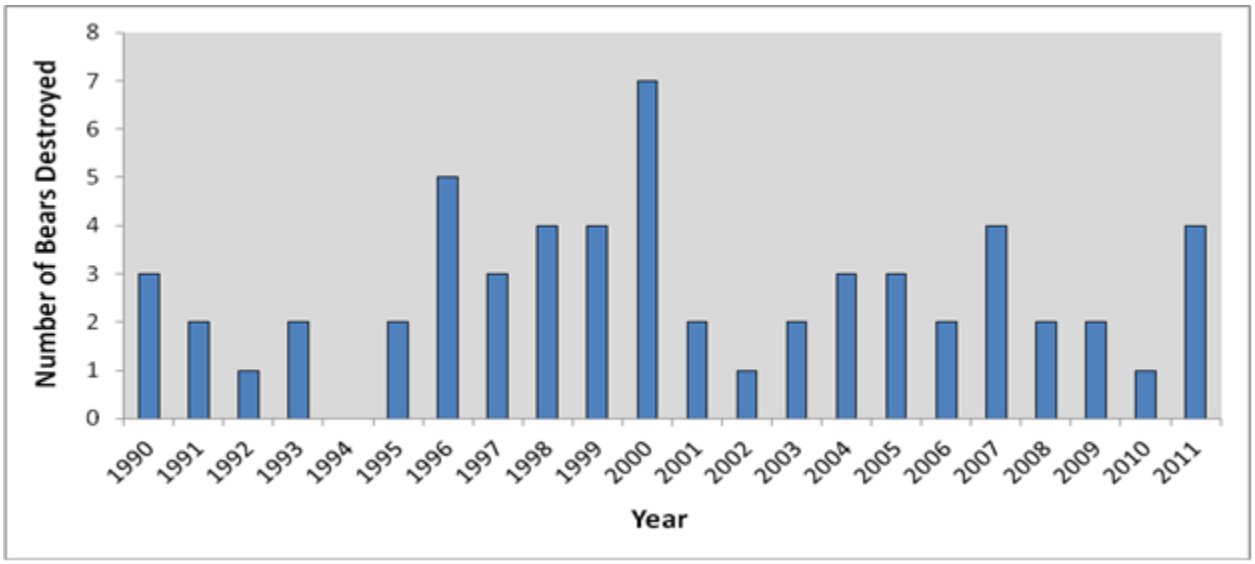
Table 3. Number of grizzly bears killed according to primary kill type category as recorded in the CI or PWOR databases by 11-year period for the Babine Watershed Monitoring Trust Study Area, 1990-2011.

Kill Type		Year	No. Bears Destroyed
Domestic Anthropogenic Attractant (DAA)			
	Smokehouse	1990-2000	0
	Fish fence	1990-2000	0
	Trap line	1990-2000	0
	Garbage	1990-2000	1
	Barbeque	1990-2000	0
	Pets	1990-2000	0
	Not recorded (Animal Control)	1990-2000	4
Subtotal DAA			*5*
Sighting		1990-2000	0
Illegal Kill		1990-2000	4
Limited Entry Hunt		1990-2000	24
1990-2000 Total			*33*

Kill Type		Year	No. Bears Destroyed
Domestic Anthropogenic Attractant (DAA)			
	Smokehouse	2001-2011	0
	Fish fence	2001-2011	0
	Trap line	2001-2011	1
	Garbage	2001-2011	0
	Barbeque	2001-2011	0
	Pets	2001-2011	0
	Not recorded (Animal Control)	2001-2011	0
Subtotal DAA			*1*
Sighting		2001-2011	0
Illegal Kill		2001-2011	2
Limited Entry Hunt		2001-2011	23
2001-2011 Total			*26*
All Years (1990-2011)			59

We could not identify a trend in the number of grizzly bear mortalities within the BWMT study area, 1990-2011 (Fig. 2). The peak year of bears destroyed in 2000 (n = 7) was the result of the illegal killing of a female and her three cubs on Nilkitkwa Lake. We did not locate any records for grizzly bears destroyed in 1994 by the LEH or PWORs. We were told that it is possible that fewer LEH tags were issued in 1994 or that the number of tags was reduced to compensate for the over harvest allocation (A. Hamilton pers. comm.). We also could not locate any problem wildlife life kills for 1994. We remain uncertain about the lack of data for that year.

Figure 2. Number of grizzly bears destroyed within the Babine Watershed Monitoring Trust Study Area by year, 1990-2011 (*n* = 59).



4.1.1 Problem Bear, Animal Control, and Illegal Kills

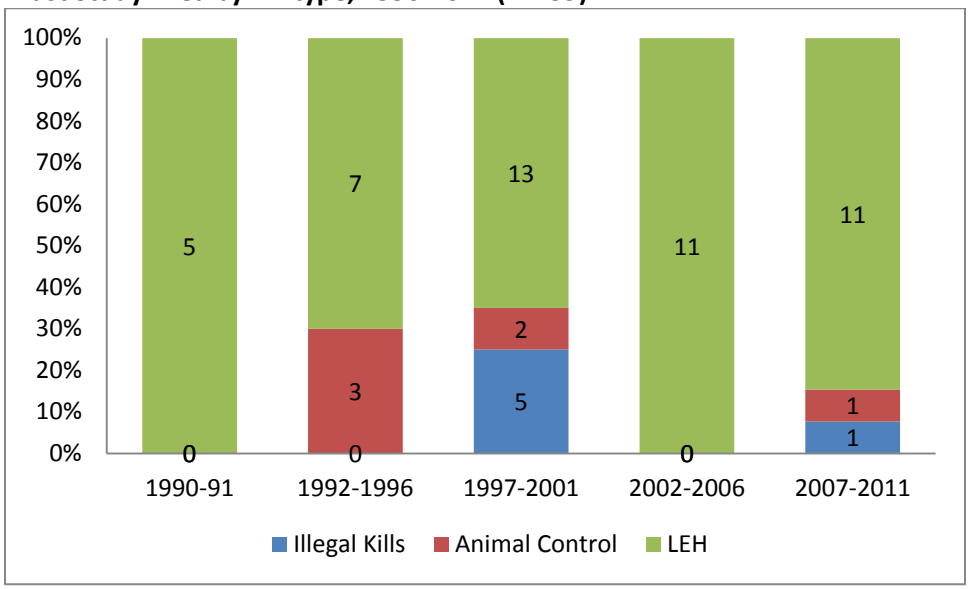
From 1990-2011, six bears were killed as "problem" wildlife or animal control ($\bar{x}$ = 0.27 bear/year) representing 10% of the overall kills for this period. Three of the four bears destroyed as a result of 'animal control' were located at Fort Babine or the Kisegaas Indian Reserve (Figs. 3, 4, Table 3). These reports occurred between 1990-2000 and did not have any attractants listed, although it is assumed there would have been anthropogenic attractants involved due to the proximity of the bears to human settlements. The two grizzly bears destroyed as "problem" wildlife followed a PWOR. One was attracted to unsecured garbage and returned after being relocated, and the other was caught in a rural trap line in winter. Both bears were killed by local residents. The rest of the PWORs within the study area resulted in a variety of other, non-lethal management actions. Kills related to domestic anthropogenic attractants were highest in fall (*n* = 5) followed by summer (*n* = 1) with none reported for spring[1].

Illegal Kills – From 1990-2011, six bears were taken without a legal licence comprising 10% of the overall recorded kills within the BWMT study area. Four bears were illegally killed between 1990-2000 representing 12% of kills for that period, and two between 2001-2011 (8%). Fort Babine and Nilkitkwa Lake appear to be where the majority of bears were killed without a legal licence, however this hotspot was represented by the four animals (female and three cubs) that were destroyed by the same offenders in 2000 (Fig. 5, Table 3). The other two illegal kills

[1]Definition of seasons follows Ciarniello et al. (2009) where spring = den emergence to 14 July, summer = 15 July to 20 September, and fall = 21 September to den entry.

occurred in remote locations. Illegal kills were highest in summer (n = 4) with only one each for spring and fall.

Figure 3. Percent and number of grizzly bears destroyed within the Babine Watershed Monitoring Trust Study Area by kill type, 1990-2011 (n = 59)[1].



[1]Since 22 years cannot be divided into even time periods 1990-01 represents only two years. These time periods were used to match the harvest allocations presented in Section 4.4

Figure 4. Hotspots for animal control kills for grizzly bears in the Babine Watershed Monitoring Trust Study Area and buffer, 1990-2011.

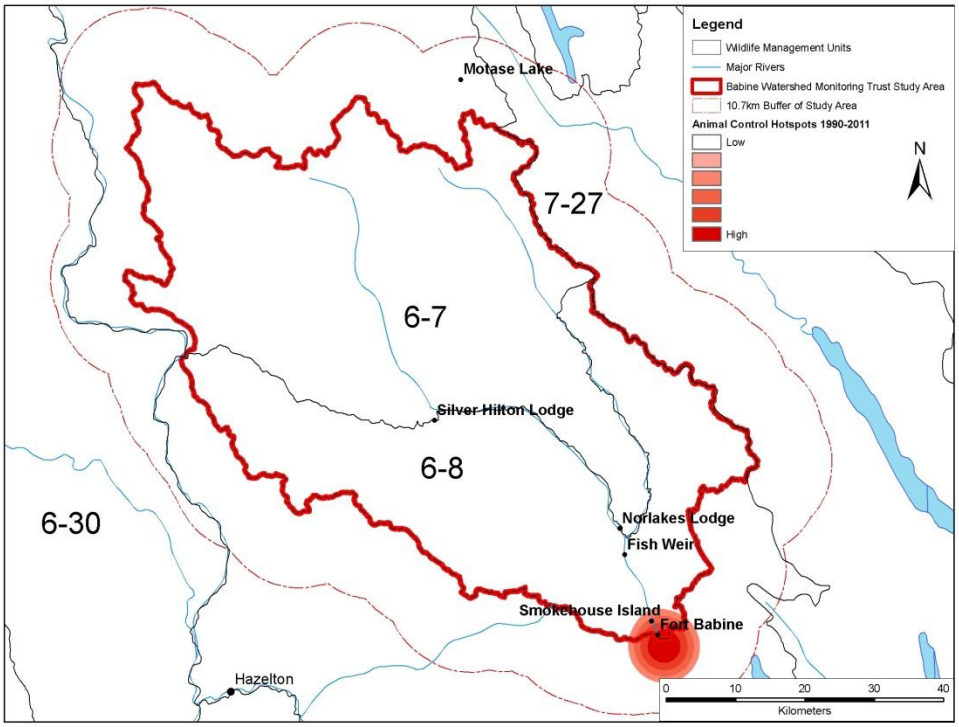
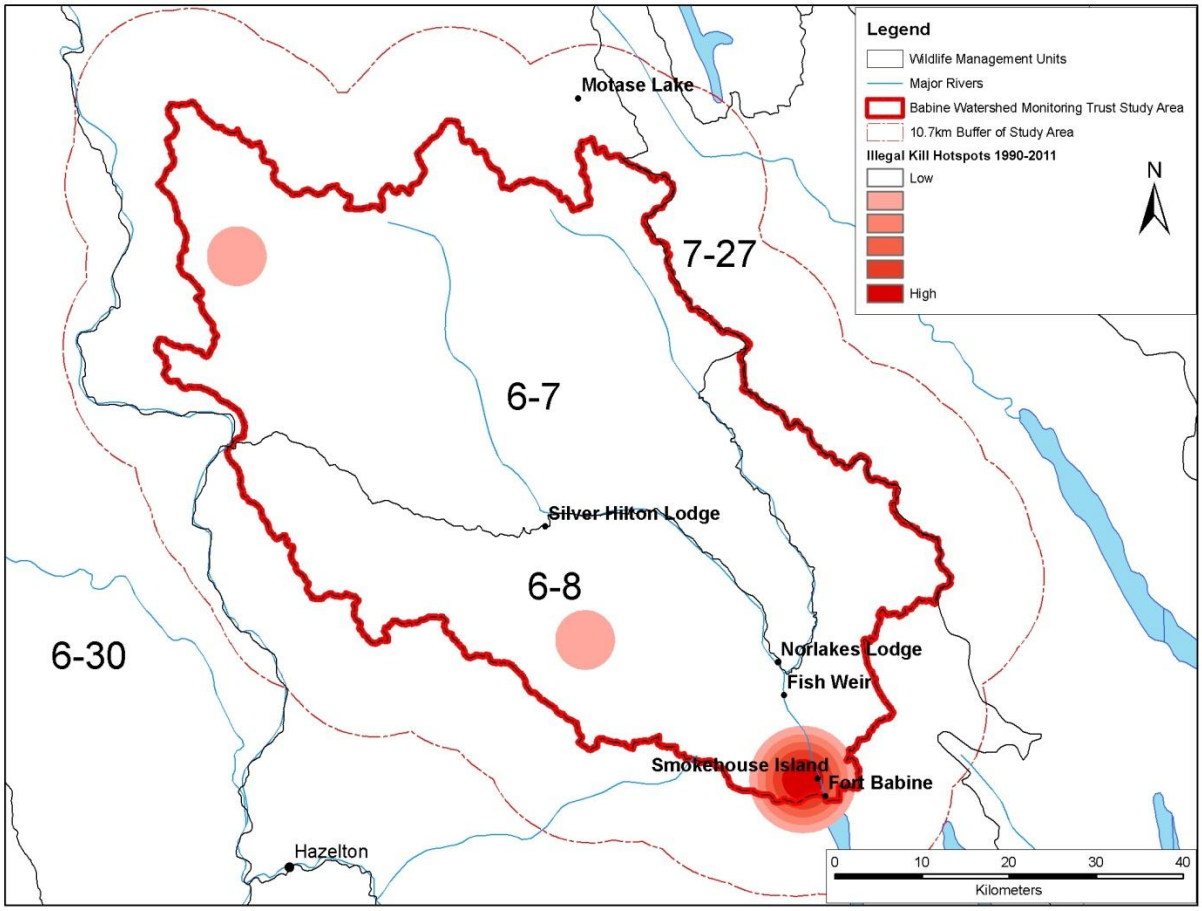


Figure 5. Hotspots for illegal kills of grizzly bears in the Babine Watershed Monitoring Trust Study Area and buffer, 1990-2011.



4.1.2 Grizzly Bear Mortality According to Planning and Management Units within the BWMT

The Kispiox and Bulkley timber supply areas (TSA) are contained with the watershed, and within those areas there are multiple planning and management units, including special management zones and landscape unit plans (Fig. 6). Over twice the number of bears were killed in the Bulkley TSA (71%) as compared with the Kispiox TSA (29%) despite the smaller area (km^2) of the Bulkley TSA (Table 4). The uneven distribution of kills between areas may suggest higher quality habitat for grizzly bears in the Bulkley TSA and/or an uneven distribution of LEH tags and/or management actions.

Of the Major Planning Units the Babine Landscape Planning Unit contained 66% of the grizzly bear kills and was also where most of the non-lethal management actions had taken place, followed by the West Babine SRMP (29%). Taking into account the number of bears killed per unit area was also higher in the Babine LPU being ~4.5 times greater than the West Babine SRMP and Nilkitkwa LPU (Table 4). Within the West Babine SRMP the Shedin (12% of the

study area; 41% of the West Babine SRMP; 0.012 bears per unit area) and Babine River (10% of the study area; 35% of the West Babine SRMP; 0.010 bears per area) had the highest number of grizzly bears killed. In the Nichyeskwa the north 0.021 pers per unit area while no bears were reported killed in the south Nichyeskwa. Only two grizzly bears were recorded to have been destroyed on Federal Indian Reserve Lands, however, those lands only accounted for 16.14 km^2 of the study area resulting in the highest kills per unit area (Table 4). Interviews with a number of participants indicated that this number highly underestimated 'true' grizzly bear mortality associated with First Nation reserves.

Figure 6. Planning and management units within the Babine Watershed Monitoring Trust study area.

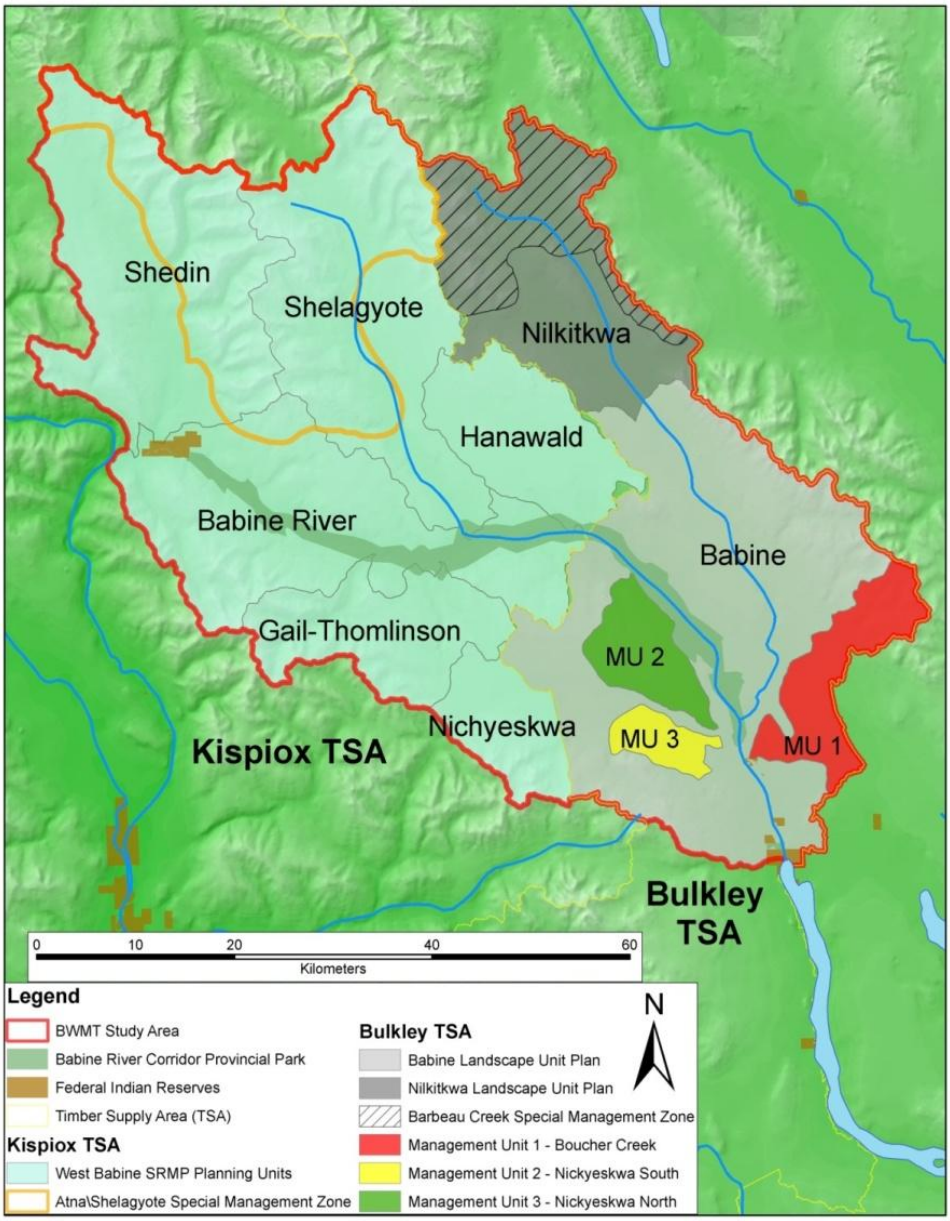


Table 4. Number of grizzly bears killed within the Babine Watershed Monitoring Trust Study Area planning and management areas, 1990-2011.

BWMT Sub-Areas (km^2)	No. Grizzly Bears Killed (59)	No. Grizzly Bears Killed per area	No. Non-lethal Management Actions	Total
Timber Supply Areas				
Kispiox TSA (2,372.04)	17	0.004	2	19
Bulkley TSA (1,650.39)	42	0.010	61	103
Total	59		63	122
Major Planning Units				
West Babine SRMP Planning Units (2,365.93)	17	0.007	2	19
Nilkitkwa Landscape Unit Plan (445.33)	3	0.007	0	3
Babine Landscape Unit Plan (1,205.07)	39	0.032	61	100
Total	59		63	122
West Babine SRMP Planning Units				
Gail (239.95)	1	0.004	0	1
Hanawald (229.3)	1	0.004	0	1
Babine River (581.92)	6	0.010	2	8
Shelagyote (580.9)	1	0.002	0	1
Shedin (606.08)	7	0.012	0	7
Nichyeskwa (131.78)	1	0.008	0	1
Total	17		2	19
Babine Landscape Unit Plan - Management Units				
Nichyeskwa-North (97.4)	2	0.021	0	2
Nichyeskwa-South (45.66)	0	0.000	0	0
Boucher Creek (141.92)	2	0.014	0	2
Total	4		0	4
Special Management Zones				
Atna/Shelagyote SMZ (698.68)	1	0.001	0	1
Barbeau Creek SMZ (233.3)	1	0.004	0	1
Total	2		0	2
General Provincial/Federal Areas				
Babine River Corr. Prov. Park (153.39)	4	0.026	2	6
Federal Indian Reserves (16.14)	2	0.124	6	8
Total	6		8	14

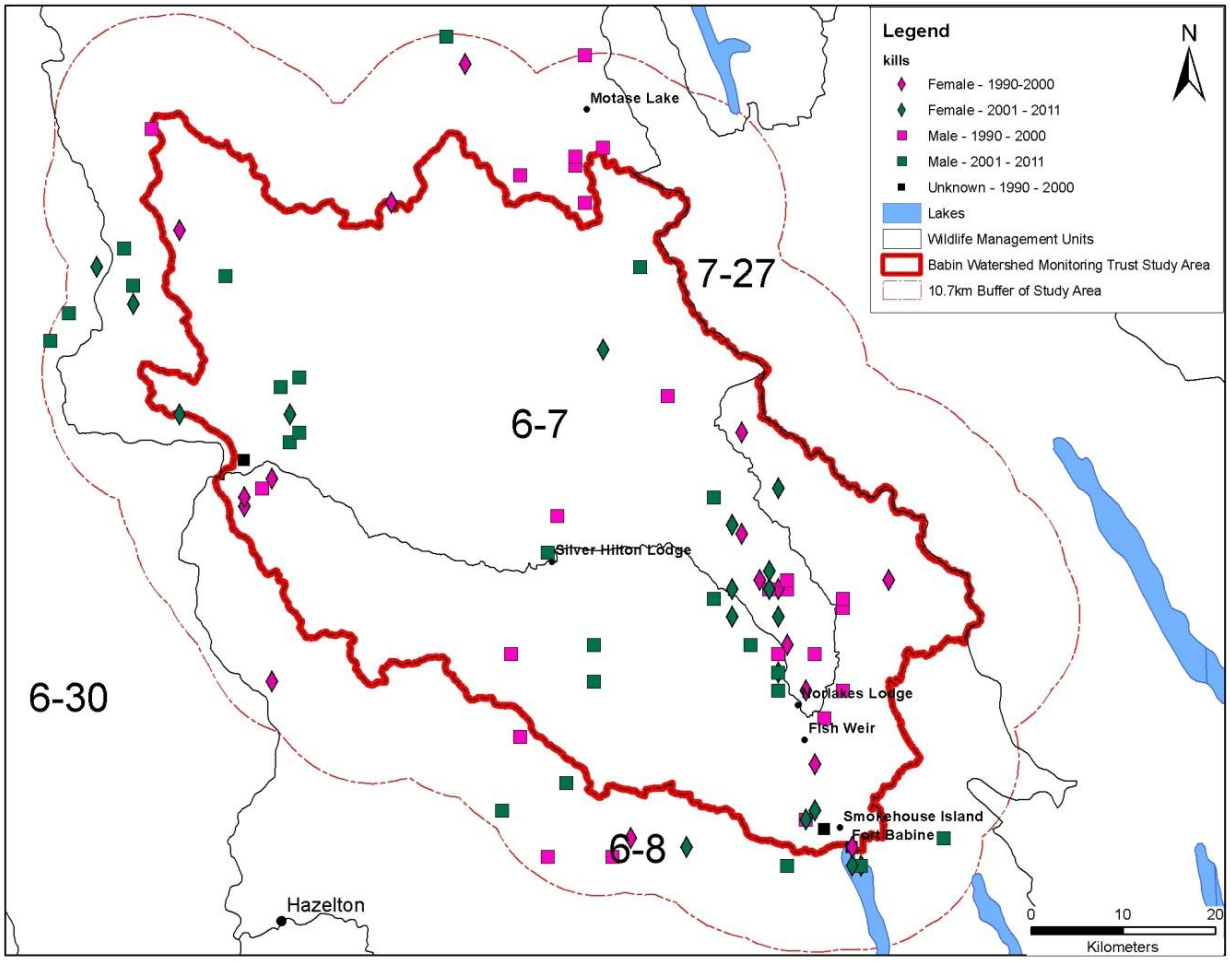
4.2 Grizzly Bear Mortality by Gender

From 1990-2011, a similar number of males (n = 28) and females (n = 26) were killed (Table 5) however we do not know how this compares with the gender ratio of the BWMT population. Female bears killed were on average younger than male bears ($\bar{x}$ = 8 years vs. 10 years). The oldest bear killed was a male at 26 years, and 23 years for females. Thirty-two percent of female bears killed and fourteen percent of male bears killed did not have an age recorded. Of the six animals from 1990-2000 where sex was unknown, one bear was killed via LEH, one was killed as animal control in Fort Babine and the other four were the three cubs of the sow killed illegally on Nilkitkwa Lake. There was a notable cluster of female bear mortalities in the northeast which were primarily LEH and the result of a guide outfitter that works that area from a fly in camp at Motase Lake (Fig. 7). The fish weir and Norlakes lodge area also had more females killed than males.

Table 5. Age and gender of grizzly bears killed in the Babine Watershed Monitoring Trust Study Area, by 11 year periods and cumulative, 1990-2011.

Time Period	Number of Bears			Number of Bears With Recorded Age			Mean Age		Standard Error Age		Range of Age	
	F	M	U	F	M	U	F	M	F	M	F	M
1990-2000	13	14	6	9 of 13	13 of 14	0 of 6	6	9	1.72	2.03	2, 18	1, 24
2001-2011	12	14	-	8 of 12	11 of 14	-	10	11	2.67	2.61	3, 23	2, 26
Total 1990-2011	**25**	**28**	**6**	**17 of 25**	**24 of 28**	**0 of 6**	**8**	**10**	**1.57**	**1.6**	**2, 23**	**1, 26**

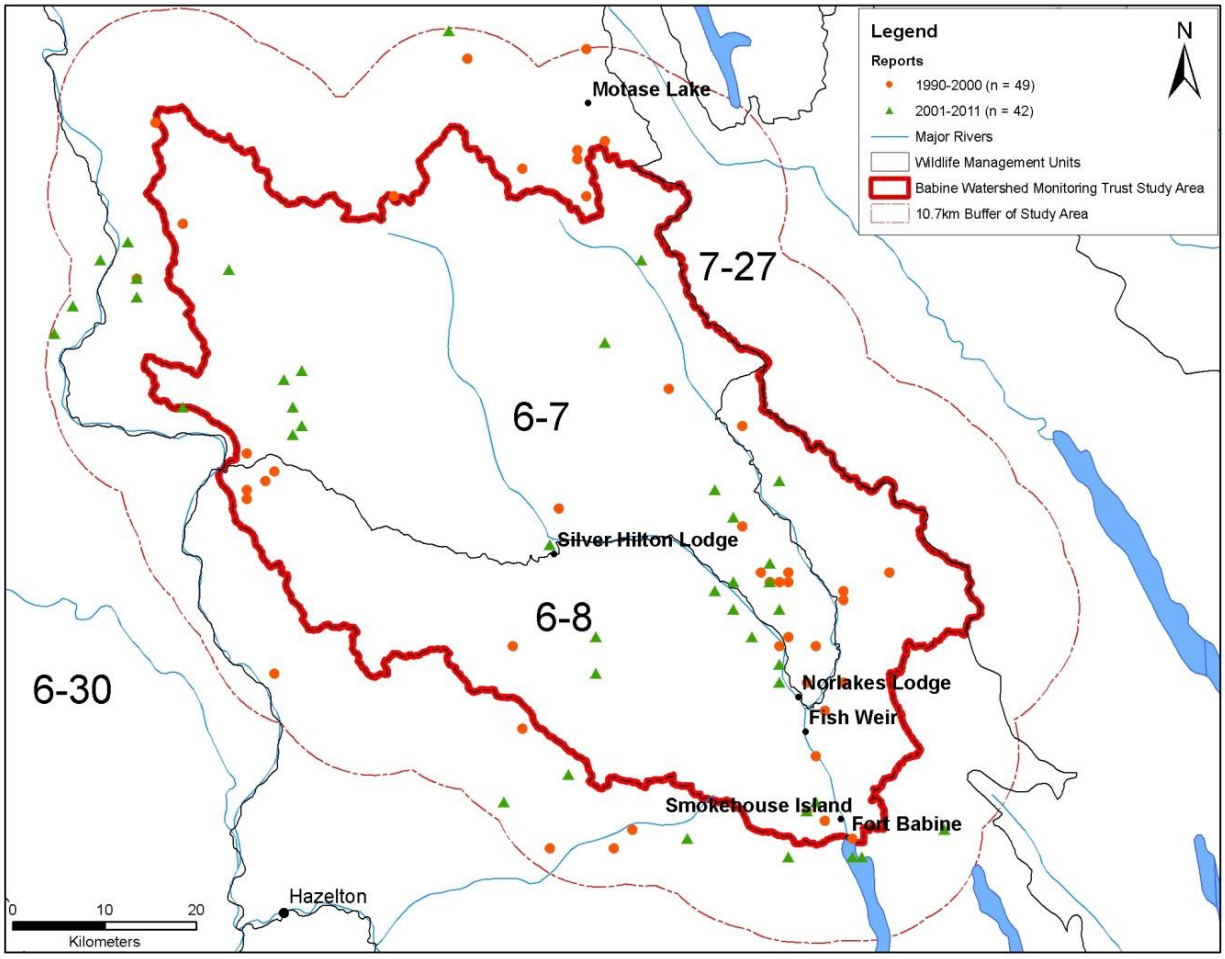
Figure 7. Grizzly bear kills by gender for the Babine Watershed Monitoring Trust Study Area and buffer by 11-year period, 1990-2011.



4.3 Grizzly Bear Mortality & Potential Associations

The spatial distribution of grizzly bear mortality in Figure 9 appears to be related to three main causes that are themselves related to specific areas: (1) the LEH and guide outfitter territories; (2) road access, particularly adjacent to the only two authorized road accesses to the Babine River (upstream and downstream); and (3) possibly human access associated with major salmon bearing rivers (Fig. 8). Following we discuss each potential causal link. For potential associations with biogeoclimatic zones (BEC) or landcover types refer to Appendices 7.2 and 7.3.

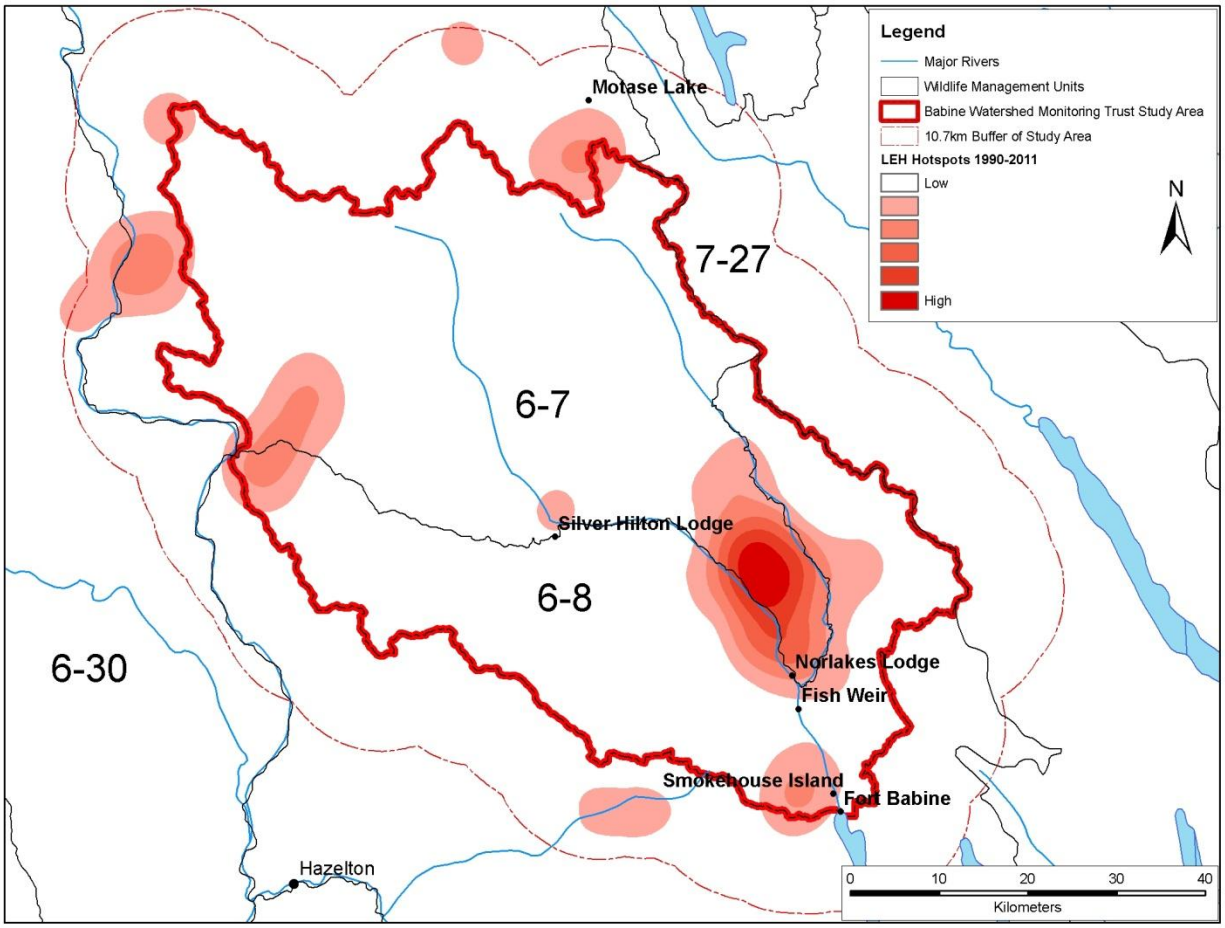
Figure 8. Grizzly bear kills recorded in the Compulsory Inspection and Problem Wildlife Occurrence Reports for the Babine Watershed Monitoring Trust Study Area and buffer by 11-year period, 1990-2011.



4.3.1 Grizzly Bear Mortality and the Limited Entry Hunt

There are several hotspots for hunted bears; however the highest number of kills occurred in the area between the Babine and Nilkitkwa Rivers (Fig. 9). The cluster of mortalities in the northeast was primarily LEH and the result of a guide outfitter that works that area from a fly in camp at Motase Lake. Hunting was allowed within the Babine River Corridor Provincial Park and the aforementioned hotspots include a large portion of the park and adjacent areas (BC Parks 2011).

Figure 9. Hotspots of grizzly bear mortality for the limited entry hunt (LEH) for the Babine Watershed Monitoring Trust Study Area and buffer, 1990-2011.



Bears were killed similarly during the spring and fall LEH hunting seasons for the 1990-2000 period (Table 6). From 2001-2011 more bears were killed during the fall hunting season (65%) as compared to spring (35%).

Table 6. Number of grizzly bears killed according to the hunt season[1] in the Babine River Watershed Trust Study Area, 1990-2011.

Time Period	Spring	Fall	Total
1990-2000	12	12	24
2001-2011	8	15	23
Total 1990-2011	20	27	47

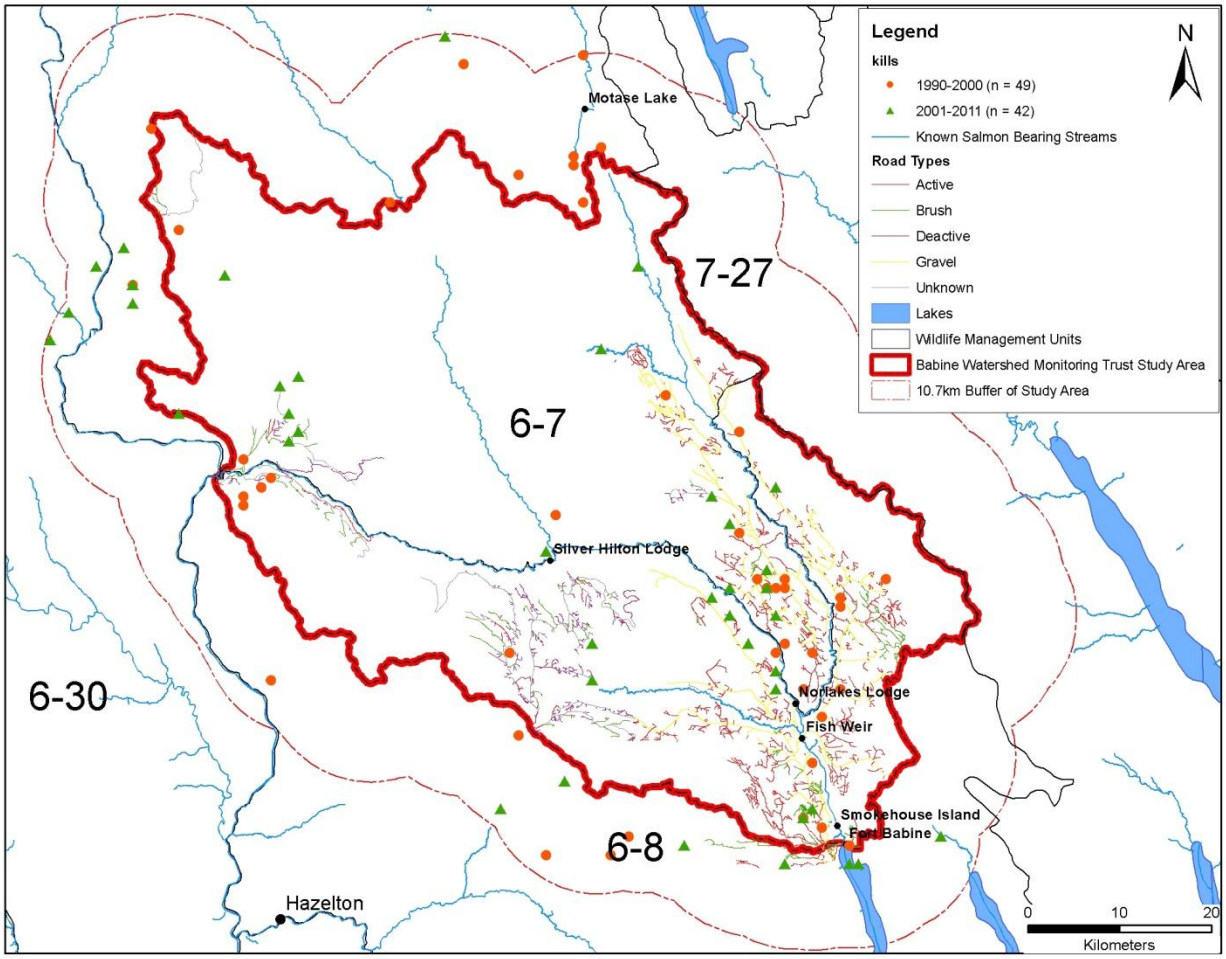
[1] Hunting season is defined by the Ministry of Forests, Lands and Natural Resource Operations, Fish and Wildlife Branch (http://www.env.gov.bc.ca/fw/wildlife/hunting/regulations/).

4.3.2 Grizzly Bear Mortality and Road Access

Grizzly bear mortality appears to be associated with the road network (Fig. 10). There were two authorized road access points into the Babine River area that occurred upstream and downstream. The upper Babine River Bridge was built prior to planning for this area and it was not addressed in land use planning, while downstream access was the subject of a Forest Practices Board investigation (D. Wellwood pers. comm.). The mortalities in the northwest appear to be associated with a mainline that crosses the Skeena and to Tommy Jack pass (north-western corner). This access area was recommended by biologists for access control but that control was not implemented (Wellwood and Pflaz 2009); it crosses through the Atna-Shelagyote Special Management Zone. The grizzly bear mortalities south along the Suskwa River appeared to be associated with a road into the BWMT study area - a spur of which was gated to prevent a circle route to the eastern part of the BWMT area (D. Wellwood, pers. comm.). There was also a cluster of mortalities between the Nilkitkwa and Babine which was an area where an access control was proposed in early planning but later not considered (D. Wellwood, pers. comm.). There are several other hotspot locations, which appear to be associated with the presence of accessible roads around Smokehouse Island and the Kisegaas Indian Reserve. The study area contained a number of forestry related on-block dirt and gravel roads that also appeared to be related to grizzly bear mortality. The mountainous area around Kuldo does not have many roads however K. Nixon (pers. comm.) described a number of well laid out hiking and trapping trails which could explain the hotspot in that region.

To determine if the relationship between grizzly bear mortality and distance to roads is indeed statistically significant as opposed to simply occurring as would be expected by chance (i.e., random) further advanced statistical analyses than presented here are required. Typically these types of questions are evaluated in wildlife studies by employing a use (i.e., bear mortalities) versus availability (i.e., random distances to roads) Resource Selection Function (Manly et al. 2002) analysis design. A logistic discriminant function (Seber 1984: 308-317) may then be estimated to contrast the distribution of grizzly bear mortality locations with the variables in question, such as distance to a road. Coefficients for these types of model are estimated using logistic regression. This type of advanced use/available statistical analysis is beyond the scope of this project but is required to factually conclude that mortalities were indeed associated with the road network or distance to salmon stream (etc). An example of using logistic regression to model grizzly bear mortality locations against variables for grizzly bears in northern BC may be found in Ciarniello et al. 2009. Based on the following results, we recommended an RSF based use/available analysis as an informative next step in examining the factors that may be contributing to the mortality of grizzly bears within the study area.

Figure 10. Grizzly bear mortality locations, roads, and major salmon bearing rivers for the Babine Watershed Monitoring Trust Study Area, 1990-2011. A road layer was not available for the buffer area so roads within the buffer are not represented.



From 1990-2000, within the BWMT study area 39% of grizzly bear kills were closest to an 'active' road, followed by 27% for gravel roads (Table 7, Fig. 10). From 2001-2011, the majority of grizzly bear kills were again closest to an 'active' road (35%, Table 7). Overall, fewer kills occurred in close proximity to roads labelled as 'deactive', 'brush' or 'unknown' (Table 7, Fig. 10).

Table 7. Number (*n* = 59) and percent of grizzly bears killed according to the distance to the nearest road for the Babine Watershed Monitoring Trust Study by 11-year period, 1990-2011.

Road Type	Time Period					
	1990-2000					
	Number of Bears	Percent of Total (%)	Median Distance (m)	Mean Distance (m)	SE	Range (m)
Active	13	39	161	306	103	36, 1262
Brush	5	15	147	132	52	27, 308
Deactive	4	12	1812	2543	1273	372, 6176
Gravel	9	27	362	410	122	9, 1252
Unknown	2	6	1124	1124	563	561, 1686
	2001-2011					
	Number of Bears	Percent of Total (%)	Median Distance (m)	Mean Distance (m)	SE	Range (m)
Active	9	35	460	520	192	76, 1923
Brush	4	15	111	129	44	49, 245
Deactive	2	8	1521	1521	1478	43, 2999
Gravel	5	19	824	1994	1416	26, 7625
Unknown	6	23	582	1932	1250	113, 8028
	1990-2011 Totals					
	Number of Bears	Percent of Total (%)	Median Distance (m)	Mean Distance (m)	SE	Range (m)
Active	22	37	209	394	99	36, 1923
Brush	9	15	147	131	33	27, 308
Deactive	6	10	1812	2202	917	43, 6176
Gravel	14	24	453	975	520	9, 7625
Unknown	8	14	600	1730	931	113, 8028

4.3.3 Grizzly Bear Mortality and Salmon Bearing Rivers

Most bear kills were located within 200 m of a river or stream however this may be influenced by the number of rivers/streams on the landscape (Table 8, Fig. 10). The median distance to a known salmon bearing river was >1.6 km ($\bar{x}$ >2 km) suggesting there was not a link between bear mortality and salmon bearing streams although some bears were killed within 25 m of a salmon bearing stream (Table 8). Similar to distance to roads, to determine if the relationship between grizzly bear mortality and salmon bearing streams is indeed statistically significant further advanced statistical use/available analyses are recommended. Those analyses were beyond the scope of this contract.

Table 8. Distance to the nearest salmon bearing river/stream for the 59 grizzly bears killed in the Babine Watershed Monitoring Trust Study Area by 11-year period, 1990-2011.

River Type	Time Period			
	1990-2000			
	Median Distance (m)	Mean Distance (m)	SE	Range (m)
Known Salmon Bearing River/Stream	1657	2234	348	464, 8769
River/Stream	109	157	30	7, 925
		2001-2011		
	Median Distance (m)	Mean Distance (m)	SE	Range (m)
Known Salmon Bearing River/Stream	2127	3097	605	25, 12548
River/Stream	175	166	23	10, 462
		1990-2011 Totals		
	Median Distance (m)	Mean Distance (m)	SE	Range (m)
Known Salmon Bearing River/Stream	1820	2614	332	25, 12548
River/Stream	137	161	20	7, 925

4.4 Population Density Estimates and Mortality Rates

Population density estimates were recently reviewed by the Provincial government for 2012 (A. Hamilton per comm.). The most recent density estimates for the WMUs within the BWMT study area are provided in Table 9. These numbers, among other factors such as potential depletions for the unreported mortality rate, form the basis upon which the maximum allowable mortality rate is calculated to aid in determining the harvest allocation for grizzly bears. Harvest allocation was also updated for 2012 and although not yet published has been included for reference (Table 10).

Mowat et al. (2004) recently designed a new multiple regression model to estimate population density for grizzly bears and this method has been used in several areas within BC, including the Babine. The estimated density, updated this year, is considerably different than the MOE numbers for WMU 6-8, which is estimated to contain more than an order of magnitude less bears (15.4 bears/1,000 km^2) using Mowat et al.'s (2004) method than the current MOE estimates. Conversely, WMU 6-7 was estimated by MOE to contain fewer bears than Mowat et al.'s (2004); however, the difference was not nearly as large being 1.4 bears per 1,000 km^2. The differences in densities for WMU 6-8 means that mortality rates, which were calculated to be greater than the final allowable mortality rate based on MOE's population estimates, would be

well above the harvest allocation had we used Mowat et al.'s (2004) estimated population densities as a base for those units. Similarly, harvest allocations which are currently considered 'safe' using MOE's densities (see Tables 13, 14) could potentially be over the harvest allocation had we based them on Mowat et al's (2004) densities. No analyses were conducted on those estimates because they are not the current working estimates for the harvest allocation, but they are provided here for comparison since this method (i.e., Mowat et al 2004) is becoming the preferred method to estimate grizzly bear population density in BC.

Table 9. Estimated grizzly bear population density determined by the Ministry of Environment (MOE) in comparison with Mowat et al.'s (2004) estimate within the wildlife management units included in the Babine Watershed Monitoring Trust Study Area, 2012. Grizzly bears are currently managed using the MOE estimate.

Estimated Grizzly Bear Population Density for 2012 - Density (number of bears/1000 km²)		
WMU	**MOE's Estimate**	**Mowat et al.'s Estimate**
6-7	35.2	36.6
6-8	16.9	1.4

Table 10. Estimated harvest allocation for grizzly bears by Wildlife Management Unit in the Babine Watershed Monitoring Trust Study Area, 2012

Estimated Harvest Allocation for Grizzly Bears in 2012 (%)				
Wildlife Management Unit	Maximum Human Caused Mortality Rate	[1]Estimated First Nations Harvest Rate	[1]Estimated Unreported Mortality Rate	Final Allowable Mortality Rate
6-7	6.0	0.40	0.90	4.70
6-8	6.0	0.55	0.90	4.55

[1]These estimates are subtracted from the Maximum Human-Caused Mortality Rate to obtain the final Allowable Mortality Rate.

The population estimates for Grizzly Bear Population Units (GBPUs) were also under review within the MOE for 2012. The BWMT study area contained 3,912.91 km^2 of the larger Babine BBPU. Only a small portion (2.71 km^2) fell within the Omineca GBPU along the eastern boundary and we believe this was the result of mismatches with the GIS layers and assumed the boundaries were supposed to match each other (i.e., we omitted the 2.71 km^2 in the Omineca which was along the boundary and contained no kills). What is apparent from Figure 11 is the vast size of the GBPU compared with the BWMT study area. In the province grizzly bears are managed using the GBPU whereas harvest allocations are calculated for each WMU.

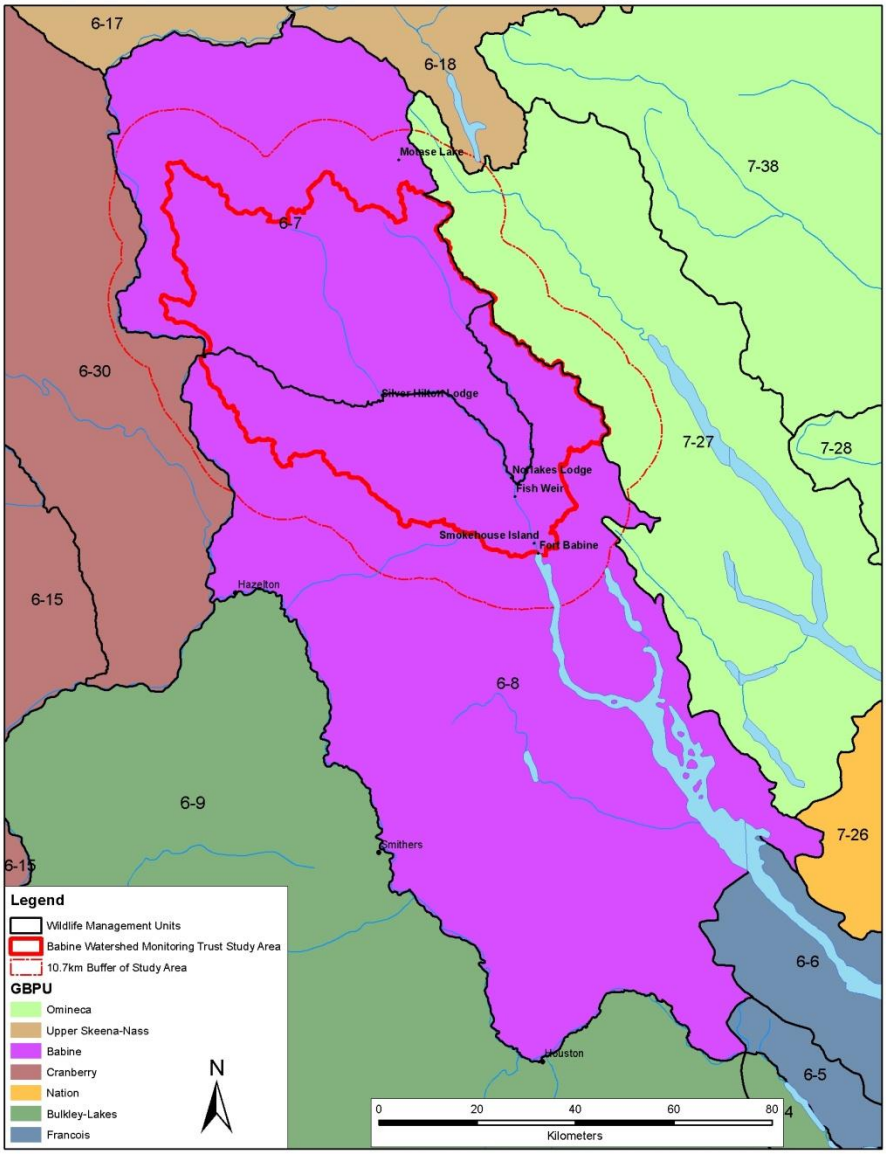
In 2008 the population estimate for grizzly bears in the Babine GBPU was reduced by 201 grizzly bears as compared with the estimate provided in 2004 (N = 487). According to the unpublished population estimates for 2012, the number of grizzly bears has increased in the Babine GBPU since 2008 by an estimated 27 bears (Hamilton 2012) (Table 11).

Table 11. Number of grizzly bears (est.) as determined by the Ministry of Environment within each GPBU included within the Babine Watershed Monitoring Trust study area and buffer area for 2004, 2008 and 2012.

	Number of Grizzly Bears by stated Year for each GBPU		
GBPU	**2004**	**2008**	**2012**
Babine	487	286	313
[1]Omineca	726	481	402
[1]Cranberry	341	341	349
[1]Upper Skeena-Nass	661	661	755

[1]The 10.7 km buffer area included three other GBPUs: the Cranberry, the Omineca and the Upper Skeena-Nass (Fig. 11). Buffer analyses have been provided in Appendix I.

Figure 11. The grizzly bear population units (GBPUs) surrounding and encompassing the Babine Watershed Monitoring Trust Study Area and buffer.



Historical population density estimates for wildlife management units were not available, so mortality rates over time were calculated using the most current population estimate with the assumption that the distribution of bears is uniform across the entire WMU once non-bear habitat had been removed. The portion of the BWMT study area included in each WMU was calculated and the number of grizzly bears expected for those areas was determined based on the area (Table 12).

Table 12. Area in km² of grizzly bear habitat and number of grizzly bears based on area in the Babine Watershed Monitoring Trust Study Area that was contained within each Wildlife Management Unit (WMU), 2012.

Wildlife Management Unit	Area (km²)	Number of bears
6-7	2259.93	79.6
6-8	1652.98	27.9
TOTAL	3915.62	

Note: The portion of WMU 7-27 contained within the BWMT area was likely the result of GIS overlay boundary issues. No grizzly bears were recorded to have been killed in that small area and therefore we omitted this unit from any analyses.

Annual mortality rates, female mortality rates and mortality over the 5 year harvest allocation period were calculated (Tables 13, 14). Bold and underlined values under total annual mortality represent years where the number of animals harvested and destroyed exceeded the harvest allocation for 2012. In the case of female mortality, it was recommended that values higher than 3% be considered a potential concern (A. Hamilton, pers. comm.).

We did not detect overharvest of grizzly bears in WMU 6-7 as it related to the annual mortality rate or the portion of that rate that is considered acceptable kill rate for females. For WMU 6-8 kill rates were over harvest allocation in 7 of the 22 years (32%) when compared to the harvest allocation for 2012. Female mortality rates were also over harvest allocation in 9 of the 22 years (41%) in WMU 6-8. Fort Babine and several of the other hotspot areas for bear mortality occurred within WMU 6-8 as previously indicated.

Table 13. Annual mortality rate and annual female mortality rate for the Babine Watershed Monitoring Trust study area by Wildlife Management Unit (WMU), 1990-2011. Yellow highlighted values represent years where grizzly bear kills exceeded the harvest allocation for 2012.

Year	Total Annual Mortality Rate		Annual Female Mortality Rate	
	Wildlife Management Unit			
	6-7	6-8	6-7	6-8
1990	0	0.107	0	0.143
1991	0.025	0	0	0
1992	0.013	0	0.025	0
1993	0.013	0.036	0.025	0
1994	0	0	0	0
1995	0.013	0.036	0	0.072
1996	0.013	0.143	0	0.143
1997	0.025	0.036	0.025	0
1998	0.038	0.036	0.025	0
1999	0.013	0.107	0.025	0.072
2000	0.013	0.215	0.025	0.072
[1]2001	0	0.072	0	0
2002	0.013	0	0	0
2003	0	0.072	0	0.072
2004	0.025	0.036	0.025	0
2005	0.025	0.036	0	0.072
2006	0.013	0.036	0	0
2007	0.025	0.036	0.050	0.072
2008	0.025	0	0.025	0
2009	0.025	0	0.050	0
2010	0.013	0	0.025	0
2011	0.013	0.107	0	0.143

For percent multiply the mortality rate by 100

[1]During the spring of 2001 there was a province-wide moratorium on the hunting of grizzly bears.

Harvest allocation is re-evaluated every five years and population densities are updated when new science is released (A. Hamilton pers. comm.). We recalculated mortality rates working backwards from 2011 in 5-year periods to match government procedures for harvest allocation. These mortality rates over five years suggest, again, that grizzly bears are potentially being over-harvested within the BWMT study area, especially in WMU 6-8. The majority of these harvest rates were well above the acceptable 6% human-caused mortality rate set by the Province.

Table 14. Mortality rate by five year period to match the harvest allocation period for the Babine Watershed Monitoring Trust study area by Wildlife Management Unit (WMU), 1990-2011

	Five-Year Period, Matching Harvest Allocation				
WMU	**2011-2007**	**2006-2002**	**2001-1997**	**1996-1992**	**1991-1990***
6-7	**0.113**	**0.075**	**0.088**	**0.050**[1]	0.025
6-8	**0.143**	**0.179**	**0.465**	**0.215**	0.107

* A two year period, due to the time frame of the study.
[1]This is over the final allowable mortality rate for 6-7 but not the maximum human-caused mortality rate (6%) (see Table 10).

4.5 Problem Wildlife Occurrence Reports Not Resulting in a Bear Mortality

4.5.1 Relocated and Translocated Bears

The PWORs resulted in a variety of non-lethal management actions ranging from a CO attending the call, potentially setting up a culvert trap or snare, or simply providing advice over the phone and not responding to the call. If a trap was set up and a bear was caught, it was typically relocated, unless it had shown signs of aggression towards people in which case it was destroyed.

From 1990-2011, eighteen bears were moved into or out of (i.e., translocated) or moved to another area within (i.e., relocated) the study area. From 1990-2000, 11 bears were moved representing 65% of domestic anthropogenic attractants (DAA) calls (n = 11/17), while 7 were moved during 2001-2011 representing 35% of DAA calls (n = 7/20). It appeared that efforts were made to relocate a bear before destroying it, although this was more common from 1990-2000. Ten bears were translocated into the BWMT study area from external regions, four bears were translocated out of the study area, 3 were relocated within the study area, and 1 bear was moved to an unknown location. Nine of those bears were killed at a later date but all kills were outside of the study area; five of those 9 were shot via LEH, 1 was poached, and 3 were killed as problem bears.

4.5.2 Domestic Anthropogenic Attractants – PWORs Not Resulting in a Bear Mortality

Examining why people reported bears helps with determining how best to focus Bear Smart messages to reduce the root cause of problem. The top domestic anthropogenic attractant (DAA) from 1990-2000 was garbage (40%) and the top DAA from 2001-2011 was smokehouses (50%; Table 15). For the study years, 1990-2011, smokehouses were the highest ranked DAA (53%) followed by accessible garbage (19%; Fig.12, Table 15). PWORs around the fish fence decreased following the erection of an electric fence around the DFO camp.

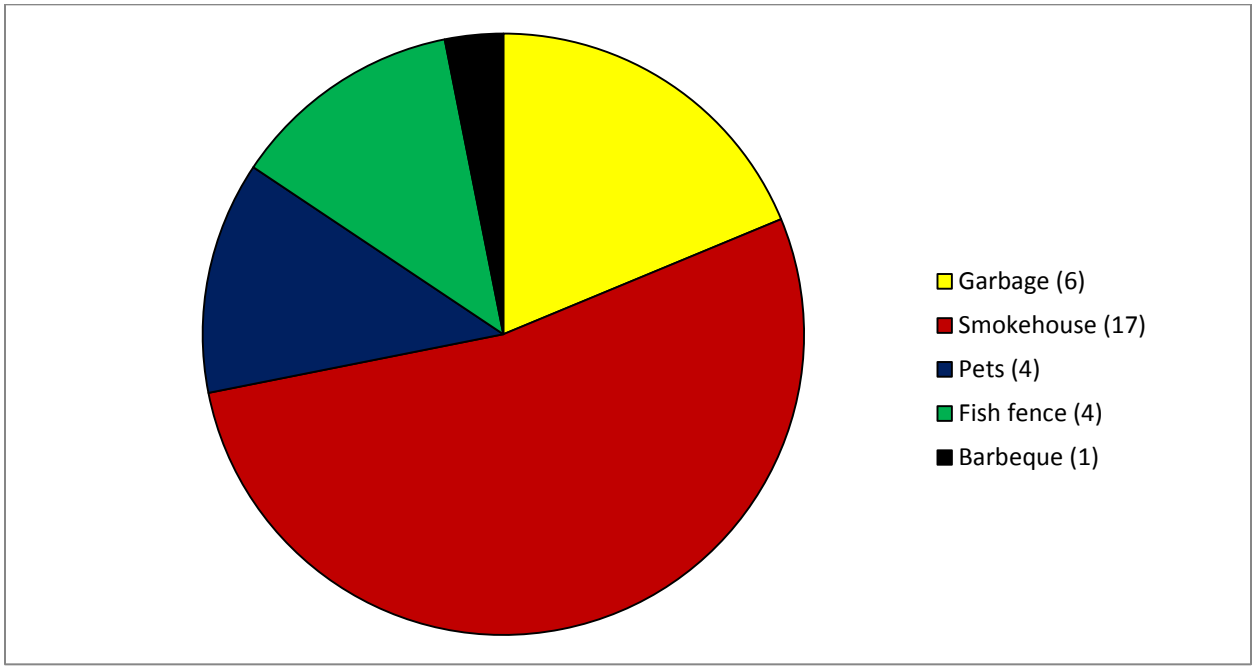
Reports of bear 'sightings' went up six-fold and the number of PWORs more than doubled from the first time period (1990-2000) to the second time period (2001-2011) (Table 15). This increase in numbers corresponds to anecdotal evidence provided by DFO camp

manager Mike Jakubowski (pers. comm.) and Pierce Clegg, owner/operator of Babine Norlakes lodge (pers. comm. 2012). Both claim that starting in the late 1980s, with increased human usage, grizzly bears in the area became increasingly habituated to people.

Table 15. Number of grizzly bear complaints that did not result in the death of a bear recorded by the COS by 11-year period for each of the main attractant categories for the Babine Watershed Monitoring Trust Study Area, 1990-2011.

Domestic Anthropogenic Attractant Type	Year	No. Recorded
Smokehouse	1990-2000	2
Fish fence	1990-2000	4
Trap line	1990-2000	0
Garbage	1990-2000	6
Barbeque	1990-2000	1
Pets	1990-2000	0
Not recorded	1990-2000	0
Sighting	1990-2000	2
1990-2000 Total		*15*
Smokehouse	2001-2011	15
Fish fence	2001-2011	0
Trap line	2001-2011	1
Garbage	2001-2011	0
Barbeque	2001-2011	0
Pets	2001-2011	4
Not recorded	2001-2011	0
Sighting	2001-2011	12
2001-2011 Total		*32*
All Years (1990-2011)		*47*

Figure 12. Number of PWORs for each of the main attractant types (sightings not included) that did not result in the death of a grizzly bear for the Babine Watershed Monitoring Trust Study Area, 1990-2011.



4.6 All Reports: Grizzly Bear Mortalities & PWORs Not Resulting in a Bear Mortality

4.6.1 Problem Wildlife Occurrence Reports

Grizzly bear reports in the study area appeared to be dependent upon the frequency of contact between humans and bears. The majority of the PWORs originate in Fort Babine (67%), where there are approximately 60 year-round residents (Figs. 13, 14) (Lake Babine Nation 2011). This was likely due to the density of people in a small area, and the considerable amount of fish processing that occurs in the village in the fall. Fall was also identified as the season with the highest bear mortality for the study area. The second most common location for 'problem' bears was around the DFO fish fence on the Babine River during the months of August, September and October (Fig. 14). These areas were identified as hotspots making them priority areas for focused educational messages within the watershed.

Figure 13. PWORs (kill & management actions) by location for the Babine Watershed Monitoring Trust Study Area, 1990-2011.

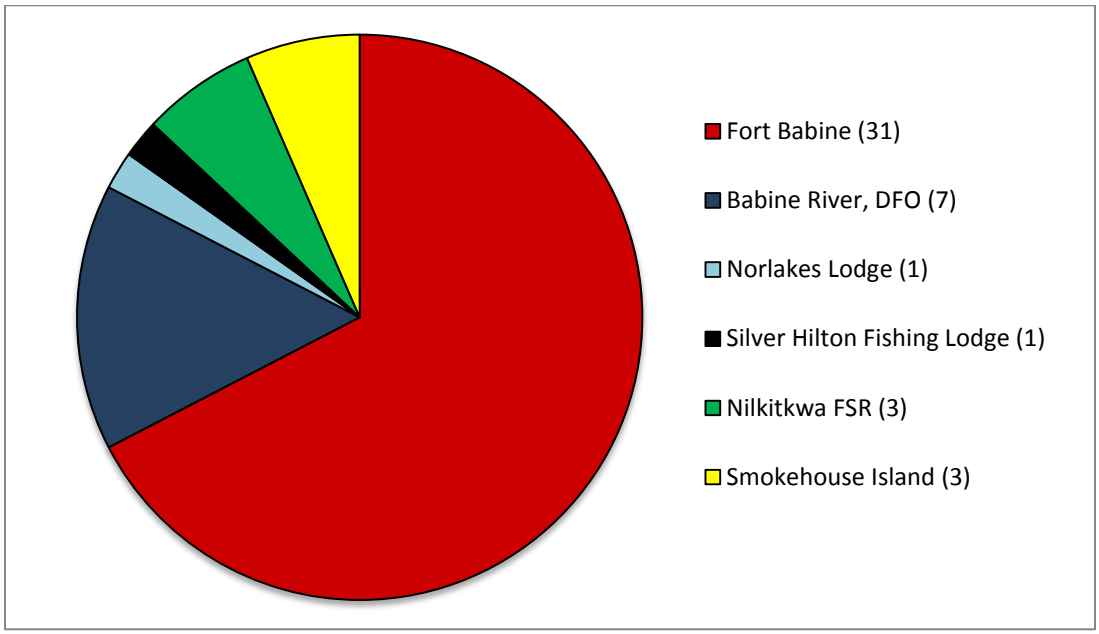
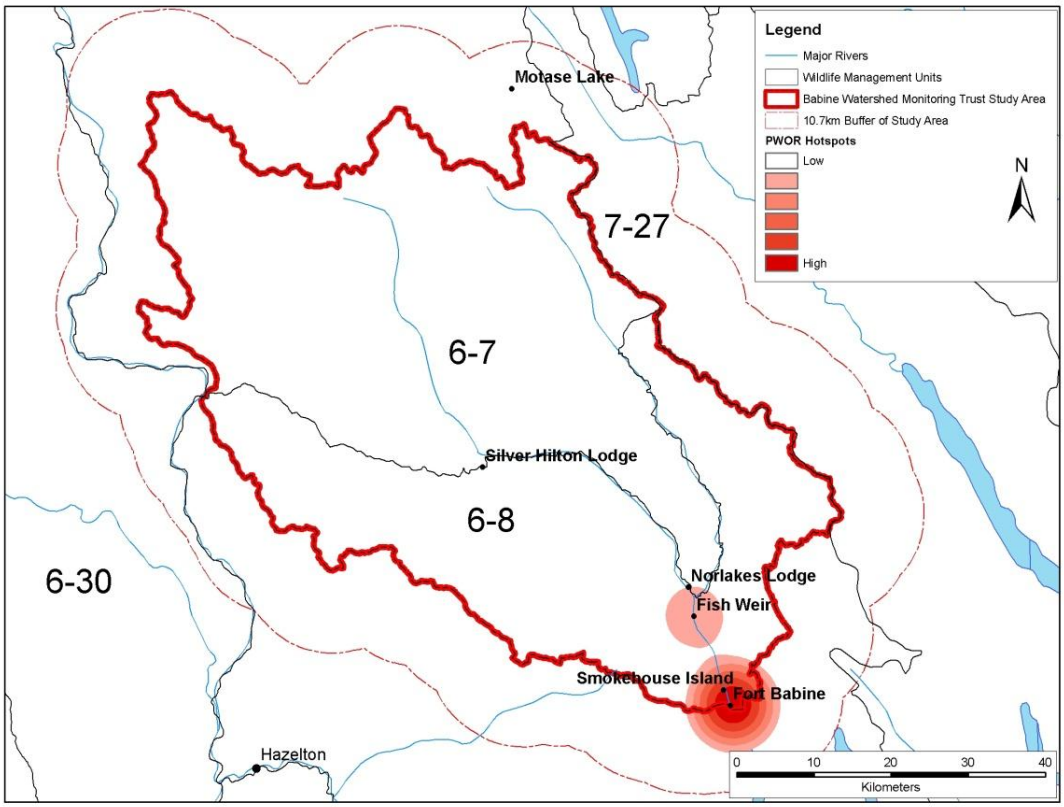


Figure 14. PWOR Hotspots (kill & management actions) for grizzly bears in the Babine Watershed Monitoring Trust Study Area and buffer, 1990-2011.



4.6.2 Spatial Representation of All Lethal & Non-Lethal Reports

Overall, there appeared to be several hotspot areas that represented all of the grizzly bear reports (i.e., lethal and non-lethal) from 1990-2011 within the Babine watershed (Fig.15, 16). The majority of these areas appear to be associated with the presence of people (Fort Babine, DFO fish fence, guide outfitters) and road accessibility within each hotspot. The hotspot identified in the northeast Motase Lake area was associated with a guide outfitter operation.

Figure 15. Grizzly Bear Compulsory Inspection, Problem Wildlife Occurrence Reports & moved bears for the Babine Watershed Monitoring Trust Study Area and buffer by 11-year period, 1990-2011.

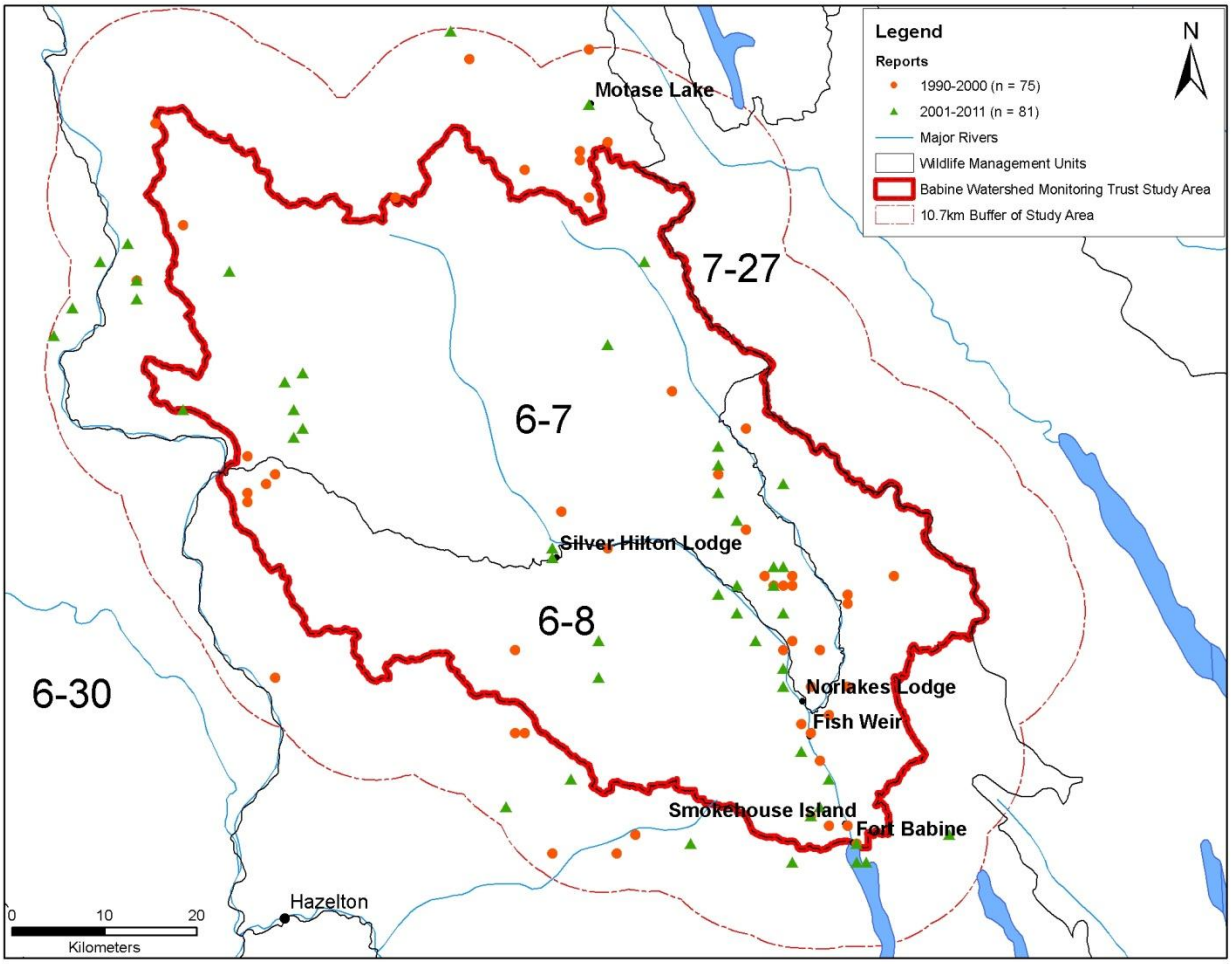
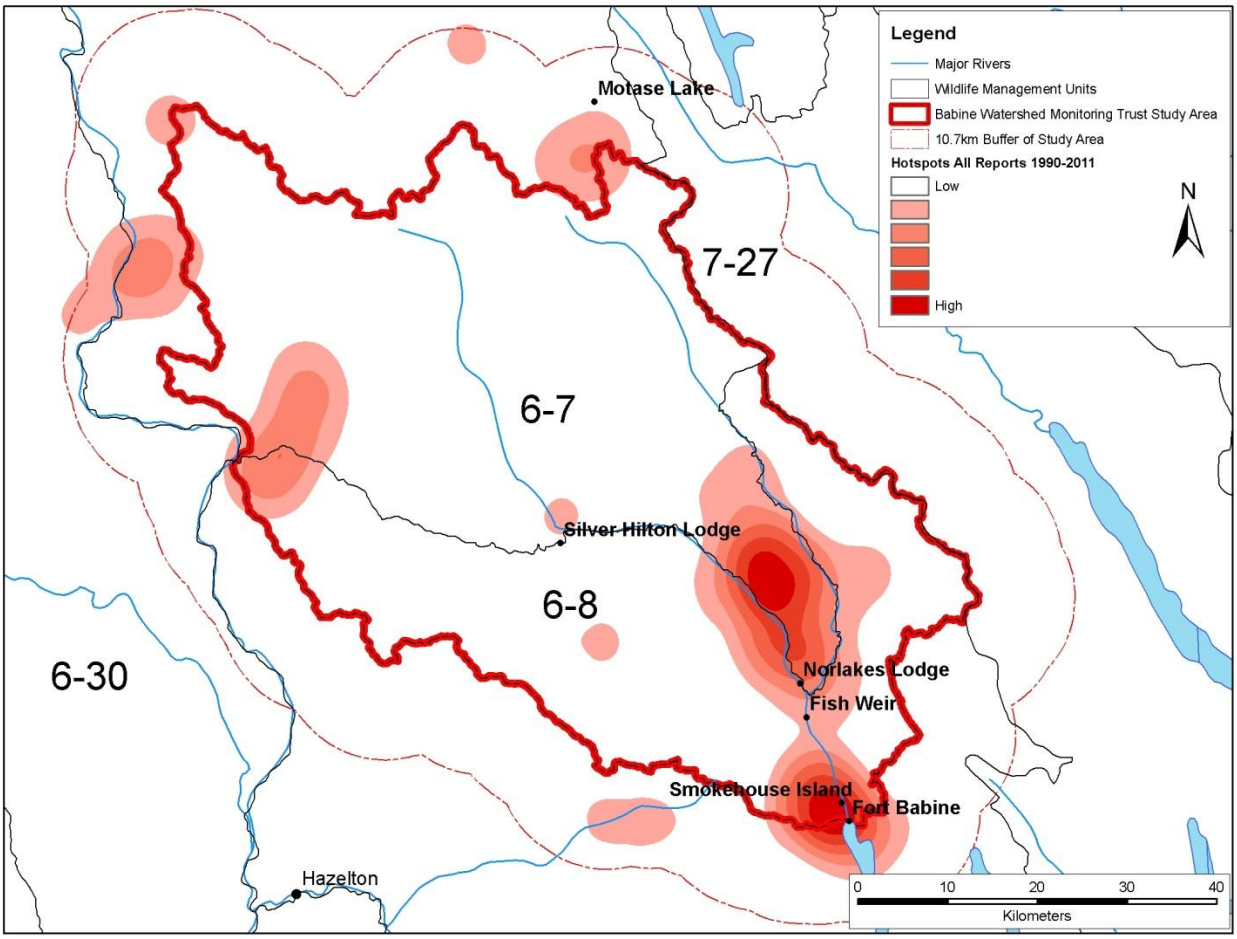


Figure 16. Hotspots for grizzly bear reports (CI records, PWORs and moved) for the Babine Watershed Monitoring Trust Study Area and buffer, 1990-2011.



4.7 Bear Observations

Most of the time bears were sighted feeding in and around the river (J. Howard, S. MacMillan documentation). Based on notes provided of these observations it appeared the majority of park and river users responded appropriately when grizzly bears were in the area; bear(s) were given space and people did not feed, approach or threaten bears. We found no negative incidences between humans and bears recorded in these observations. What we found notable with these observations was the high number of grizzly bear family groups that were recorded to use the Park and weir areas, suggesting use of those areas was biased towards females.

Table 16. Bear observations conducted by BC Parks in around the DFO fish fence and parking area, August-September, 2005-2011 (J. Howard, S. MacMillan, BC Parks).

Year	Bear descriptions	Adults	Cubs	Total number of bears
2005	There was one identifiable single bear, as well as an unknown lone bear. There were two sets of family groups, one female with three COYs and another female with two COYs.	4	5	9
2006	There were four identifiable single bears, and four family groups, two of which were the same family groups as in 2005. Those two females still had all of their cubs, one with three yearlings and the other with two yearlings. The two new females had three two-year old cubs each.	8	11	19
2007	There were two identifiable single bears, and two family groups consisting of one female with 3 cubs, and another female with 2 cubs. One family group was believed to have been one of the family groups from 2006, minus a cub.	4	5	9
2008	There were two identifiable single bears, one of which has returned from the previous year, as well as an unknown lone bear. There was only one family unit consisting of a sow and her two cubs and was believe to be one of the same units as in 2007.	4	2	6
2009	There were two identifiable single bears and a family unit consisting of a sow and three cubs.	3	3	6
2010	There were two identifiable sub adults and two unknown lone bears in 2010. There were two family units, one of which had 3 cubs and the other had 4 cubs.	6	7	13
2011	There were two identifiable single bears and one unknown bear. Only one family unit was present, and she had two cubs.	4	2	6
	Average number of bears around the fish fence/year:	**10**		

4.8 Education Evaluation

The status of bear awareness education within the Babine watershed varied among user groups. The Babine River Corridor Provincial Park opened in 1999, averaging >2,300 visitors a year, and has become a popular destination for hikers, fishermen, rafters, kayakers and other recreational users (Table 17). The opening sentence on the Park's website was about grizzly bears and avoiding undesirable interactions with them (BC Parks 2011). We found this information to be consistent with Bear Smart messaging and presented in a clear and concise manner. Unfortunately, visitors to the park did not have access to an interpretive centre or information kiosk where Bear Smart recommendations could be made readily available and issues may be discussed in person. BC Parks has many useful educational tools, especially on their website, but for this particular park there is no way to utilize them unless visitors take the

initiative to educate themselves on bear awareness prior to their arrival. Park rangers can be another good resource for visitors regarding Bear Smart messages, however, there is not a permanent ranger assigned to this Park. Parks staff are required to watch the 'Staying Safe in Bear Country' videos, participate in firearms training, and sometimes a bear awareness course is provided for employees (D. Wellwood has taught the course in the past). BC Parks also wrote a Bear-Human Conflict Prevention Plan as a guideline for staff on how to minimize human-bear conflict while maintaining bear populations. These are all excellent initiatives for staff but must also be consistently passed along to park users.

Table 17. Number of visitors to Babine River Corridor Provincial Park as calculated or estimated by BC Parks, 2005-2011.

Year	Park Visitors		
	August	September	October
2005	180	180	-
2006	780	315	240
2007	2228	512	-
2008	2440	236	-
2009	8176	0	
2010	10704	748	1324
2011	2356	180	380
Average/year	**2391**		

The Fisheries and Oceans Canada (DFO) Babine River fish fence was installed in 1946 and was used to count sockeye and other salmon entering Babine Lake (Fisheries and Oceans Canada 2005). Bears appeared to be attracted to the salmon particularly because the weir forces the salmon to pool as they attempt to navigate the weir area. In addition, after some of the salmon spawn their carcasses pile up and create an attraction for bears. To reduce the number of carcasses DFO staff actively pitched them over the fence; however, they remained to accumulate in shallow areas down river. The camp for DFO employees working at the fence was adjacent to the river and following numerous bear encounters, an electric fence was erected around the camp in the early 2000s. DFO has installed signs around the weir, warning visitors and fishermen about the potential for a bear encounter.

West Fraser Timber is the primary resource extraction company in the area. Two of their divisions have used the Babine watershed in the past, Houston Forest Products and Pacific Inland Resources. Field operation crews have had to watch the 'Staying Safe in Bear Country' video series in the past, and continue to receive training on how to use bear spray, which they must carry with them when in the bush. As of last year, West Fraser Timber introduced a webinar based wildlife training course taught by Dr. Rick Bonar, a wildlife biologist based out of Hinton, AB. The other resource extraction company contacted was Falcon Drilling Ltd. in

Prince George. Dan Bomford, safety supervisor, explained that they had historically worked in the Babine, but had not been in that area for a number of years. In the past, employees were not provided with any formal bear education training but were provided bear bangers and bear spray and were shown how they are used in the field. Staff were also allowed to carry a firearm by personal choice, but at this time this is no longer permitted.

The Collingwood Brothers Guides and Outfitters have a fly-in lodge in the northeast corner of the watershed surrounding Motase Lake. We located this company while examining the hotspot of bear kills around the lake found in our spatial analysis. We contacted Reg Collingwood, one of the owner-operators. A short, informal briefing is given to clients upon their arrival at the camp on bear encounters and how to keep a clean camp. There is no formal staff training on bear awareness, as Mr. Collingwood noted that all employees are seasoned outfitters and rely on their own bear experiences as education.

Several angling lodges were contacted but only the Babine Norlakes Steelhead Camp responded. We found that this company makes notable efforts to ensure their guests are educated and kept safe during their time in camp and on the river (Pierce Clegg, pers. comm.). Clients and employees, including kitchen and housekeeping staff, are armed with three bear bangers and a can of bear spray. They are taught how and when to use these tools and are provided with information on how to avoid a bear encounter. Clients were guided while fishing and the guides stay nearby throughout the day. If there is a bold bear in the area, staff will aggressively use bear bangers to scare it off, which they noted has been very successful (P. Clegg, pers. comm.). The guides have a daily chore of tossing fish carcasses back into the river. A supercharged burning barrel was used to incinerate garbage and leftover camp food. A dog is based in camp as a deterrent. There was a firearm on site, but it has never been used in response to a grizzly bear encounter. We found Bear Smart practices of the Babine Norlakes Steelhead Camp to be excellent and this lodge could represent a model for other companies to follow.

We contacted three of the four rafting companies that were stated to use the Babine River (J. Howard, pers. comm.). Each company provides one to two commercial trips, lasting several days to a week, on the Babine. Skeena Valley Expeditions, based out of Terrace, provided a briefing to clients on the first evening of their trip that discussed basic bear biology and what type of behaviours may be exhibited, how to avoid an encounter, and what to do if there was an encounter or an attack. Clients are required to keep a clean camp and people are recommended to stay in groups and make noise when walking on shore (Hatha Callis, owner-operator, pers. comm.). Staff did not receive any formal training on bear awareness, but they were noted to be experienced outdoors people.

Nahanni River Adventures, based out of the Yukon, provided their clients with a 30 minute presentation on best practices for traveling in bear country (Neil Hartling, owner-operator, pers. comm.). Clients are frequently reminded about keeping a clean camp throughout

their trip. The owner draws on his 28 years experience as a guide as well as educational resources from Parks Canada and the video 'Staying Safe in Bear Country' to teach his clients. New staff are required to watch 'Staying Safe in Bear Country', although there is low turn over within their company. Aquabatics, located in Smithers BC and Calgary AB, provided clients with a briefing on what to do in the case of a bear encounter or attack (Simon Coward pers. comm.). They discuss the benefits of being in large groups and ensure they keep a clean camp. Senior staff attend a bear awareness course in Canmore, AB.

We made several attempts at contacting the Fort Babine band office, however communication was never established.

5.0 Discussion

The grizzly bears within the Babine Watershed Monitoring Trust study area are part of a larger population that belong to the Babine Grizzly Bear Population Unit. Provincially the Babine GBPU has been designated as a top priority for monitoring and population inventory (Apps 2011). Population inventory refers to inventories on absolute abundance and/or distribution and connectivity (Apps 2011). Previous reports on grizzly bears and land use activities in the Babine have also identified concerns regarding human-bear conflicts and bear mortalities having a negative impact on the bear population (Wellwood 2005). Our results support these concerns as we conclude that the "safe" limits of mortality set by the Provincial government have repeatedly been exceeded within the BWMT study area for all bears as well as for females. The mortality rates calculated within this report were above the current harvest allocation levels across multiple years.

Presently, grizzly bear population size in the province is estimated through evaluation of habitat, bear sighting records and expert opinions. Population densities are then assigned by wildlife management unit, which accounts for other factors such as historic mortality (Hamilton and Austin 2004). The Babine watershed is known to be a difficult region for population estimates due to the part coastal and part interior ecosystem (A. Hamilton, pers. comm.). Previous studies in the area that used a grizzly bear monitoring index (GBMI) did not reveal any population trends over the monitoring period although land use activities and human-bear conflict were predicted to be negatively impacting the population (Hatler 1998, Wellwood 2005). We noted two contrasting sets of population densities calculated for this area and we based our results on the set that generally contained higher densities, suggesting that "safe" limits of grizzly bear mortality would have been even more exceeded had we based them on the more conservative estimates.

Nearly 80% of the mortality within the BWMT study area was related to the limited entry hunt. The legal harvest of bears should be more easily managed than management actions or

illegal kills because they are controlled through government issuing of permits. We offer 4 explanations for the high harvest rates we report:

(1) Lack of available historic grizzly bear density numbers that would have been used to calculate the mortality rate. The historic population density information for wildlife management units 6-7 and 6-8 were not available therefore we had to base our mortality rates on the current 2012 estimates. However if the past population numbers were estimated to be higher than reported today it would result in a larger harvest allocation in previous years (i.e., we would have been able to vary the denominator, at least by 5-year harvest allocation periods). If the number of bears estimated by MOE within the Babine GBPU is used to indicate past density of bears then it demonstrates that the MOE believed there was a larger population of bears before 2008.

(2) The 2012 population estimates underestimate grizzly bear density (similar to #1 above). However, we used the higher of the 2012 estimates provided by the government which would mean we were actually being conservative in our calculations of mortality rates. We also used those densities because they are currently being applied for harvest allocation for those WMUs (A. Hamilton, pers. comm.). The uncertainty in the population estimates provided, and the numerous years that the acceptable mortality rate was exceeded, highlights the need for a population inventory for this GBPU.

(3) Bear density is uneven across the WMU (also similar to #1 and #2 above). It is possible that the study area or portion of it had a higher density of bears than the remaining WMU. We used the same methods to calculate mortality rates as the Provincial government. An assumption inherent within their method is that after the removal of non-bear habitat bears are evenly distributed across the MU. This assumption is of course false and we know bears select certain habitats over less suitable habitats which would result in an uneven distribution of bears with more bears in higher quality habitats/areas. If the habitat quality for bears was a lot higher in one area of the WMU as compared with another area estimated densities could also largely vary and this would not necessarily be reflected using the assumption of a uniform distribution. D. Heard (pers. comm.) noted that G. Schultz believes the west half of WMU 6-8 is 27 bears/1,000 km^2 thereby being similar to the estimate of WMU 6-30 and opposed to the current estimates of 16.9 bears/1,000 km^2 provided by MOE and 1.4 bears/1,000 km^2 by Mowat et al. (2004). If true, this would result in more bears than currently estimated within parts of the BWMT study area.

(4) The BWMT area is a population sink. The study area, due to attractants for bears provided by the DFO weir and Fort Babine may be acting as a population sink for bears, drawing them in from a 'larger' area and resulting in a higher rate of kills than within the remaining area of the WMUs. Many suspect that the Babine watershed, in particular the southern half, is acting as a population sink (A. Hamilton, pers. comm. and D. Wellwood, pers.

comm.). The area contains productive salmon-bearing rivers and wild habitat that may contain greater forage productivity than surrounding areas. For example, the DFO fish fence causes fish to pool in this area making them easier for bears to catch. There are also a number of fish carcasses that pile adjacent to the weir area, again attracting bears. We also think that it is likely that bears are being drawn into this area, but from what distance we remain uncertain. The concern that we note with our results was the high number of female bears, particularly family groups that were reported or killed within the Park and DFO weir areas. Domestic anthropogenic attractants in areas like Fort Babine may also be negatively affecting the population more than surrounding areas. We think that it would be useful to examine bear kills in the larger area of the WMUs because to remain within the harvest allocation we would expect those to be less than we report for the BWMT study area.

We could not detect any grizzly bears killed within the BWMT whether LEH or PWOR for 1994, and only one bear was reported killed (by a non-resident hunter) within the buffer. We investigated to ensure we were not missing any data. We were told that it is possible that fewer LEH tags were issued in 1994 or that the number of tags was reduced to compensate for the over harvest allocation (A. Hamilton, pers. comm.). We remain uncertain about the lack of data for that year. Any additional kills would increase the reported mortality rate for 1994.

Illegal kills were more likely to be reported in areas where the human population is larger or there was higher human traffic, such as the DFO fish fence or Fort Babine. We think that it is possible that the number of poached bears could potentially be higher than what has been reported here. We were told of reports of poaching but only included those that could be verified through CIs. An estimate of unreported grizzly bear mortality was included within the LEH calculations and we recommend that continue for this GBPU.

The legal First Nations harvest of grizzly bears for sustenance, social or ceremonial purposes are not required to be reported within the compulsory inspection system. An estimate of grizzly bear mortality by First Nations was included within the LEH calculations and we recommend that continue to be factored into the harvest allocation. We also recommend a reporting system for grizzly bear mortality attributed to First Nations. It is prudent to maintain a database of the sex and age structure, as well as the cause of grizzly bear kills for population management purposes. We think that a reporting system for these kills is needed, especially in an area such as the Babine GBPU where so little is known about the population.

The hotspot for PWORs was Fort Babine, demonstrating the need for consistent and accurate Bear Smart education directed at local residents. Due to the remote location of Fort Babine and the limited resources available to the Conservation Officer Service (COS), attending calls in that area did not occur often unless there was a situation that required a response. There were two Conservation Officers (COs) based out of the Smithers office and they responded to calls across the entire Skeena region (K. Nixon, pers. comm.). Overall the primary attractant for

bears was smokehouses followed by accessible garbage. We recommend that a Bear Smart education program be initiated that focuses on those primary attractant types (i.e., the root of the human provided attractant for bears) rather than having the COS be responsible for bears that are already attracted to the area. We suggest implementation of a consistent education program within the village that teaches and encourages residents how to properly secure their attractants. We also recommend that Fort Babine designate particular areas for fish processing and investigate ways to make those areas inaccessible to bears (e.g., electric fencing). In the current system of bear management we found very little evidence of proactive management designed to dissuade the development of 'problem' bear behaviour. We also believe that some of our conversations provided anecdotal information that suggested the killing of grizzly bears associated with human-provided attractants was at least a magnitude higher than reported in the CI database.

We found that generally the Bear Smart messages provided by companies to their clients was fairly accurate however for the most part it appeared to be too broad in content and varied among companies. The 'Staying Safe in Bear Country' video series released in 2001 is the International Association for Bear Research and Management (IBA) endorsed standard safety protocol for human-bear interactions and encounters as determined by the Safety in Bear Country Society. This series emphasizes using both a proactive and behavioural approach to reducing risk. We recommend this resource be the base used to educate people on what to do when living, working or recreating in bear country (IBA 2007, www.bearbiology.com). Those videos are widely used across Canada by government groups, companies and corporations whose employees are working in bear country and by the general public.

Bear awareness for recreationalists venturing into the area independently would have been done as their own prerogative, and potentially many people are entering the area without proper Bear Smart knowledge. Ideally a seasonal BC Parks booth or kiosk information centre should be present at the BC Parks parking lot and/or within Fort Babine. This would allow visitors to have access to appropriate bear awareness and bear safety information.

5.1 Summary of Recommendations

We have based our recommendation on the information summarised in this report which included grizzly bear harvest mortality, non-hunting mortality, frequency and intensity of conflicts, and anthropogenic food source incidents. Those factors as they contribute to grizzly bear kills were examined in the context of detectable spatial features and characteristics potentially influencing risk of mortality.

(1) Conduct a Population Inventory of the GPBU

The BWMT study area is a fraction of the larger Babine GBPU. To accurately determine what is happening at the population level for grizzly bears the Trust needs to consider an area much larger than the current study area. This is an expensive initiative that would need to be carried out with the support of the Provincial government. The Trust should lobby the

government to conduct a DNA-based population inventory on the Babine GBPU. This GBPU has previously been identified as a top priority for monitoring and population inventory (Apps 2011). Based on annual harvest rates that exceed a threshold of 6% of the estimated population within a WMU, (best currently available estimate provided by BC MoE) our results indicate over-harvest, particularly of WMU 6-8. New inventory could reduce the uncertainty related to this indication. Apps (2011) provides a proposed design and methods to achieve the required data to complete an appropriate grizzly bear inventory within a GBPU.

(2) Implement a variety of population trend monitoring techniques within the BWMT area

Population trend monitoring has been extremely successful in a number of areas, most notably the recovery zone of the Northern Continental Divide Ecosystem (Kendall et al. 2009). In the NCDE they used DNA based techniques to monitor population size, trend, survival, and movement corridors that potentially link separate populations. We think that a variety of hair trapping techniques could be successfully implemented in the BWMT study area since it has numerous bear trails and mark trees that could be capitalized upon for obtaining DNA samples from bears. DNA would also provide information on the sex ratio of males to females, potentially showing whether the weir and Park were attracting more females than surrounding areas. A properly designed monitoring study may provide additional inferences about the larger population when statistical techniques are applied; however, we note that the BWMT study area does not have biological closure of its boundaries as it relates to a population inventory for bears.

If a population inventory was carried out on the larger GBPU the samples obtained within the BWMT area could be compared genetically with those obtained throughout the GBPU which may allow for some inferences to be made regarding the distance bears are drawn into the area.

(3) Reduce uncertainty through use of a Bear Smart Outreach Educator and Coordinator

We think that the best way to deliver Bear Smart messaging specific to the type of human-bear encounters that are occurring within the area, and to reduce uncertainty about the various bear smart messages being delivered, is through the use of a dedicated Outreach and Education Coordinator throughout the bear season. Potentially this person could work in conjunction with BC Parks and monitor the Park as well as adjacent areas. Seminars on proper fish processing within bear country could be provided at Fort Babine and in Smithers. We suggest that First Nations be included within this initiative.

- This position could also act to monitor bear kills that may not be reported in the CI database.
- This person could also be responsible for quantifying the behaviours of bears, humans, and the overlap between the two. In 2007, a study was designed to quantitatively increase the understanding of bear-human interactions and human impacts on bears for the south entrance of the Babine River Corridor Provincial Park (Ciarniello 2007). The Trust could capitalize on using portions of that study design.

(4) Discuss the need for Motorized Vehicle Access Control

We think that it is likely that grizzly bear mortality was related to the road network; however it was beyond the scope of this project to assess availability and apply statistical methods of habitat selection required for use-availability analyses. A framework for monitoring access was suggested by Wellwood and Pfalz (2009) however this monitoring would not include population responses. Our results suggest that a closer examination of grizzly bear mortality as it relates to road access and the types of roads closest to grizzly bear deaths should be further examined. The BWMT should pass on information that suggests that current access controls may be inadequate to maintain grizzly bears. The results of a monitoring road access study could be used to identify and prioritize areas for potential access control.

(5) Examine grizzly bear mortality at the GBPU level for comparison with this work

The Trust could consider assessing grizzly bear mortalities for the entire Babine GBPU. Those results could be compared with what has occurred within the BWMT study area. For harvest rates to be within the harvest allocation we would expect grizzly bear kills to be less than what we report. Since this question is primarily related to whether harvest allocations in the BWMT are sustainable we suggest only the mortalities of bears be considered.

(6) Consider the Use of Radio-collars to Monitor Bear Movements

We noted uncertainty among local biologists regarding the attraction of the Park and weir areas for bears and the home range size of bears that use these areas. The only radio-collaring work in the area had only one female that had a small, well defined home range and was not necessarily thought to be reflective of the larger population (MacHutchon and Mahon 2002). Outfitting a sample of bears with GPS radio-collars would allow for the movement of bears that were captured within the BWMT study area to be monitored throughout the foraging and denning seasons. It would also provide insight in to how salmon availability in this study area might influence movements, which is important for this mixed coastal-interior area. Bear movements would also allow for detailed habitat selection studies (e.g., Ciarniello 2009). We suggest that this information would be particularly useful in combination with DNA trend monitoring techniques.

6.0 Literature Cited

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Geographic Information System Data Layer Sources

Provincial Biogeoclimatic Subzone:
ftp://ftp.for.gov.bc.ca/HRE/external/!publish/becmaps/GISdata/CurrentVersion.

Freshwater Atlas Stream Networks:
https://apps.gov.bc.ca/pub/geometadata/metadataDetail.do?recordUID=50648&recordSet=ISO19115

Salmon Bearing Streams: http://www.env.gov.bc.ca/esd/distdata/ecosystems/bc50kfiss/hist_fish_dist/

Landsat™ Images: http://glovis.usgs.gov/

Appendix 7.1: Buffer Analyses

A local expert on bear biology expressed concern that the BWMT study area did not consider ecological boundaries for bears when determining the monitoring area (D. Wellwood, pers. comm.). Upon examination of Landsat™ images we noted that in particular the northern and southern boundaries tended to be open, lower elevation valleys that with the addition of the Babine River running through may actually facilitate movement for bears. We applied a 10.7 km buffer based on the average female home range size for interior grizzly bears (Ciarniello et al. 2009) since the concern was primarily with female bears being attracted to the weir and Park areas. However, during subsequent discussions with government employees it was noted that the addition of the buffer was also arbitrary in that it did nothing to limit immigration or emigration for bears (D. Heard, pers. comm.). The addition of the buffer also meant the inclusion of four different GBPUs.

The Provincial government recently held a meeting where the issue of determining boundaries for grizzly bear populations was the focus and a collective decision was not reached (A. Hamilton, pers. comm.). It was suggested that if we increase we do so to the size of the Babine GBPU. Although the recommendation to examine the entire Babine GBPU was a good suggestion because it would have allowed us to make comparisons with that portion of the GBPU that is within the BWMT area it was well beyond the scope of the contract, primarily due to the size of the GBPU. In addition inclusion of the buffer analyses in the main text of the report was found to be confusing and did not lend more to what had occurred within the BWMT study area. Therefore, for clarity we removed the buffer analyses and have placed them in the following appendix.

Buffer Analyses

There were 32 reports of grizzly bears killed in the buffer area (buffer area only); 29 (91%) of those bears were destroyed legally through the limited entry hunt (LEH), 3 (9%) were animal control kills and no bears were reported to have been killed illegally.

Table A-1. Grizzly bears killed in relationship to the distance to the nearest salmon bearing river/stream for the buffer surrounding the Babine Watershed Monitoring Trust Study Area by 11-year period, 1990-2011 (*n* = 32).

River Type	Time Period		
	1990-2000		
	Mean Distance	SE	Range
Known Salmon Bearing River/Stream	4896.23	924.11	181, 11625
River/Stream	166.39	41.67	5, 466
	2001-2011		
	Mean Distance	SE	Range
Known Salmon Bearing River/Stream	3175.96	957.84	95, 14409
River/Stream	171.76	39.93	5, 485
	1990-2011 Totals		
	Mean Distance	SE	Range
Known Salmon Bearing River/Stream	4036.09	672.64	95, 14409
River/Stream	169.07	28.39	5, 485

Table A-2. Number of grizzly bears killed according to the predominant land cover type for the buffer area, 1990-2011.

	Time Period		
Leading Species	1990-2000	2001-2011	1990-2011
Aspen	0	0	0
True Fir	0	1	1
Alpine Fir	9	4	13
Western Hemlock	1	3	4
Lodgepole Pine	1	0	1
Spruce	1	2	3
Hybrid Spruce	1	1	2
No Species Recorded	3	5	7
TOTALS	16	16	32

Table A-3. Number of grizzly bears killed according to the age of the landscape in stand age years for the buffer area by 11-year period, 1990-2011.

Stand Age (years)	Time Period		
	1990-2000	2001-2011	1990-2011
0-19	4	5	9
20-39	-	1	1
40-59	-	-	-
60-79	-	-	-
80-99	1	-	1
100-119	1	-	1
120-139	-	2	2
140-159	-	-	-
160-179	-	-	-
180-199	-	2	2
200-219	3	4	7
220-239	-	-	-
240-259	1	-	1
260-279	4	1	5
280-299	1	-	1
300-319	-	1	1
320-339	-	-	-
340-359	1	-	1
Totals	16	16	32

Table A-4. Area in km² of the buffer area that is contained within each GBPU.

Grizzly Bear Population Unit	Area (km²)
Omineca (5)	926.22
Upper Skeena-Nass (59)	14.88
Babine (61)	2368.75
Cranberry (63)	314.39
TOTAL	3624.24

Table A-5. Area in km² of the buffer area that is contained within each Wildlife Management Unit (WMU).

Wildlife Management Unit	Area (km²)
6-8	1291.08
6-18	14.88
6-30	314.39
6-7	1077.67
7-27	926.22
TOTAL	3624.23

Table A-6. Number of grizzly bears calculated in the buffer area by Wildlife Management Unit (WMU), assuming uniform distribution, 2012.

WMU	Number of bears
6-7	37.9
6-8	21.8
6-30	9.6
7-27	6.5

Table A-7. Estimated harvest allocation for grizzly bears by WMU supplied by the Ministry of Environment, 2012

Estimated Harvest Allocation for Grizzly Bears in 2012 (%)				
Wildlife Management Unit	Maximum Human Caused Mortality Rate	Estimated First Nations Harvest Rate	Estimated Unreported Mortality Rate	Final Allowable Mortality Rate
6-7	6.0	-0.40	-0.90	4.70
6-8	6.0	-0.55	-0.90	4.55
6-30	6.0	-0.84	-0.60	4.56
7-27	4.0	0	-0.30	3.70

Table A-8. Total annual mortality rate and annual female mortality rate for the buffer area by Wildlife Management Unit (WMU), 1990-2011. Yellow highlighted cells indicate harvest rates that are higher than the Maximum Human Caused Mortality rate for the WMU, while purple highlighted cells are harvest rates above the Final Allowable Mortality Rate.

Year	Total Annual Mortality Rate			Annual Female Mortality Rate		
	Wildlife Management Unit					
	6-7	6-8	6-30	6-7	6-8	6-30
1990	**0.079**	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0.026	0.046	0	0.053	**0.092**	0
1993	0	0.046	0	0.000	**0.092**	0
1994	0.026	0	0	0	0	0
1995	0.053	**0.092**	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0.053	0.046	0	0	0	0
2000	0.053	0	0	0.053	0	0
2001	0	0	0	0	0	0
2002	0.026	**0.092**	0	0	**0.092**	0
2003	0.053	0	0.104	0	0	0.208

Year	Total Annual Mortality Rate			Annual Female Mortality Rate		
	Wildlife Management Unit					
	6-7	6-8	6-30	6-7	6-8	6-30
2004	0.026	0.046	0	0	0	0
2005	0.026	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0.046	0.104	0	0	0
2008	0	0.046	0	0	**0.092**	0
2009	0	0	0	0	0	0
2010	0	0.046	0.104	0	0	0
2011	0	**0.092**	0	0	**0.092**	0

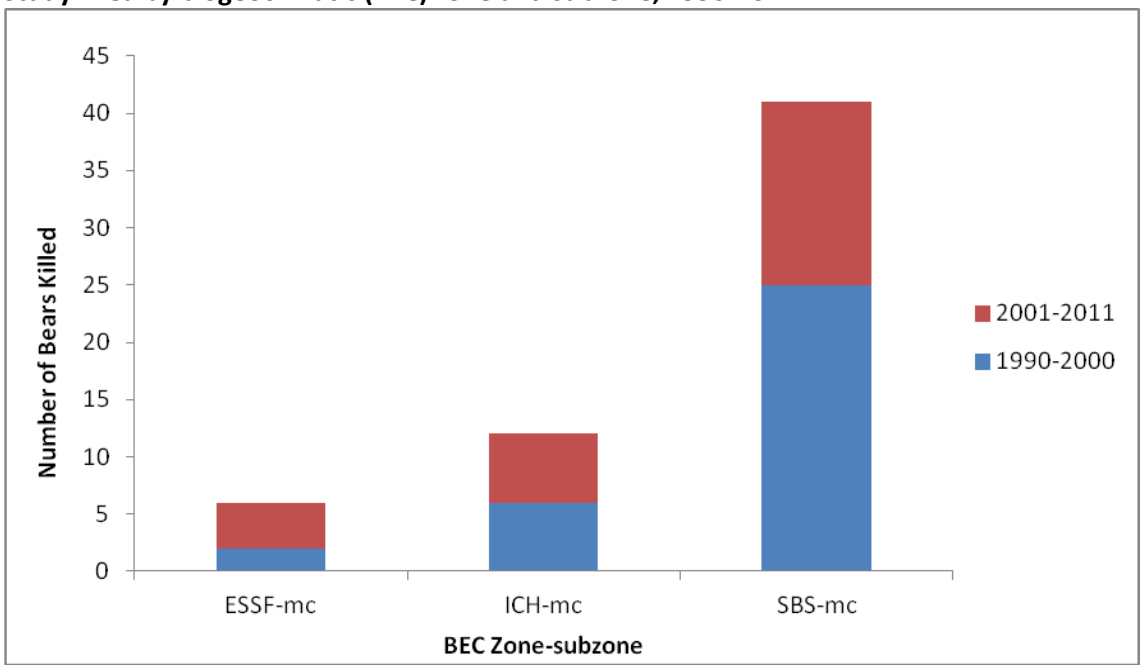
[1]No grizzly bear kills occurred in the portion of WMU 7-27 that was contained within the buffer.

Appendix 7.2: Grizzly Bear Mortality and Bigeoclimatic Zones (BEC) for the BWMT Study Area (no buffer)

Appendix 7.2 and 7.3 represent a summary of grizzly bear mortality locations as they relate to biogeoclimatic zone/subzone, landcover type, and the age of the forest stand. The reader is reminded that although the majority of grizzly bears died in SBSmc it is likely that this BEC zone dominates the study area, for example. To more accurately determine if a significant relationship exists between these types of attributes and the mortality of bears advanced statistical analyses that are beyond the scope of this project are required. We recommend that the next step in these analyses would be to employ a Resource Selection Functions (RSF) use/available design. RSF are mathematical equations relative to the probability of use. Logistic regression would be used to model the distribution of grizzly bear mortalities as they relate to these types of local landscape attributes (model variables). In that design the mortalities would be assigned 1 (use) and 0 would be assigned to randomly generated GIS locations across the study area according to their BEC zone, landcover type and/or forest stand type. The results would allow one to determine if grizzly bear mortalities were indeed associated with the local landscape attributes or were simply occurring as would be expected by random.

The number of grizzly bears killed in the different BEC zones is likely highly dependent upon the amount of area of each zone within the study area. Grizzly bears were killed within all three BEC zones, although they were most commonly destroyed within the sub-boreal spruce zone (Fig. A-1).

Figure A-1. Number of grizzly bears destroyed (*n* = 59) in the Babine Watershed Monitoring Trust Study Area by biogeoclimatic (BEC) zone and subzone, 1990-2011.



Appendix 7.3: Grizzly Bear Mortality & Landcover Type and Stand Age for the BWMT Study Area (no buffer)

In the BWMT study area grizzly bears were most often killed in stands where the leading tree species was Lodgepole pine (21%), followed by spruce forests (10%) and stands of non-commercial value which tended to be riparian areas, meadows and wetlands (9%) (Table A-9). We again caution the reader that this represents mortalities only and to more accurately determine if a significant relationship exists between the landcover type and age of the stand where bears were dying advanced statistical analyses that are beyond the scope of this project are recommended.

Table A-9. Number of grizzly bears killed according to the predominant land cover type for the Babine Watershed Monitoring Trust Study Area, 1990-2011.

	Time Period		
Leading Species	**1990-2000**	**2001-2011**	**1990-2011**
Aspen	3	1	4
True Fir	2	3	5
Alpine Fir	3	4	7
Western Hemlock	2	1	3
Lodgepole Pine	14	7	21
Spruce	5	5	10
Hybrid Spruce	0	0	0
Non-commercial value	4	5	9
TOTALS	33	26	59

Grizzly bear kills primarily occurred in old age stands >100 years (cumulative n = 35, 59%), while 30.5% of bears killed were in young regenerating stands ranging in age from 0-19 years had (Table A-10). We did not secure a cutblock layer but the young stand age, and the difference between kills in non-commercial stands, indicates that kills may have an association with cutblocks.

Table A-10. Number of grizzly bears killed according to the age of the landscape in stand age years for the Babine Watershed Monitoring Trust Study Area by 11-year period, 1990-2011.

Stand Age (years)	Time Period		
	1990-2000	**2001-2011**	**1990-2011**
0-19	10	8	18
20-39	-	1	1
40-59	2	1	3
60-79	-	-	-
80-99	1	1	2

Stand Age (years)	Time Period		
	1990-2000	2001-2011	1990-2011
100-119	-	1	1
120-139	3	-	3
140-159	1	1	2
160-179	3	3	6
180-199	8	1	9
200-219	-	4	4
220-239	3	-	3
240-259	1	3	4
260-279	1	1	2
280-299	-	1	1
300-319	-	-	-
320-339	-	-	-
340-359	-	-	-
Totals	33	26	59

We provided a Landsat™ image of the watershed to visually assess kills in association with landcover features such as cutblocks and roads (Fig. A-2). Grizzly bear kills in the hotspot LEH area between the Babine and Nilkitkwa Rivers appear to be associated with cut blocks of varying ages (Fig. A-2). Grizzly bears are known to commonly feed within cut blocks and the roads associated with those blocks have been linked or warned to be associated with increased bear mortality (Ciarniello 2012, Nielsen et al. 2004*b,c*). Additionally, successful hunting of bears is likely to occur in areas where there is higher visibility.

Figure A-2. Grizzly bear mortality locations and land cover for the Babine Watershed Monitoring Trust Study Area and buffer, 1990-2011.