Yukon

SR-22-06

Review of grizzly bear monitoring and mortality management in the Yukon

August 2022

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Government of Yukon
Fish and Wildlife Branch
SR-22-06

Preamble

This document was prepared for the Grizzly Bear Conservation and Management Plan Working Group, which was tasked with developing a Yukon-wide grizzly bear conservation and management plan. This review focuses on the Yukon's current monitoring and mortality management regime.

Acknowledgments

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Yukon summary

Population status	- Designated as “Special Concern” under COSEWIC. - General Status conservation rank of Sensitive. - NatureServe conservation rank of S3-Vulnerable. - International Union for Conservation of Nature (IUCN) Red List category of Least Concern.
Population estimation method (baseline)	Expert opinion; expert extrapolation; DNA-based spatially explicit mark-recapture. Population size is estimated at different spatial scales, depending on need (e.g., ecoregions, Bear Management Units [BMUs], etc.)
Management units	Depends on management need: e.g., BMUs for harvest.
Sustainable harvest rate	BMUs outside the Inuvialuit Settlement Region (ISR): - Up to 4% of the total estimated population size within the BMU. - Up to 2% of the estimated female population size within the BMU. - Up to 6% of the estimated male population size within the BMU. Within the ISR: - A sustainable harvest rate of 3% of bears age 2 years and older is used to estimate the annual total allowable harvest for each community hunting area. - No more than 33% of the harvest should be females. - Inuvialuit harvesters are subject to a quota.
Population monitoring	Age, sex, and mortality information from tracking of harvest and other sources of mortality can be used to identify areas of potential concern. Harvest reporting is mandatory for licensed harvesters.

Population status: population size and trends

National and territorial status

Grizzly bears are legally listed as "Big Game" under the Yukon *Wildlife* Act. They are nationally assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Special Concern (COSEWIC 2012). Once listed under the federal *Species at Risk* Act, a national management plan for the species will be required. In the Yukon, they have a General Status conservation rank of Sensitive and a NatureServe conservation rank of "S3-Vulnerable". The Yukon does not have species at risk legislation, so grizzly bears have no territorial species at risk designation.

Grizzly bears are found across the Yukon, but population-specific information is limited as they are difficult and expensive to study and monitor. It is also not clear what defines a bear population in the Yukon; consequently, current management units are not biologically based. Rather, "populations" are defined based on the area of interest (e.g., ecoregion, bear management unit, local and/or regional study area) or management focus (e.g., bear management units for harvest; watersheds for environmental assessments).

In most of the territory, the status of bears is unknown, but mortality trends suggest most "populations" are sustainable (see Mortality trends for BMUs outside the ISR 1980-2016 on page 33). There are some areas in Yukon where there may be conservation concerns, based on more recent mortality information (e.g. southwest Yukon; see Spatial distribution of mortality (territorial perspective) 1980-2016 on page 39). Grizzly bears are sensitive to human disturbance and are subject to higher mortality risk in developed areas where conflicts are common and roads create access (COSEWIC 2012). Grizzly bear populations are susceptible to declines; moreover, once a population declines, it can be slow to recover (see Factors to consider when managing mortality for grizzly bears in Yukon on page 20).

Population estimates for grizzly bears in the Yukon

Population estimates for specific areas in the Yukon have been derived from expert opinion, survey work (aerial, DNA, etc.) or a combination of both. The Government of Yukon has recently completed studies in the Yukon North Slope (YNS) and the Southern Lakes region to update population information in these areas (see page 13). Considerations for further monitoring work can be found in Appendices 1 and 2.

Ecoregion based population estimates

Ecoregion based population estimates were derived from expert information collected in the 1980s (Table 1; Figure 1; Smith and Osmond-Jones 1990). Loosely, this approach assumes more bears will be found in good habitats and less bears will be found in moderate to poor quality habitats (Banci et al. 1994). More specifically, biologists familiar with bears in the Yukon (B. Smith, A. Pearson, and G. Lortie) developed density estimates for ecoregions based on their

own expert opinion, interviews with outfitters/guides and density estimates from northern interior population studies (mostly conducted outside of the Yukon) (Smith and Osmond-Jones 1990). Population size estimates were then calculated for each ecoregion based on its size and estimated bear density within the ecoregion.

Table 1. Density and population estimates for grizzly bears in the Yukon, shown by ecoregion, based on the informed, expert-based method conducted in the 1980s. Population size estimates were calculated based on the size of the ecoregion and estimated bear density within the ecoregion (note that ecoregion boundaries have been updated since Smith and Osmond-Jones 1990). Different population estimates have been used to manage bears that fall within ecoregions in the Yukon North Slope, which is part of the Inuvialuit Settlement Region (*; British-Richardson Mountains and the Yukon Coastal Plain).

Ecoregion	Area (km^2)	Density estimate (bears per 1,000 km^2)	Population estimate
Boreal Mountains and Plateaus	953	15.4	15
Eagle Plains	20,534	8.6	177
Fort MacPherson Plain	2,812	9.6	27
Hyland Highland	14,611	10.8	158
Klondike Plateau	38,703	11.0	426
Liard Basin	21,221	9.3	198
Mackenzie Mountains	43,078	14.6	629
Mount Logan	4,219	0	0
Muskwa Plateau	732	10.8	8
North Ogilvie Mountains	39,515	10.7	422
Old Crow Basin	14,693	11.7	171
Old Crow Flats	6,005	11.4	68
Peel River Plateau	14,864	9.8	145
Pelly Mountains	34,443	14.7	506
Ruby Ranges	22,865	18.2	416
Saint Elias Mountains	19,357	14.8	286
Selwyn Mountains	35,424	14.6	519
Yukon Plateau-Central	26,966	14.7	396
Yukon Plateau-North	57,426	15.3	878
Yukon Southern Lakes	30,055	16.3	489
Yukon-Stikine Highlands	7,067	22.2	157
British-Richardson Mountains*	23,026	16.1	371
Yukon Coastal Plain*	4,735	16.5	78
Total	483,305		6,540

Density estimates were based on factors thought to influence grizzly bear abundance, including topographic diversity, salmon spawning, ungulate diversity and abundance, small mammal populations, habitat types (i.e., productive bottomlands, mesic and hygric alpine habitats, and habitats with no bear food), and recent burns. Estimates were for the presumed carrying capacity of the ecoregion (i.e., potential densities based on how many bears the area was believed to support), not necessarily how many bears were actually believed to be in the ecoregion. Consequently, density estimates may be high because they are not corrected for factors that reduce carrying capacity like land use disturbances, areas with high human densities, human caused mortality, etc. (Smith and Osmond-Jones 1990; Banci et al. 1994).

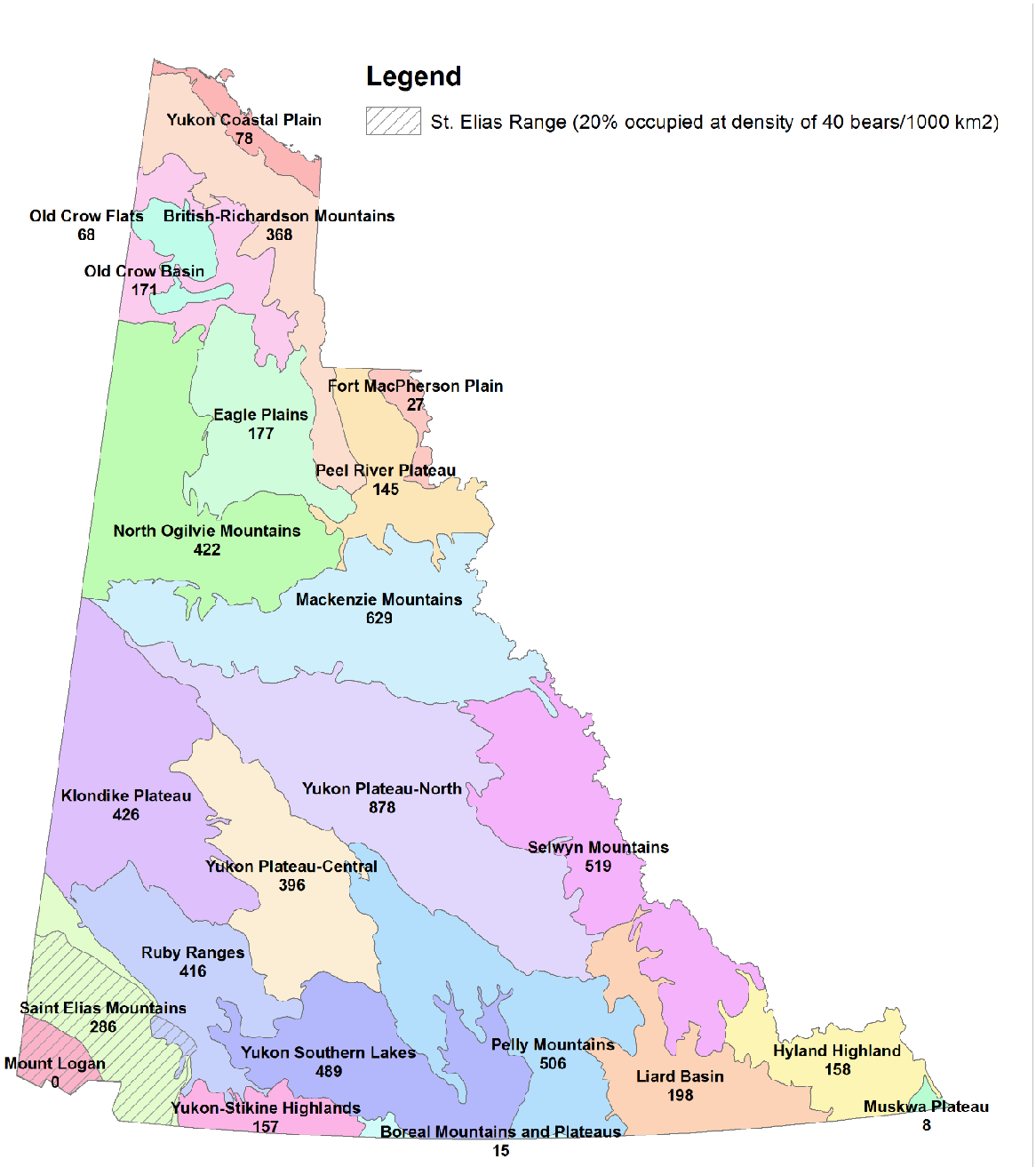


Figure 1. Estimated grizzly bear population size for ecoregions in the Yukon (see Table 1 for more information).

Population estimates for Bear Management Units

Outside of the Inuvialuit Settlement Region (ISR), Bear Management Units (BMU) are currently the scale at which the Government of Yukon tracks and manages grizzly bear mortality; hence, population size and density is estimated for each BMU (Table 2; Figures 2 and 3). Each BMU is made up of one or more ecoregions. Population size is estimated as the total sum of bears

estimated to be in each ecoregion (bear density per ecoregion area multiplied by the size of the ecoregion area) that makes up the BMU (Table 2; also see Figure 4 for an example). Within the Yukon portion of the ISR, grizzly bear mortality is managed within the YNS, not individual BMUs (e.g., Figure 2).

Table 2. Grizzly bear population estimates and density estimates for individual BMUs. Note that different population estimates have been used to manage bears within BMUs that contain the Yukon North Slope (*; West Arctic; East Arctic).

BMU (reference number)	Area (km^2)	Density estimate (bears per 1,000 km^2)	Population estimate
Aishihik (13)	23,282	13.9	324
Anvil (8)	9,971	16.0	160
Arkell (17)	7,744	17.6	136
Big Salmon (19)	13,340	15.1	202
Bonnet Plume (5)	11,175	12.8	143
Cassiar (20)	36,064	13.9	503
Dezedeash (16)	4,866	21.4	104
Eagle Plains (94)	22,763	9.3	211
East Arctic (92)*	9,500	16.4	156
Frances (21)	13,709	11.1	152
Glenlyon (14)	10,163	16.0	162
Gold (96)	36,900	12.8	471
Hart (4)	18,251	14.0	255
Hyland (22)	28,606	11.1	319
Klondike (3)	9,741	16.1	157
Kluane (98)	29,174	13.6	396
Knorr (99)	10,399	10.0	104
Laberge (97)	8,640	14.8	128
MacMillan (9)	22,456	15.1	339
Nadaleen (6)	8,897	13.1	117
Nisling (11)	9,039	15.5	140
North Ogilvie (2)	14,903	10.9	162
Old Crow Flats (93)	23,661	11.6	273
Pelly (15)	15,487	15.2	235
Richardson (95)	18,090	11.5	209
Ruby (12)	2,141	20.0	43
Southern Lakes (18)	8,175	18.2	148
Stewart (7)	20,334	14.9	302
West Arctic (91) *	14,167	15.0	212
West Ogilvie (1)	14,460	12.6	182
White (10)	7,444	13.4	100
Total	483,541		6,545

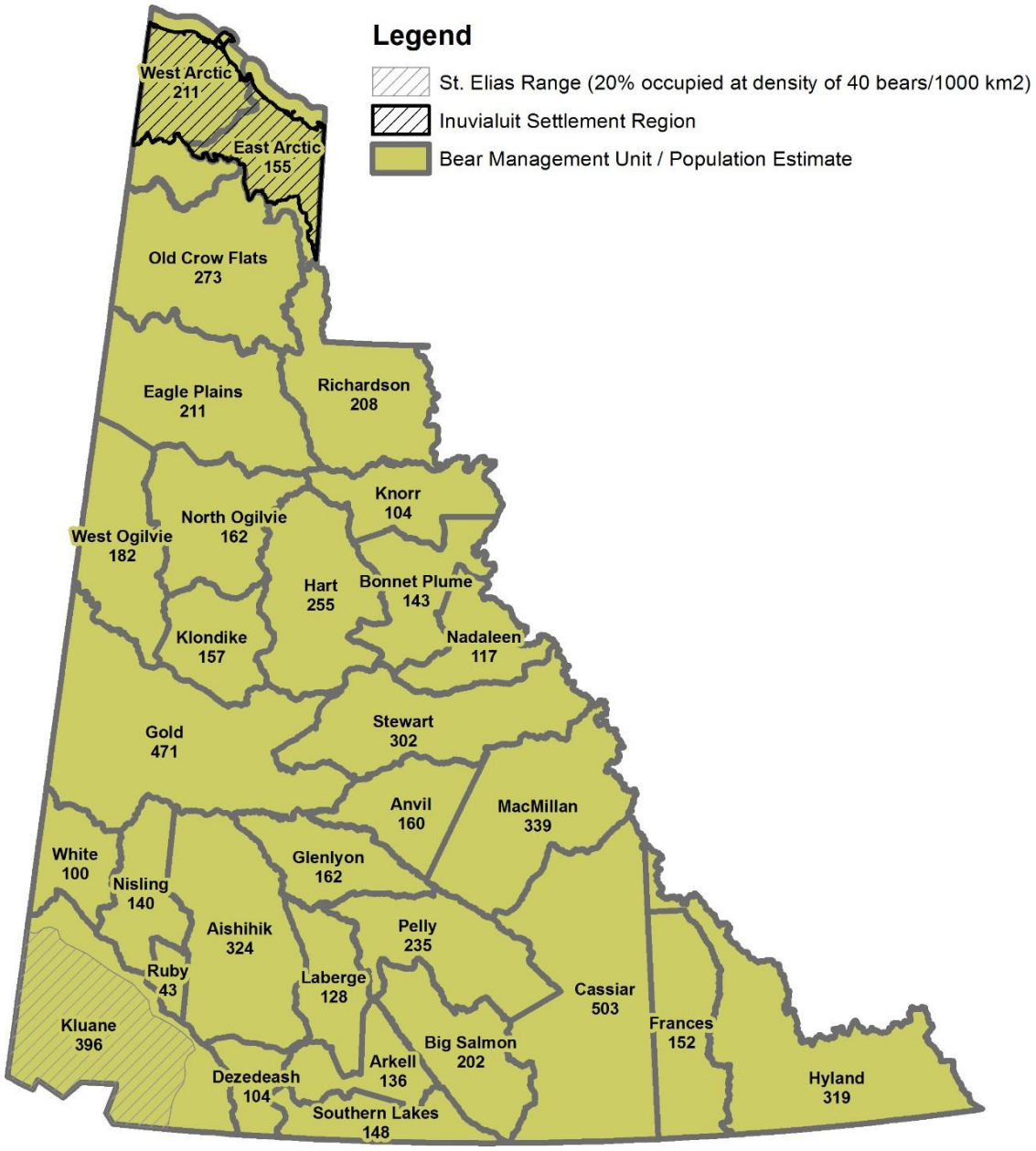


Figure 2. Population size estimates for individual BMUs in the Yukon. Different population estimates have been used to manage harvest of bears that fall within BMUs in the Yukon North Slope, which is part of the Inuvialuit Settlement Region (predominantly the West Arctic BMU [minus Vuntut National Park] and East Arctic BMUs). For example, Nagy and Branigan (1998) used an estimate of 155 bears for the Eastern Yukon North Slope and 150 bears for Ivvavik National Park when developing harvest rate recommendations for bears on the ISR (total of 305 bears).

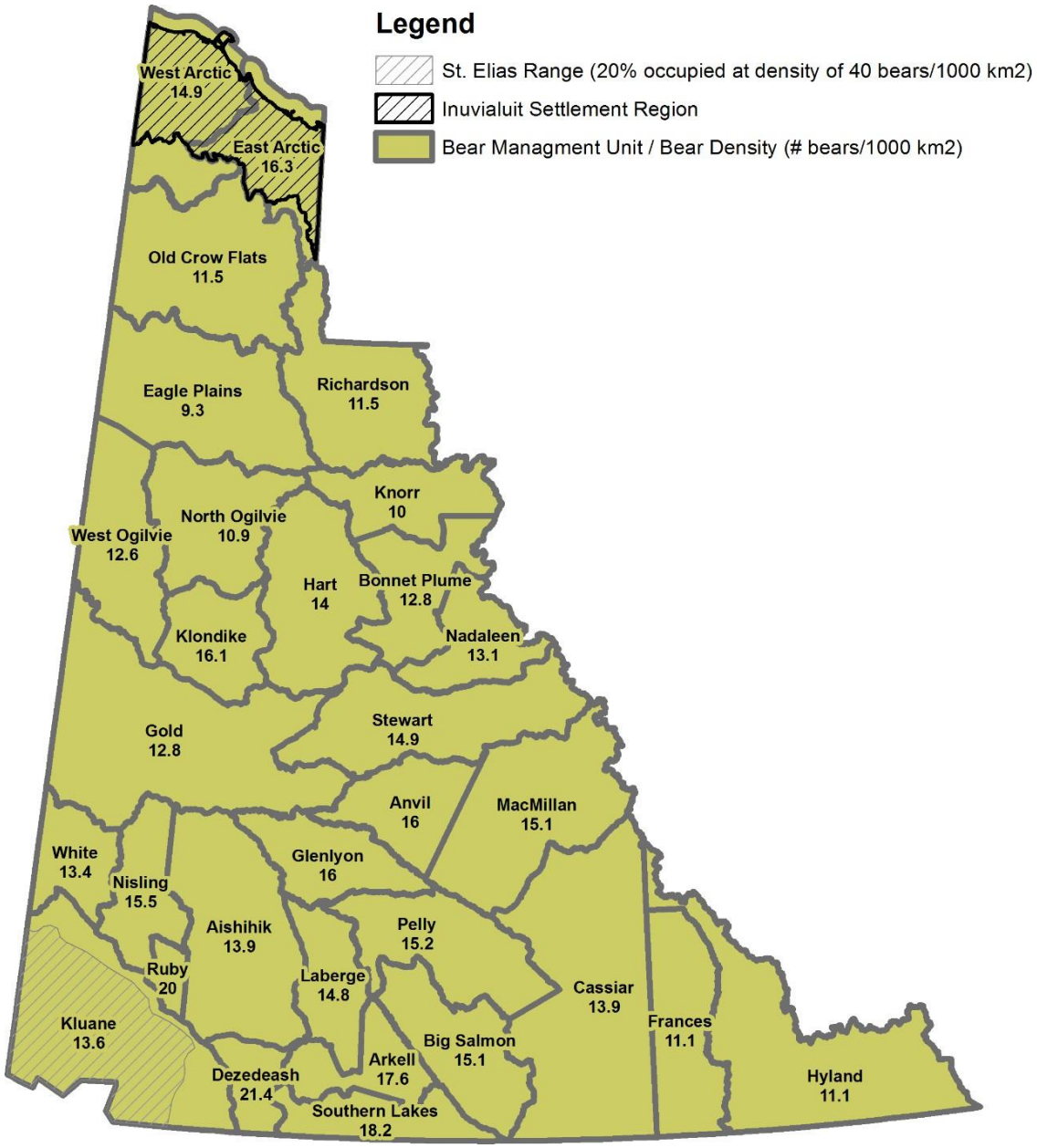


Figure 3. Population density estimates (in parentheses) for individual BMUs in the Yukon (bears per 1000 km^2). Note that different density estimates have been used to manage harvest of bears that fall within BMUs in the Yukon North Slope, which is part of the Inuvialuit Settlement Region (predominantly the West Arctic BMU [minus Vuntut National Park] and East Arctic BMUs).

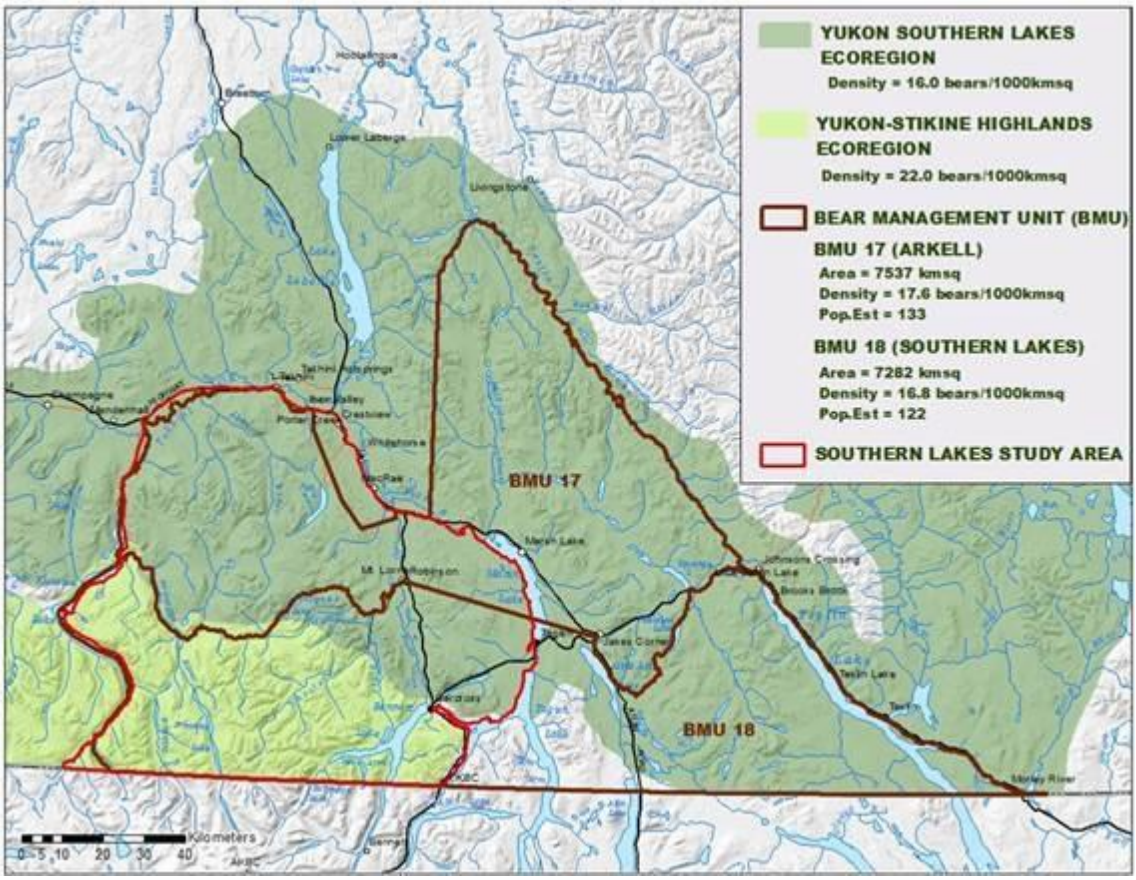


Figure 4. Grizzly bear density and population estimates for Bear Management Units overlapping the Southern Lakes 2012-13 grizzly bear study area (Arkell BMU 17 and Southern Lakes BMU 18). Density and population estimates for the BMUs were calculated from the area of overlapping ecoregions and the ecoregion densities.

The primary boundaries for BMUs follow Outfitting Concessions areas or subsections of the Outfitter Concessions. Exceptions to this are (1) the Yukon North Slope, where the East and West Arctic BMUs are modified to match Game Management Areas, and (2) in the Southwest Yukon, where the Kluane BMU extends from Outfitting Concessions to the Yukon Border. There are also misalignments along the YT-NWT border.

Mowat et al. (2013) used regression modeling to estimate density and population size within the Yukon's BMUs based on predicted relationships between bear density and factors like habitat productivity, human use of the landscape, and human-caused mortality (Appendix 3). There is a good correlation between Mowat et al. (2013)'s and Smith and Osmond-Jones (1990)'s estimates; however, Mowat et al. (2013) typically predicts more bears within BMUs than Smith and Osmond-Jones (1990). Most of the estimates using the Smith and Osmond-Jones (1990) approach or Mowat et al. (2013) have not been verified with recent empirical data.

Recent population estimates based on local area studies conducted in the Yukon

Yukon North Slope

The first bear study on the YNS was conducted in the Barn Mountain area in 1972 to 1975 (Nagy et al. 1983a; Figure 5). This study obtained information on the morphological characteristics of bears, denning habits, and population parameters. Researchers used a direct aerial count of bears to estimate population size. However, issues with study design meant the majority of the data collected from this study was not used to establish population size (e.g., no sightability correction factors were applied to the estimate; immigration and emigration were not accounted for; study size and duration was too small). Instead, population parameter estimates were applied to the YNS from other studies conducted in the Northwest Territories and neighboring Alaska, resulting in a population point estimate of 316 bears (no confidence intervals; Nagy 1990).

The YNS is contained within the East and West Arctic BMUs. The ecoregion based estimate for YNS is 306 bears, but this estimate is high as it also includes Vuntut National Park, which is outside the ISR but part of the West Arctic BMU. In the *Co-management Plan for Grizzly Bears in the Inuvialuit Settlement Region, Yukon Territory and Northwest Territories*, Nagy and Branigan (1998) used an estimate of 155 for the Eastern Yukon North Slope and 150 for Ivvavik National Park when developing harvest rate recommendations for bears on the ISR (a total of 305 bears).

The population size of grizzly bears on the YNS was updated between 2006 and 2007 using a DNA-based spatially explicit capture-recapture design (Yukon Fish and Wildlife Branch Report 2016). New population size estimates were based on extrapolations of the data collected in the core study area, where the population size was estimated at 87 (95% CI=72-106) and 104 (95% CI=85-128) bears, including dependent offspring (Figure 4).

Two updated population estimates are presented because bear density varied across the study area and factors that appeared to drive density patterns varied between years. Specifically, density patterns appeared to be driven by ecodistrict in 2006 and Porcupine caribou distribution in 2007. Extrapolating the relationship between bear density and ecodistrict in the core study area to the YNS resulted in a “high estimate” of 431 bears (95% CI=349-532), including dependent offspring. Extrapolating the relationship between bear density and caribou in the core study area to the YNS resulted in a “low estimate” of 290 bears (95% CI=235-358), including dependent offspring. ~55% of the bears in the core study area were females. Based on the DNA results, more than 65% of bears were predicted to be in Ivvavik National Park, but it is not clear if this was a seasonal or year-round trend (Parks Canada, *unpublished information*). Population trend was also assessed by tracking survival and reproductive rates of 35 collared bears (17 females, 18 males) between 2004 and 2010. This information suggests the YNS population was stable or at carrying capacity during the 2004 to 2010 period.

Given differences in study design, differences in the current population estimates, and the amount of time between studies, it is not clear how or if the YNS population changed between the periods of the 2004-2010 and Nagy’s (1990) work. A local and traditional knowledge study was also conducted on grizzly bears in the Yukon North Slope (WMAC-[NS] 2008). Most of the

interviewees in this study felt that there wasn't much change in the population over the last 20 years (also see ***Traditional and Local Knowledge***, page 18).

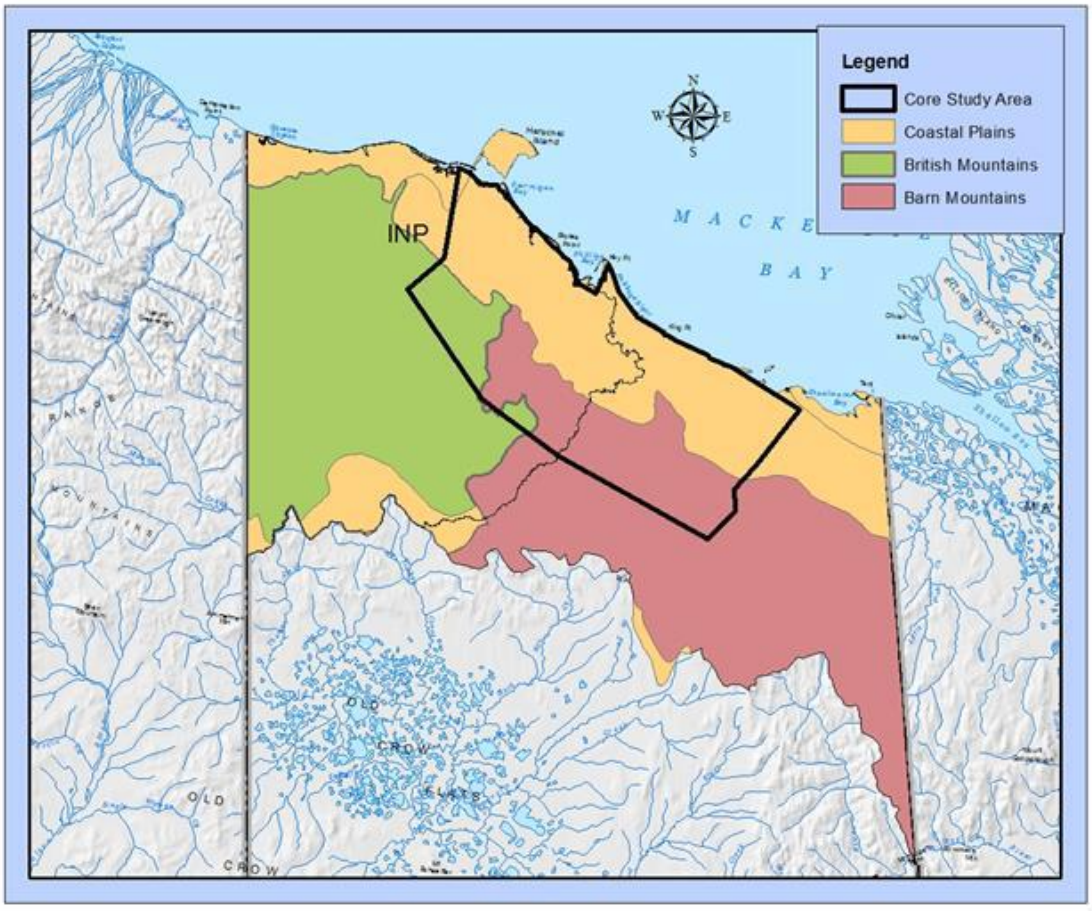


Figure 5. Ecodistrict groups on the YNS used for spatially explicit capture-recapture analysis. The colored regions of the ecodistrict groups represent the spatial extent of the YNS or the Yukon portion of the ISR. INP refers to Ivvavik National Park.

Southern Lakes

In 1985, grizzly bear abundance was estimated in a 6,310 km^2 area in the southwest Yukon (Coast Mountain Range; Larsen and Markel 1989). Preliminary results suggest 82 to 139 bears were in the area (average of 100), with a density estimate of 13 to 22 bears per 1,0 km^2 average of 16 per 1,0 km^2.

Work was conducted from 2012 to 2013 to update the population size estimate for grizzly bears in the Southern Lakes using a DNA-based spatially explicit capture-recapture design (Figure 6; Yukon Fish and Wildlife Branch Report 2017). Preliminary results suggest a density of 11 bears per 1000 km^2 (95% CI: 9–13 bears per 1000 km^2) within the core study area (7,859 km^2) using pooled data across years (Yukon Fish and Wildlife Branch Report 2017). This equates to a conservative population estimate of 82 (95% CI 69–97) bears, including dependent offspring. Sixty-one percent of bears in the core study area were females. Age

cannot be determined from the hair samples, so it isn't known what proportion of the study population was made up of cubs or subadults.

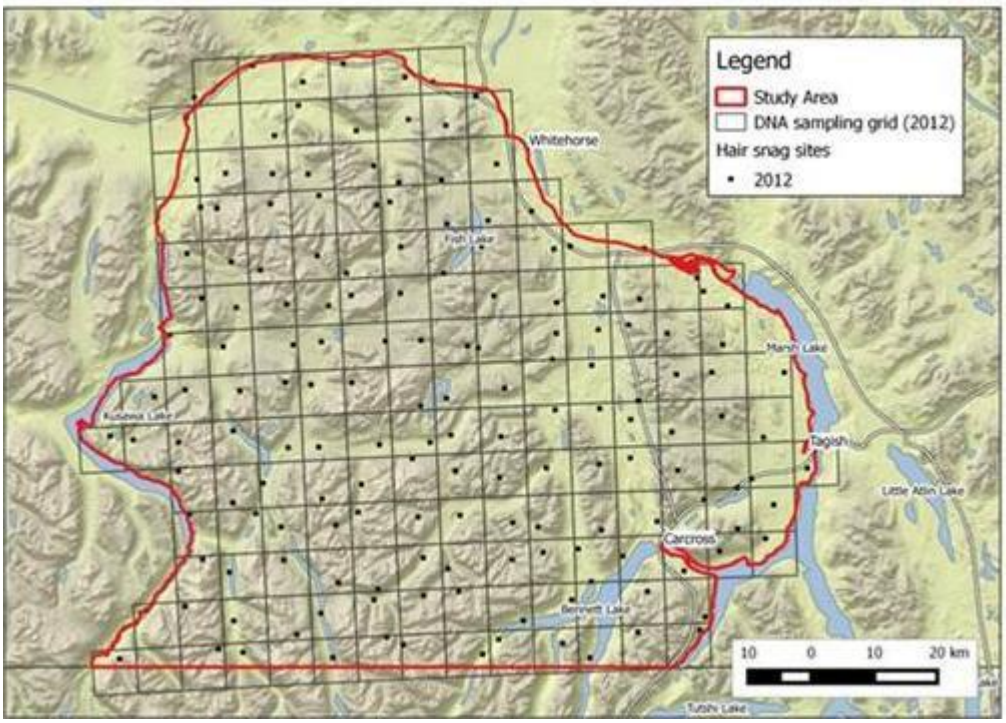


Figure 6. Study area for the Southern Lakes grizzly bear population study.

The DNA based estimate is lower than the ecoregion based estimate derived in the 1980s. The study area was largely found in two ecoregions: Yukon Southern Lakes (61%) and Yukon-Stikine Highlands (38%). Based on the original ecoregion based approach to estimating population size, there are an estimated 144 bears in the core study area (~19 bears/1000km^2) (Figure 7).

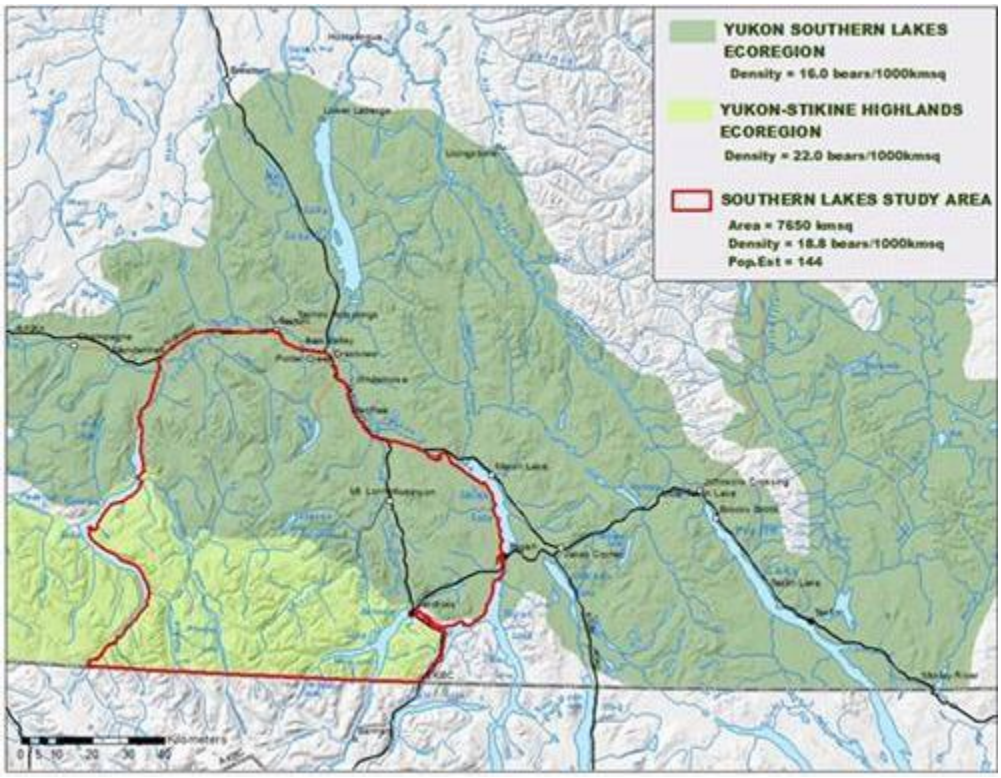


Figure 7. Ecoregion-based grizzly bear density estimates for the Yukon Southern Lakes ecoregion and the Yukon-Stikine Highlands ecoregion. Density and population estimates for the Southern Lakes study area were calculated from the area of overlapping ecoregions and the ecoregion densities.

The difference between the two estimates should not be interpreted as a decline as estimates were obtained using different approaches and are decades apart, meaning it is hard to infer trend. One outcome of this study is that ecoregion based estimates may need to be adjusted down in more developed and populated areas like the Southern Lakes study area.

Additional work is needed to determine how the core study area results should be applied to the areas outside the study area. It is suspected that conditions for bears inside the core study area (many people, lots of development/access, and lots of opportunities for conflict) are different than outside the study area (fewer people, less development/access, and fewer opportunities for conflict) so study results may not be directly transferable. This work is needed before population estimates for these two BMUs can be updated; regardless, it is known that the current eco-region based estimates for the Arkell (17) and Southern Lakes (18) BMUs are high.

In addition to the DNA mark-recapture study, 39 bears (18 females and 21 males) in the Southern Lakes Region were captured and fitted with GPS collars. Tracking of collared bears occurred between 2009 and 2016. Similar to the YNS study, collars provided location information and will be used to infer population trends based on survival and reproductive rates.

Territory wide population estimates

The Government of Yukon's working population estimate for the entire territory is 6,000 to 7,000 grizzly bears, although it is acknowledged that there is considerable uncertainty with this estimate.

Other estimates of population size exist for the Yukon. The Yukon Outfitters Association commissioned a study to examine grizzly bear harvest management in the Yukon (Sidorowicz and Gilbert 1981). Based on outfitter observations, Sidorowicz and Gilbert (1981) estimated the grizzly bear population size for the territory at 5,000 bears. Analyses on bear densities across Canada suggest the carrying capacity or maximum possible population size in the Yukon is ~6,300 bears (Banci 1991). Based on regression models that correlated bear density to mortality and habitat productivity, Mowat et al. (2013) estimated the population size for the territory at ~10,400 bears.

Other types of monitoring

Mortality monitoring

The Government of Yukon monitors the age and sex structure of the grizzly bear harvest; this reporting is mandatory for licensed harvesters (see Harvest reporting on Page 32). Age and sex information from harvest reports can be used to identify areas of potential concern; for example, a lack of older bears can suggest overharvest (Slough 2011; McLellan et al. 2016). However, only large changes in grizzly bear populations can be detected by harvest data alone (Paloheima and Fraser 1981, Harris and Metzgar 1987, McLellan and Shackleton 1988). The Government of Yukon also tracks other sources of grizzly bear mortality, including defense of life and property (DLP) kills, vehicle kills, illegal kills, etc. Understanding overall mortality trends helps managers understand if mortality is sustainable or if management actions need to be taken (e.g., reduce harvest; work to better manage attractants).

Using local observations to estimate grizzly bear population size

Ground-based monitoring or local observation programs to monitor grizzly bear abundance are often suggested by the public. These types of programs may have the potential to index changes in bear population composition, size or health; however, population estimates are difficult to derive from such techniques. For example, grizzly bear populations can be overestimated when access to bear habitat – and subsequent sightings – increase. Other factors may also impact perceptions of bear status in an area; for example, an inflow of subadult males to disturbed areas may mask an actual population decline.

In 1986, the Government of Yukon assessed the feasibility of using outfitter observations to estimate grizzly bear population size and trend in registered guiding areas in the Yukon (Smits and Smith 1986). Some outfitters were reluctant to participate because of concerns their information would lead to higher resident harvest pressures in their concession areas. In addition, Smits and Smith (1986) identified potential biases in the information collected (e.g., biases stemming from differences in ability to observe bears given different areas, seasons, and cohorts or groups; biases in identification of individual bears as result of pelage bleaching

and/or mortality within litters; concerns over multiple observers using different identification criteria). As a result, Smits and Smith (1986) concluded that using outfitter observations to estimate population size or monitor population trend was not feasible.

Traditional and local knowledge

In the Northwest Territories and the Yukon, local and traditional knowledge have been used to make quota adjustments for grizzly bear populations on the Yukon North Slope, in the Inuvialuit Settlement Region (ISR). At a broader scale, Northwest Territories has included traditional knowledge in its grizzly bear status report for its Species at Risk assessment under the SARA (NWT) Act (http://www.nwtspeciesatrisk.ca/sites/default/files/grizzly_bear_status_report_and_assessment_final_apr617.pdf).

There have been two comprehensive studies completed on grizzly bears, both from regions with land claims that straddle the Yukon and the Northwest Territories. One of these studies was completed in the ISR and focused on grizzly bear habitat use including den use, diet, movement patterns, and changes in population size (WMAC-[NS] 2008). Most of the interviewees in this study felt that there wasn't much change in the population over the last 20 years. No concerns over overall population size were raised; some interviewees speculated bear numbers were increasing and there may be too many bears. There may have been changes in local population size; however, some noted that it is hard to know how many bears there are because they move around a lot and are hard to tell apart.

The Gwich'in Renewable Resources Board and the Gwich'in Social and Culture Institute undertook a traditional knowledge study in 2012 to gather information about grizzly bear habitat use including den use, diet, biology, behavior, movements, threats, and population trends (Gwich'in Social and Cultural Institute/Gwich'in Renewable Resources Board 2014). The newly collected information built upon previous traditional knowledge studies of grizzly bears. Interviewees felt bears may be moving north into the ISR and interbreeding with polar bears, possibly because of warmer summer temperatures. They also noted the possibility of several population declines – there were fewer bears "long ago" during a period of few moose and caribou (possibly the 1940s, 1950s, 1960s). A drop in the number of bears was also related to increased use of skidoos that occurred in the late 1960s, which increased access to spring hunting areas. A drop was also noted in the 1980s to 1990s and possibly as late as the early 2000s; suggested reasons for this change include increased hunting pressure, opening of the Dempster Highway, change in the distribution of bears from the front ranges back further in the mountains, and changes in the distribution of Porcupine caribou and moose.

Interviewees felt bears were increasing or high in numbers during 2012, possibly because the Porcupine caribou herd was close to the community at this time. Many interviewees also felt the population may now be stable or increasing, though views differed, ranging from there were too many bears to the feeling that bears were in decline. Interviewees also indicated that it is difficult to understand long term population trends, because people travel differently now than in the past.

Mortality management

One of the Government of Yukon's goals for managing grizzly bears is to ensure their long term optimum productivity, which includes balancing sustainable harvest opportunities with other sources of mortality like defence of life and property kills.

Factors to consider when managing mortality for grizzly bears in the Yukon:

1. **Low reproductive rates mean it can take many years for grizzly bear populations to recover from unsustainable mortality.** Grizzly bears have one of the lowest reproductive rates of all terrestrial mammals in North America (Pearson 1975; Nagy 1990; Reynolds 1993). They don't produce young until they are older and once they start reproducing, they don't have young every year and not all cubs survive to adults. Based on data from 20 study areas in Sweden, Alaska and Canada, Schwartz et al. (2003a) predicted age of first reproduction for brown (grizzly) bears to be 4 or older. Maximum litter production occurs between 8 to 9 years of age and stays relatively high between 8 and 25 years of age, after which it declines (Schwartz et al. 2003a; also suggested by McLoughlin et al. 2003). Interbirth intervals are estimated to be every 2-4 years (Schwartz et al. 2003ab).

   Most grizzly bears in northern interior and north slope ecosystems do not reach sexual maturity until they are at least seven years old (Nagy 1990). In McLoughlin et al.'s (2003) study of barren-ground grizzly demography in NWT and Nunavut, mean age of first reproduction was 8.1 years and the average interbirth interval was 2.8 years. The aforementioned barren-ground grizzly bear study estimated the annual female survival rate at 0.979 (89%), the cub survival rate at 0.737 (74%), and the yearling survival rate at 0.683 (68%) (McLoughlin et al. 2003).

   In the Yukon, the average age of first reproduction was estimated to be 7 for bears studied in the Ogilvie Mountains, north of Dawson City (Smith 1987). Cub production varied; litters were 1-2 cubs but in any given year of the study, several females were observed without young. This was suggestive of long interbirth intervals. Although sample sizes are low, the earliest age at which a female was recorded to successfully produce a litter in the Yukon North Slope 2004-2010 study was 9 years old; there wasn't enough data to determine age of first reproduction for female grizzly bears in the 2009-2016 Southern Lakes study.

2. **The units used to manage mortality (i.e., BMUs) may not reflect biologically-based bear populations.** Additionally, some BMUs (e.g., the Ruby BMU in the Southwestern Yukon) are quite small so it can be very easy to exceed sustainable mortality.
3. **Uncertainty in population estimates for BMUs.** Population size for most BMUs were estimated in the 1980s and are based on expert opinion. Most of these estimates have not been updated or verified, even though habitat conditions – a key component of the original estimates – may have changed. Other factors like DLPs and proximity to humans can also impact the number of bears in a BMU (as it is thought for the recent Southern Lakes grizzly bear study; see Page 15). Use of other sources of knowledge to estimate population sizes and trends– including traditional knowledge –has also been limited.
4. **Grizzly bear populations are sensitive to changes in female adult survival (McLoughin et al. 2003; Garshelis et al. 2005; Schwartz et al. 2006);** much of the Yukon's harvest management regime is focused on minimizing female mortality (Smith 1987). Nonetheless, it is challenging to distinguish sex of lone adults in the field, which makes enforcing a male-only harvest difficult.
5. **Education is important for managing female mortality (e.g., telling the physical differences between male and female bears; understanding differences in habitat selection between bears).** Some of the material available to hunters include:
    a. "Take a Closer Look", a video to help hunters determine the sex of bears (http://www.adfg.alaska.gov/index.cfm?adfg=brownbearhunting.resources)
    b. "Hunt Wisely, A Guide to Male-Selective Grizzly Bear Hunting", a plain language report for hunters (http://emrlibrary.gov.yk.ca/environment/hunt-wisely-a-guide-to-male-selective-grizzly-bear-hunting.pdf)
    c. "Hunter Education and Ethics Development" training course (https://yukon.ca/hunter-education).

Considerations for the Yukon's future approach to mortality management can be found in Appendix 1.

Mortality mangement within the Inuvialuit Settlement Region

Within Inuvialuit Settlement Region (ISR), grizzly bear mortality in the Yukon is managed for the entire YNS, not at the BMU level.

Harvest regulations

Permits are required to harvest grizzly bears in the Yukon North Slope as per the *Inuvialuit Final Agreement*. Inuvialuit beneficiaries have a preferential right to harvest bears in the Eastern portion of the Yukon North Slope and an exclusive right to harvest bears in Ivvavik National Park (INP) and Herschel Island Territorial Park (the Western Arctic Region). Permits are administered by the Aklavik Hunter and Trappers Committee (AHTC). Within the ISR, subsistence harvesters can harvest bears either for the meat and the pelt, or for the pelt only (the meat does not need to be consumed).

Co-management plan

Within the ISR, grizzly bears are co-managed with the Inuvialuit by way of the Wildlife Management Advisory Council (North Slope) (WMAC-[NS]), Wildlife Management Advisory Council (NWT) (WMAC [NWT]), Parks Canada, Government of Yukon, Government of the Northwest Territories (GNWT), and the AHTC. Harvest management, as well as other management goals, are captured in the *Co-management plan for Grizzly Bears in the ISR, Yukon Territory and Northwest Territories* (Nagy and Branigan 1998). Management goals identified in the plan are:

1. To maintain current population size by ensuring that the total number of bears removed through harvest, defence kills, and illegal hunting each year is sustainable.
2. To allow recovery of populations in the event that over-hunting occurs by reducing quotas or closing areas for hunting.
3. To maintain current areas of grizzly bear habitats (Nagy and Branigan 1998).

Harvest is regulated via quota as recommended to the Inuvialuit Game Council by WMAC-(NS) and WMAC (NWT). Management areas within the Yukon North Slope include the Eastern portion of the Yukon North Slope and Ivvavik National Park/Herschel Island (Figure 8).

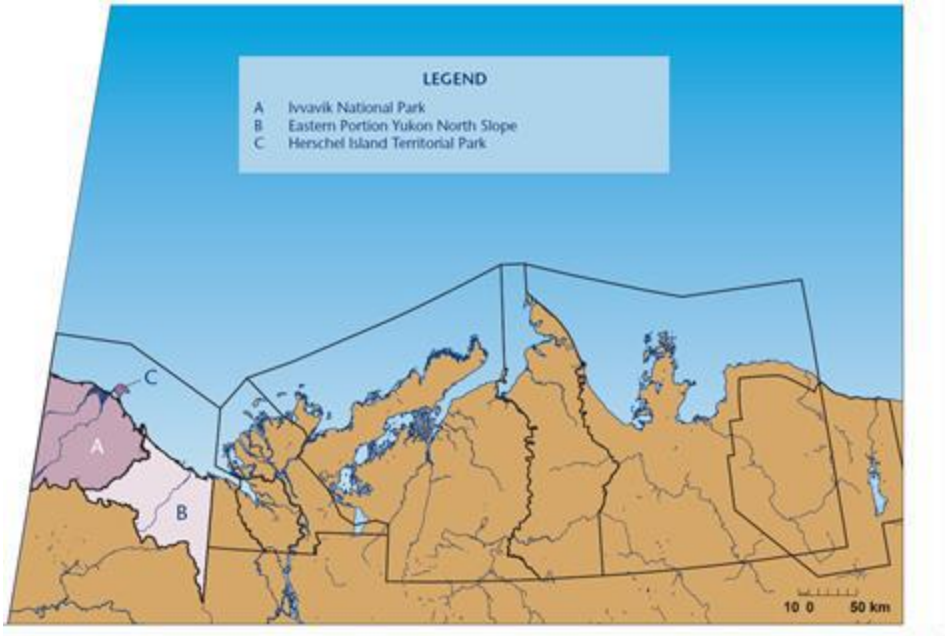


Figure 8. Harvest management areas in the Yukon portion of the ISR (From Nagy and Branigan 1998).

Sustainable mortality

Based on the *Co-management plan for Grizzly Bears in the ISR, Yukon Territory and Northwest Territories* (Nagy and Branigan 1998):

1. A sustainable harvest rate of 3% of bears age 2 years and older is used to estimate the annual total allowable harvest for each community hunting area.
2. No more than 33% of the harvest should be females.
3. The annual total allowable harvest quota accounts for known human caused mortality (e.g., kills in defence of life and property, research kills, etc).

Harvest quota and allocation

The Total Allowable Harvest (TAH) for the YNS is 13; 11 tags are allocated by Government of Yukon in the Eastern YNS and INP/Herschel Island Territorial Park and 2 tags are administered by GNWT for bears in the NWT Aklavik Hunting area.

> The TAH for bears in the YNS was established in 1994. The TAH is based on the population information and sustainable harvest; a quota implemented under the TAH is used to distribute the harvest. The number of tags issued under the quota and their distribution has changed over time. Eight tags were initially allotted under the TAH; 3 tags for INP, 5 tags for the Eastern North Slope, and no tags for Herschel. The number of available tags increased to 9 in 2004 and to 11 in 2011 in response to traditional knowledge, local observations, and preliminary results of the YNS population study. They are now distributed across INP/Herschel Island and the Eastern Yukon North Slope (Table 3).

Table 3. Grizzly bear mortality statistics for the Yukon North Slope (YNS), 1990-2016. An average of 22% of the harvest occurs in Ivvavik National Park (INP), 14% of the harvest is female, and 58% of the quota administered by Government of Yukon has been filled since the quota came into effect (currently 11 tags out of the 13 TAH).

Year*	Harvest			% harvest in INP	males	females	% females	Defense of Life and Property Kills	quota	% quota filled
	Eastern YNS	INP	Total							
1990	3	0	3	0%	2	1	33%		--	
1991	1	1	2	50%	2	0	0%		--	
1992	1	2	3	67%	3	0	0%		--	
1993	2	0	2	0%	2	0	0%		--	
1994	5	0	5	0%	5	0	0%		8	63%
1995	1	0	1	0%	1	0	0%		8	13%
1996	5	2	7	29%	5	2	29%		8	88%
1997	6	1	7	14%	5	2	29%		8	88%
1998	2	1	3	33%	3	0	0%		8	38%
1999	3	2	5	40%	4	1	20%		8	63%
2000	5	3	8	38%	6	2	25%		8	100%
2001	6	2	8	25%	7	1	13%		8	100%
2002	4	1	5	20%	3	2	40%		8	63%
2003	4	2	6	33%	4	2	33%		8	75%
2004	3	2	5	40%	5	0	0%		9	56%
2005	4	0	4	0%	4	0	0%		9	44%
2006	5	2	7	29%	7	0	0%		9	78%
2007	3	0	3	0%	3	0	0%		9	33%
2008	3	0	3	0%	2	1	33%		9	33%
2009	3	0	3	0%	3	0	0%		9	33%
2010	4	1	5	20%	4	1	20%	0	9	56%
2011	6	2	8	25%	7	1	13%	0	11	73%
2012	6	2	8	25%	6	2	25%	0	11	73%
2013	7	1	8	13%	6	2	25%	0	11	73%
2014	1	1	2	50%	2	0	0%	0	11	18%
2015	2	1	3	33%	2	1	33%	0	11	27%
2016**	6	0	6	0%	5	1	17%	0	11	55%
AVERAGE	3.7	1.1	4.8	22%	4.0	0.8	14%	0.0		58%

*The year indicated is the year the regulatory cycle ended: 1990 = April 1 1989 to March 31 1990

**Information is preliminary

Harvest patterns

Between 1990-2016 in the YNS, an average of:

- 22% of harvest occurred in INP
- 86% of harvest was male (14% female)
- 58% of the quota was filled
- 4.8 bears were harvested for the entire YNS each year (4 males and 0.8 females)

The YNS is an area with few external pressures for grizzly bears: harvest has never exceeded the established quota (Figure 9), few female bears are harvested, there are few human-bear conflicts and a high percentage of the YNS is protected with little to no existing development.

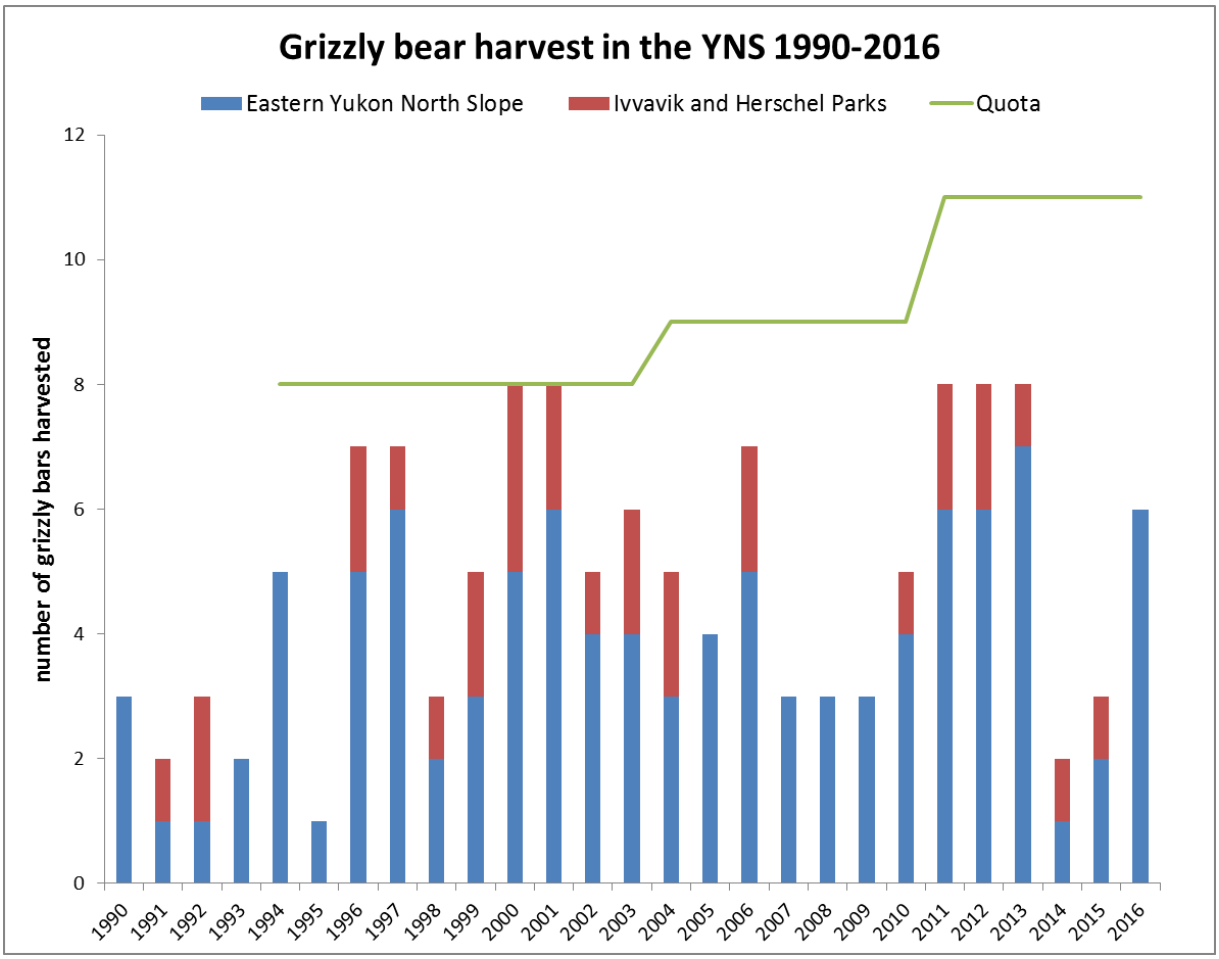


Figure 9. Grizzly bear harvest on the Yukon's North Slope between 1990 and 2016.

Mortality management for the rest of the Yukon

Grizzly bear mortality outside of the ISR is managed within BMUs (see *Population estimates for Bear Management Units* on page 8).

Total allowable mortality for BMUs outside of the ISR

Sustainable mortality rates were established using growth rate information from a study conducted in the Ogilvie Mountains from 1979 to 1984 (Smith 1987). Survival and female productivity rates were based on thirteen female bears collared during the study. These rates were analyzed using ANURSUS, which is software that uses a Leslie matrix to calculate age-specific survival rates and the population growth rate (Taylor et al. 1987). Modeling results indicated that mortality rates of 2% for the total female population, 4% of the total male population, or 3% of the total population was sustainable. Simulations indicated that mortality above these levels, particularly for females, would lead to population decline.

Sustainable mortality rates in Smith (1987) were adjusted based on the assumption that many of the Yukon's ecoregions are more productive and thereby could sustain higher male mortality than in the Ogilvie Mountains. Currently, sustainable mortality rates applied outside of the ISR are:

- up to 2% of the female population; no more than 25% of the harvest should be female.
- up to 4% of the total population.
- up to 6% of the male population.

Unless there is information to suggest otherwise, it is assumed that each grizzly bear population is made up of 50% males and 50% females. A 50:50 sex ratio is used because it allows for conservative management of females while still representing a likely sex ratio for many of the populations in the Yukon (e.g., Government of Yukon, unpublished results). Harvest, vehicle kills, and defense of life and property kills are included in mortality calculations for BMUs. Bears removed from a population via translocation and mortality stemming from woundings are not included in mortality calculations.

Types of Harvest

A hunting licence and seal is required to harvest grizzly bears. A grizzly bear may be harvested for its pelt and meat; it is illegal to waste the pelt.

Subsistence harvest - subsistence hunters have priority over other users. Subsistence harvest – in which bears are harvested for food – is thought to be low but subsistence harvest reporting is not mandatory. Rights and responsibilities for subsistence harvesters vary depending on if they are part of a Yukon First Nation, if their Yukon First Nations with a land claim, or if they are a Gwich'in beneficiary. Yukon First Nation Final Agreements assume all users will report their harvest; this information is needed to manage wildlife effectively. The Government of Yukon continues to work with First Nations, Renewable Resource Councils, the YFWMB, and

community partners to share information on grizzly bear population and mortality trends, including harvest and defense of life and property kills. In the ISR, Inuvialuit subsistence harvest is managed under quota (see Mortality management in the Inuvialuit Settlement region, page 21).

Resident harvest - residents are permitted to harvest 1 grizzly bear every 3 licence years in any open game management subzone (Figure 10). As of 2017, grizzly bear seals cost $25 for residents less than 65 years old; seals are free for residents 65 and over.

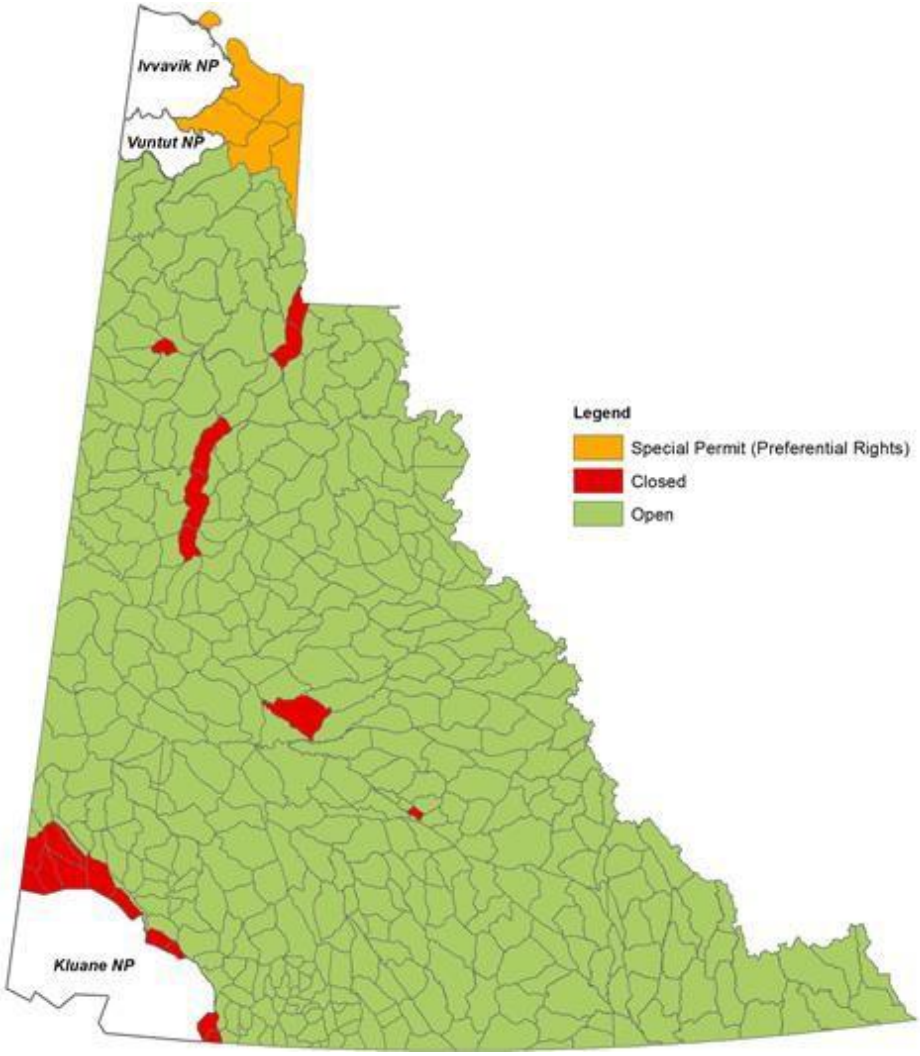


Figure 10. Open, closed and special permit zones for grizzly bears in the Yukon (current for 2017/18). Special permit zones are areas where Inuvialuit beneficiaries have preferential rights to harvest grizzly bears (orange areas of the map). Game management subzones within the Fishing Branch Ecological Reserve, the Kluane Wildlife Sanctuary, Dhaw Ghro, and along the Dempster Highway are closed to licensed harvest (red areas in the map). Ivvavik and Vuntut National Parks in the Northwestern Yukon and Kluane National Park and Reserve in the Southwestern Yukon are closed to licensed harvest.

Non-resident harvest - non-residents must hunt with registered outfitters. As of 2017, the non-resident harvest fee is $500 for males and $750 for females; any bear where proof of sex is not

provided is considered a female. A sex ratio based quota system is used to manage non-resident (outfitter) harvest; this system was put in place in 2005 after concerns about overharvest were raised under the previous system, particularly for female grizzly bears (Smith 1990).

Impact of a changing quota system

Preliminary analysis suggests female mortality has declined since the quota for non-resident harvesters has changed from annual quotas (1980-1984), to a sex weighted system (1985-2004), and then to the current sex ratio system (2005-2016) (Figure 11). Trends indicate these changes to the outfitter quota system have aided the overall management goal of reducing female grizzly bear mortality. Male mortality and total mortality have also decreased under the current sex ratio system.

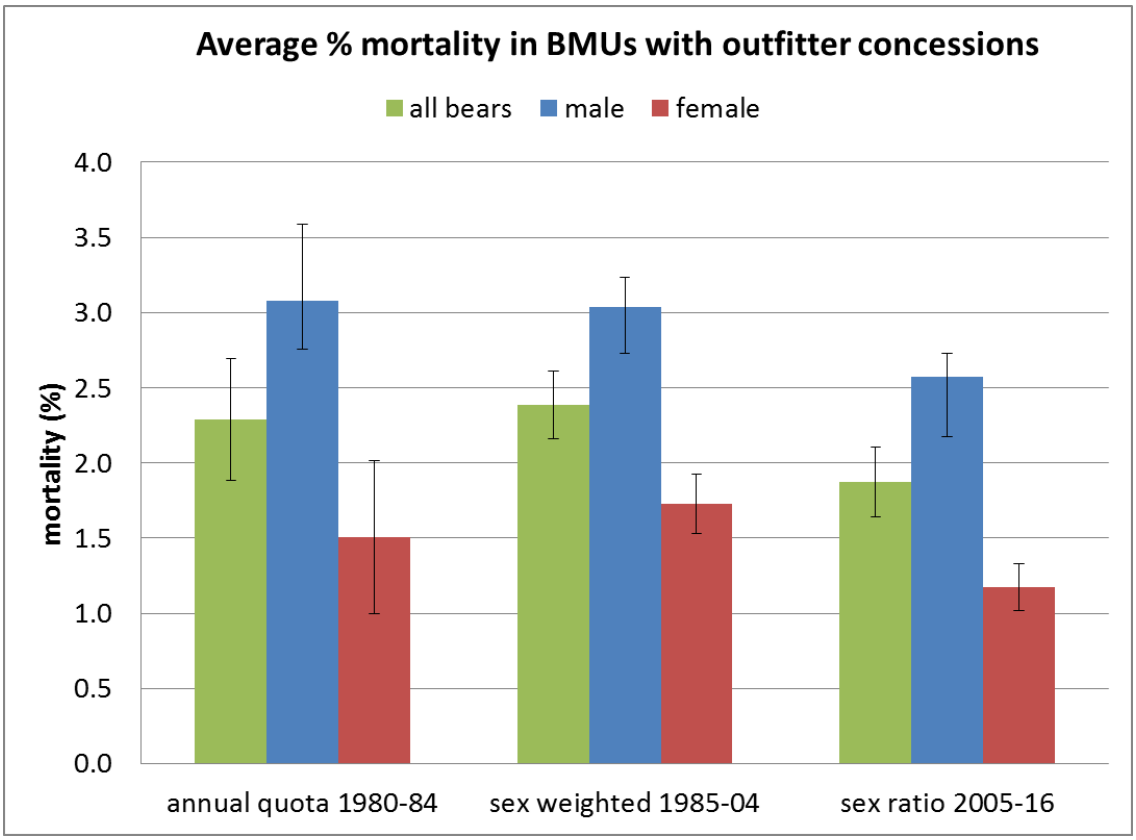


Figure 11. Average female, male, and total mortality in BMUs with outfitter concessions during three periods of different quota management: annual quotas (1980-84), sex weighted quotas (1985-04), and the current sex ratio system (2005-16). Error bars are 95% confidence intervals.

Sex ratio system (2005-current)

Outfitting areas are allocated base quotas that allow for up to 6% harvest of the male population and up to 2% harvest of the female population. Quotas are set for three year periods, which helps manage mortality pressure through time. All individuals harvested from the population are accounted for equally when calculating non-resident quotas (e.g., cubs are treated as a full bear, although human-caused cub mortality is relatively rare).

In the sex-ratio system, outfitters do not have to stop hunting when they hit their female quota. Outfitters can continue to hunt for any unused male quota. However, if the total harvest exceeds the sustainable rate for females within a concession, future three year quotas are reduced until enough bears are "paid back" to return to the base allocation. This encourages outfitters to stop hunting once the female quota is reached and/or to strongly bias harvest towards males. As outlined in Total allowable mortality for BMUs outside of the ISR (page 26), quotas are adjusted to account for other recorded mortalities in the BMU, including defense of life and property kills and resident harvest.

Some BMUs are made up of multiple subunits; specifically BMUs 7 (Stewart – 3 subunits), 9 (MacMillian – 3 subunits), 13 (Aishihik – 2 subunits), 17 (Arkell – 2 subunits), 20 (Cassiar – 3 subunits), and 22 (Hyland – 3 subunits). This helps further distribute harvest pressure spatially within the BMU.

General regulations for licensed harvest

- The harvest season is divided into spring (April 15-June 21) and fall (August 1-November 15).
- All cubs and female grizzly bears with cubs are protected from hunting. A cub includes any bear that is less than three years old.
- Special guiding of non-residents by residents for grizzly bears is not permitted.
- Harvest for the sale of parts (paws, claws, galls, teeth) is prohibited.
- The pelt cannot be wasted.

Voluntary harvest restrictions

- Residents are encouraged (but not required) to harvest males. To try and minimize female harvest, residents are asked to avoid hunting bears that are traveling in groups (these may be breeding pairs or recently weaned siblings).
- The Government of Yukon has asked licensed harvesters to not harvest grizzly bears inside the Ni'iinlii Njik Wilderness Preserve.

Impacts of changes to grizzly bear hunting regulations

Regulations for grizzly bear licensed harvest have varied over the last 40 years. For example, a bear reduction effort was conducted through liberalized licensed harvest in Game Management Zones 5, 7, and 9 from 1984/85 until 2001/02 as an ungulate management tool (e.g., Slough 2011). During this period, licensed hunters could harvest 1 bear per year and special guiding licences were available for residents to guide non-residents. Other changes included lengthening the spring and fall seasons; in addition, non-residents could harvest in areas previously closed to them. Impacts on the ungulate populations were considered minimal, possibly because of little uptake of liberalized opportunities at the time (Yukon Renewable

Resources 1997; also see Figures 12-14, which suggest licensed harvest actually declined or did not change substantively between 1984/85 and 2001/02).

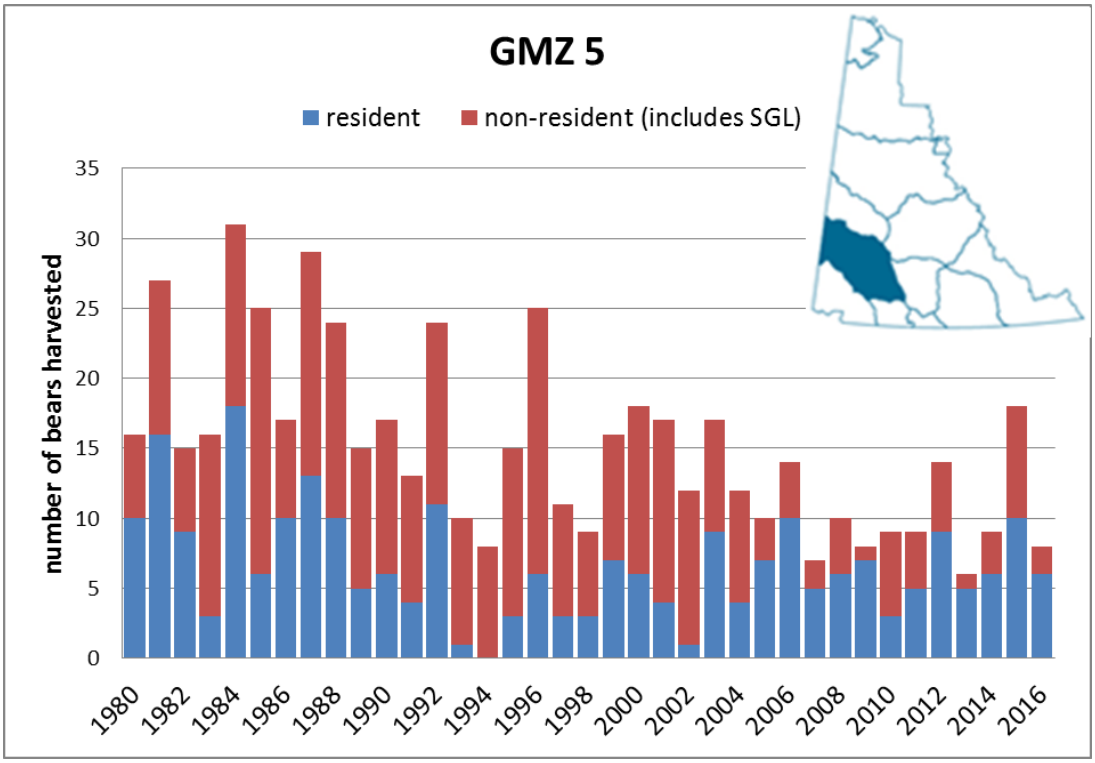


Figure 12. Harvest trends in GMZ 5 (1980-2016).

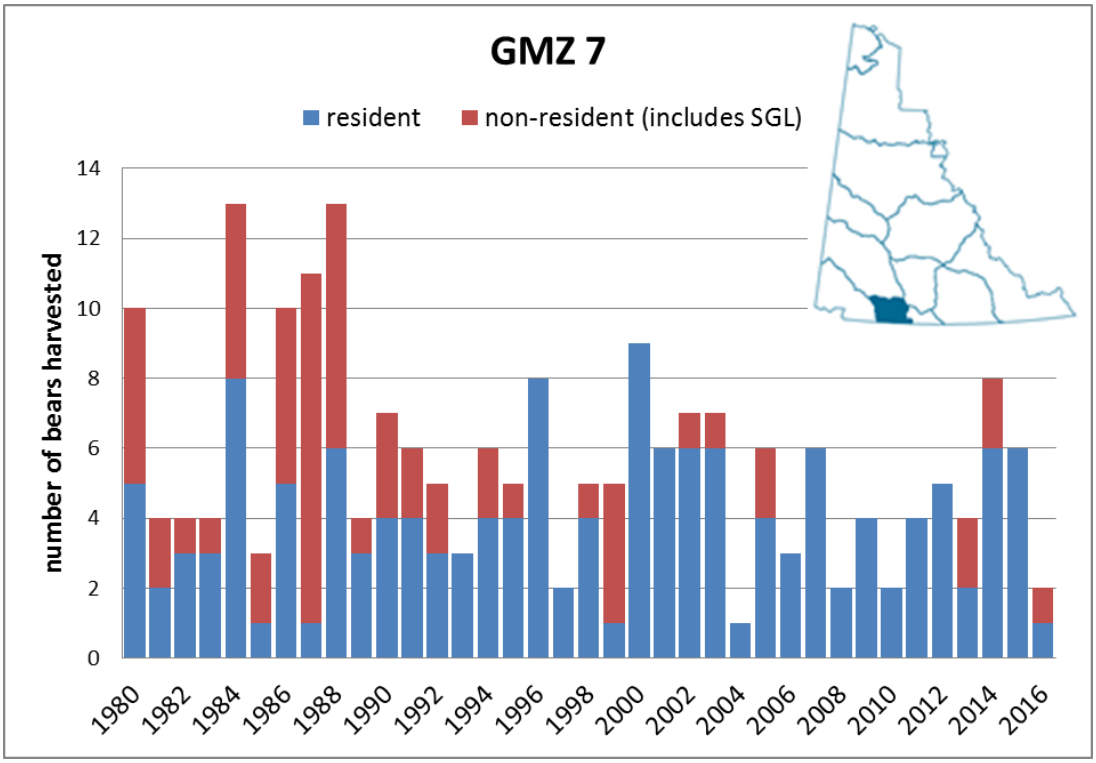


Figure 13. Harvest trends in GMZ 7 (1980-2016).

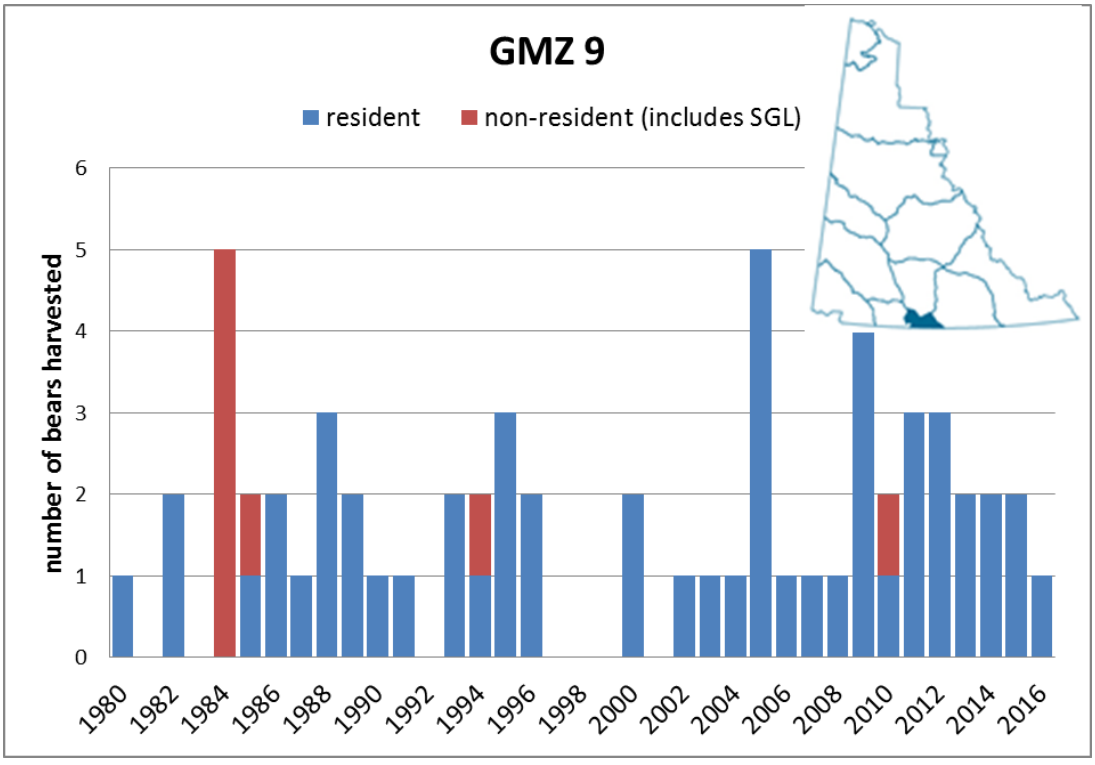


Figure 14. Harvest trends in GMZ 9 (1980-2016).

Resident harvest was previously more restrictive across the Yukon (Table 5). Since 2001/02, residents may only harvest one grizzly bear every 3 licence years in all open subzones. Over the long term, changes in regulations and outfitter quotas have resulted in fewer females being harvested (Figure 15). Harvest is considered conservative; should it be considered unsustainable, other management options that limit overall harvest numbers may be required (see Managing mortality risk on page 54).

Table 5. Example of regulation changes that apply (or applied) to all Game Management Zones in the Yukon.

Harvest year	Regulation change
1982-1983	Residents may harvest one grizzly bear for every 5 licence years
1983-1984	Residents may harvest one grizzly bear every 4 licence years.
2001-2002	Residents may harvest one grizzly bear every 3 licence years in all open subzones

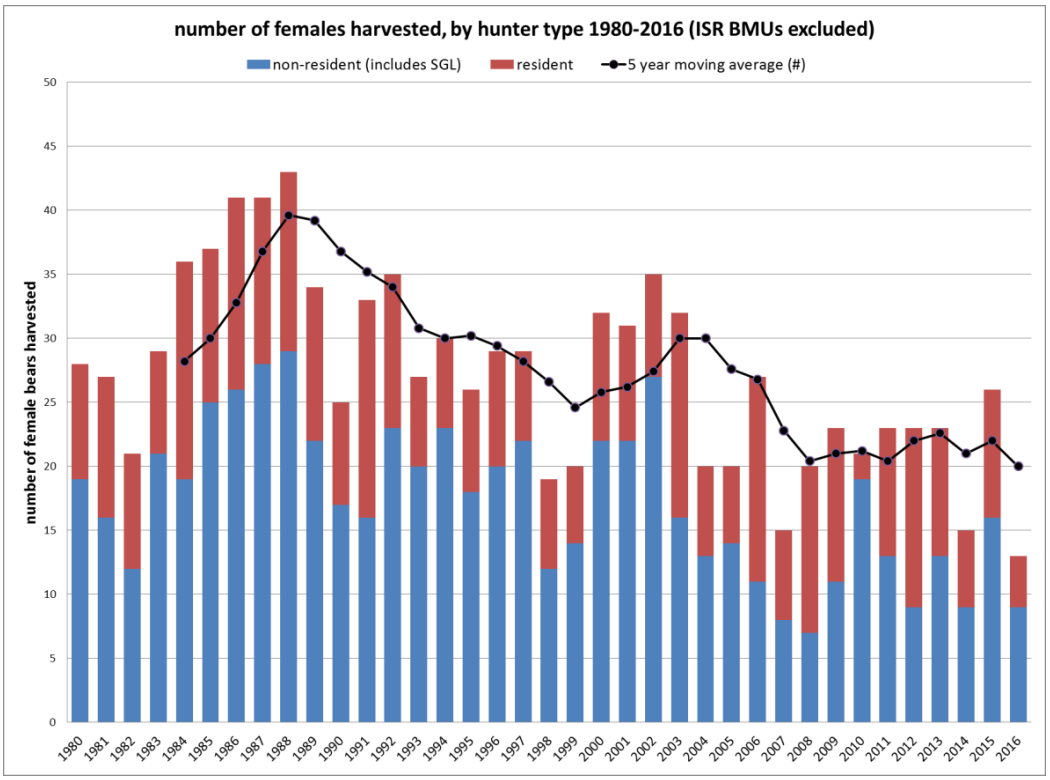


Figure 15. Number of females harvested by residents and non-residents (1980-2016).

Harvest reporting

Since 1980, harvest reporting has been mandatory for licensed harvest of grizzly bears. Biological submissions are required from residents no later than 15 days after the end of the month in which the bear was harvested or upon request by a conservation officer. For non-residents, submissions are required no more than 10 days after the close of the season in which the bear was killed or upon request by a conservation officer. The complete skull together with the baculum (penis bone) or penis sheath and scrotum attached to the hide is considered evidence of sex for a male bear. The complete skull together with the vulva attached to the hide is considered evidence of sex for a female bear. Teeth taken from harvested bears are sectioned and the annuli in the teeth are then counted to determine the age of the harvested bear.

Although harvest is managed within BMUs, harvest is reported at the game management subzone level (one BMU is made up of several game management subzones). This scale of reporting can make it difficult to understand what underlies harvest patterns. For example, understanding the relationship between specific land-use features and harvest can be challenging without precise location data. Currently, the Government of Yukon has a reporting program where hunters can voluntarily report point locations for their harvest.

Mortality trends for BMUs outside the ISR (1980-2016)

Male, female, and total mortality trends were calculated for the 29 BMUs outside the ISR and presented as annual and 5 year moving averages (e.g., average mortality for 1984 is calculated from data from 1980-1984; average mortality for 1985 is calculated from data from 1981-1985, etc.)1. Mortality is presented as percent and number of bears killed to aid in interpretation. Moving averages help smooth the annual variation in bear mortality so it is easier to infer trends. Factors underlying mortality are also presented (i.e., mortality is broken down into resident, non-resident, DLP, and other kills). **Some resident harvest may actually be a defense of life and property kill, so resident harvest could be biased high and defense of life and property kills could be biased low.**

Some changes in mortality rates may reflect changes in the outfitter quota management system and resident harvest (see Types of Harvest on page 26). The full impact of change in quota management on 5 year moving averages would not be realized until 2009 (i.e., average from 2005-2009).

To understand more recent trends in bear harvest, mortality patterns from 2012-2016 (past 5 years) is compared to trends prior to 2012.

Total mortality

Prior to 2012 and since mortality has been tracked, 5 year moving average mortality for all bears was at or exceeded 4% at least once (and often multiple times) for 8 of 29 BMUs

[1] Based on Government of Yukon data retrieved on July 15, 2017.

(Appendix 4 and 5; Bonnet Plume (5); Nadaleen (6); Nisling (11); Ruby (12); Aishihik (13); Dezedeash (16); Arkell (17); Southern Lakes (18)). Between 2012 and 2016, 5 year moving average mortality for all bears was less than 4% in 27 of 29 BMUs, suggesting that in recent history, total bear mortality in most BMUs has decreased. Between 2012 and 2016, it exceeded 4% twice in the Dezedeash (16) BMU and once in the Ruby (12) BMU.

Male mortality

Prior to 2012 and since mortality has been tracked, 5 year moving average mortality for males was at or exceeded 6% at least once (and often multiple times) for 5 of 29 BMUs (Appendix 4 and 5; the Nadeleen (6), Nisling (11), Ruby (12), Dezedeash (16), and Arkell (17) BMUs). Between 2012 and 2016, 5 year moving average mortality was at or exceeded 6% in the Ruby BMU twice. This rate was less than 6% in all other BMUs, suggesting that in recent history, male mortality in most BMUs has decreased.

Female mortality

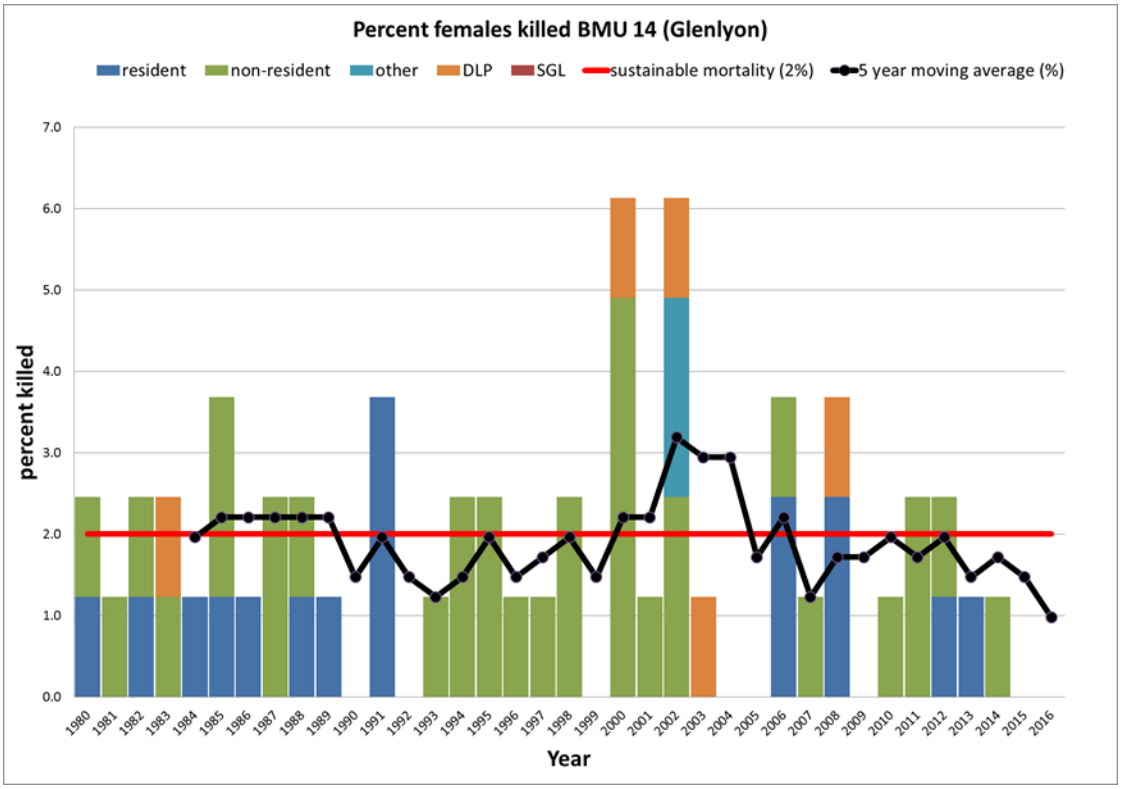
Prior to 2012 and since mortality has been tracked, 5 year moving average mortality for females was at or exceeded 2% at least once (and often multiple times) for 18 of 29 BMUs (Appendix 4 and 5). Between 2012 and 2016, 5 year moving average mortality for females was less than 2% in 23 of 29 BMUs, suggesting that in recent history, female mortality in most BMUs has decreased.

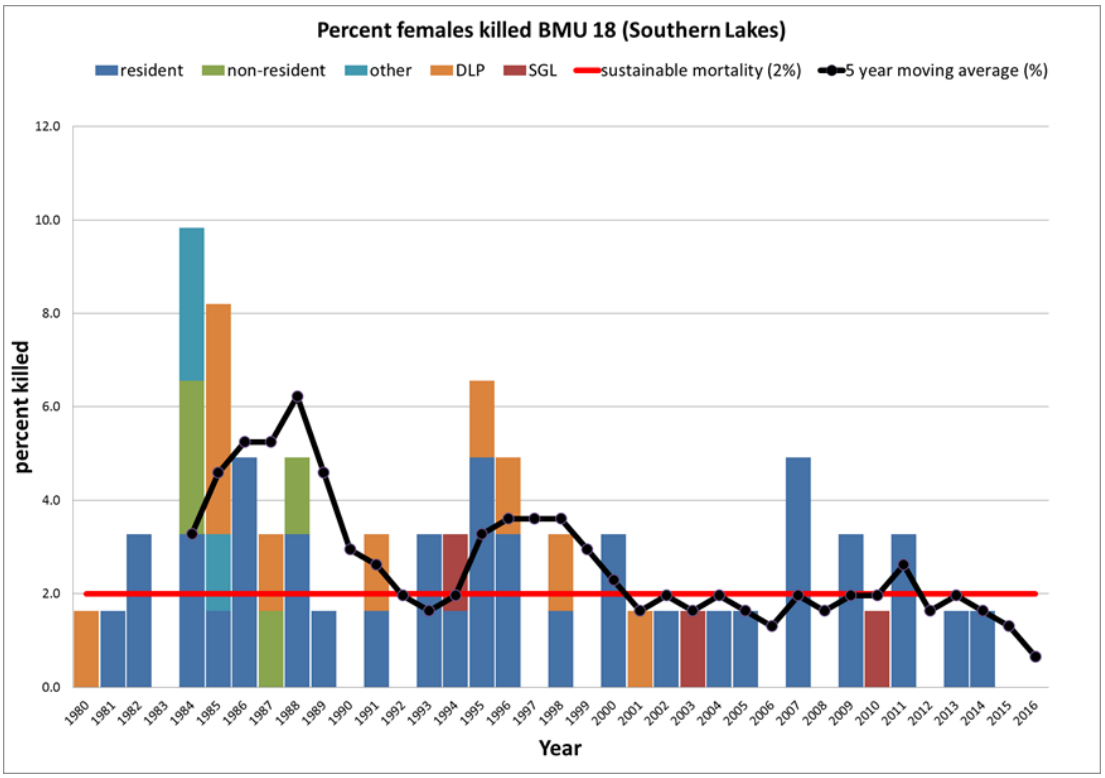
Between 2012 and 2016, 5 year moving average mortality has been 2% or higher for females in the North Ogilvie (2), Glenlyon (14), Pelly (15), Dezedeash (16), Arkell (17), and Southern Lakes (18) BMUs. A closer look at mortality patterns shows that a combination of factors can drive unsustainable mortality in any BMU, including an increase in DLP kills and an increase in licensed harvest kills (some of which may actually be DLP kills).

A note on the mortality trend figures:

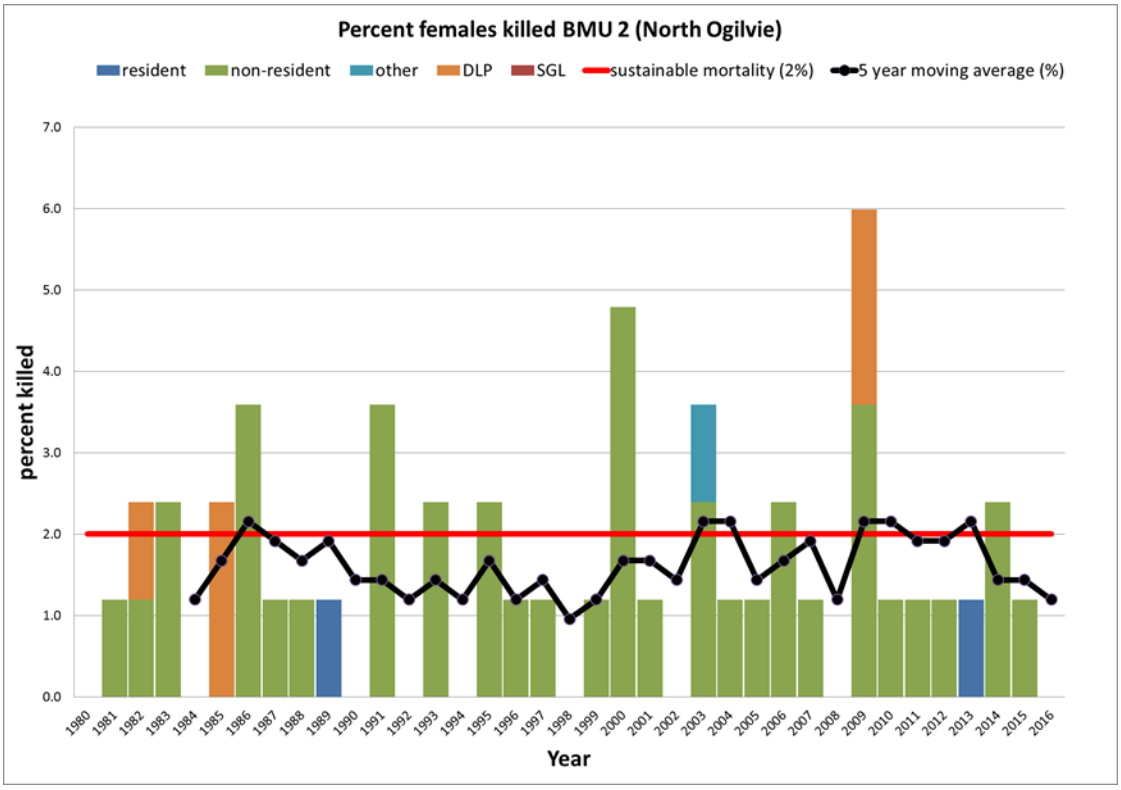
- Mortality includes:
    - resident harvest (■)
    - non-resident harvest (■)
    - defense of life and property kills (■)
    - special guided hunts (■)
    - other sources of mortality (vehicles, accidents, etc.) (■).
    - sustainable mortality (—) is 2%, 4%, or 6%, depending on if the graph depicts female, total, or male mortality, respectively.
    - 5 year moving averages (—●—) depict mortality trends over 5 year blocks and are used to help understand overall trends (e.g., 5 year average mortality for 1984 is calculated from data from 1980 to 1984; 5 year average mortality for 1985 is calculated from data from 1981 to 1985, etc.). The sex-ratio based system was implemented in 2005; impacts would be fully recognized in the 2009 averages.
- If sex of the bear was unreported, it was assumed to be female.
- Mortality estimates may be biased low as they don't include sources of natural mortality, mortality arising from wounding or poaching, and for BMUs outside the ISR, mortality from subsistence harvesters. Bears that are translocated are also not included in the calculations; these bears are considered dead to the population from which they are moved.

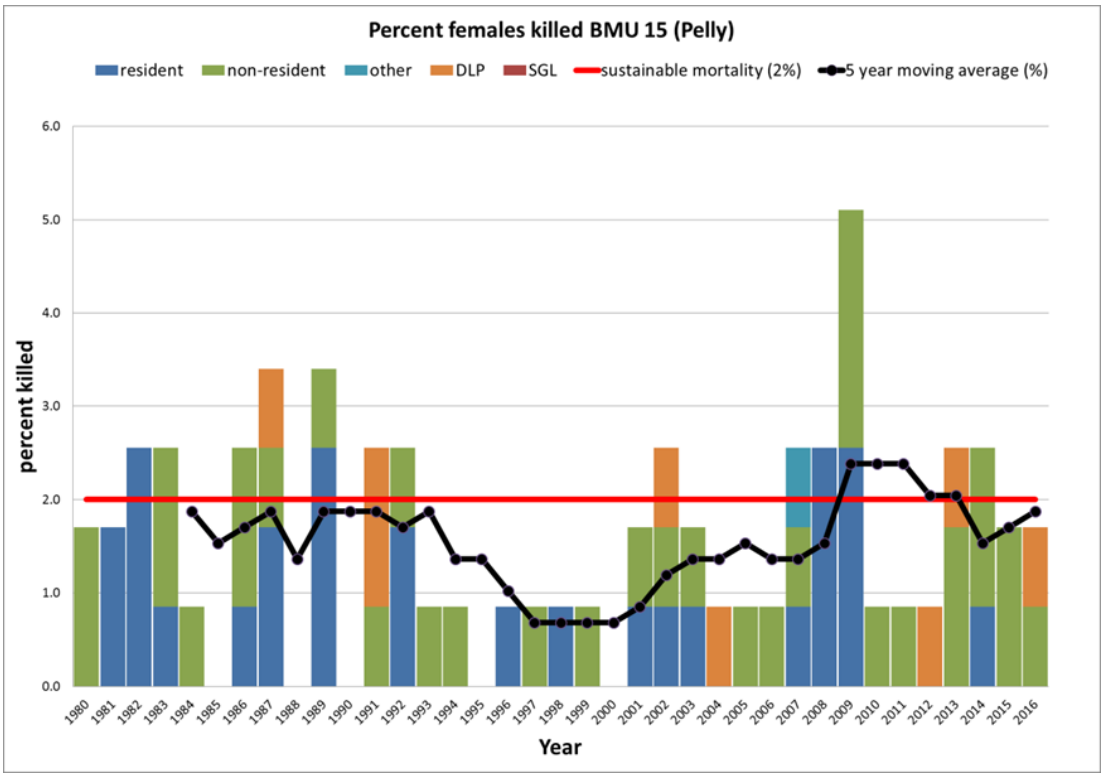
In the Glenlyon (14) and Southern Lakes (18), 5 year average mortality was 2% at least once since 2012:

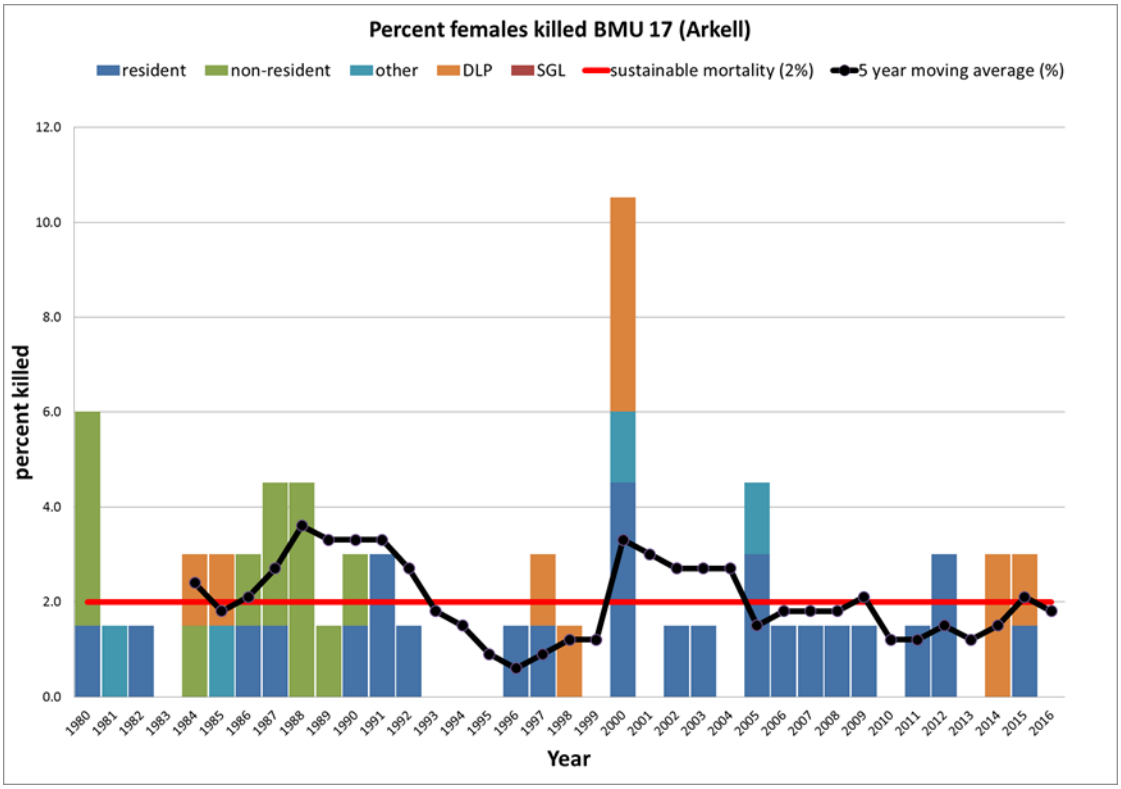

Percent females killed BMU 14 (Glenlyon)
resident
non-resident
other
DLP
SGL
sustainable mortality (2%)
5 year moving average (%)
percent killed
Year


Percent females killed BMU 18 (Southern Lakes)
resident
non-resident
other
DLP
SGL
sustainable mortality (2%)
5 year moving average (%)
percent killed
Year

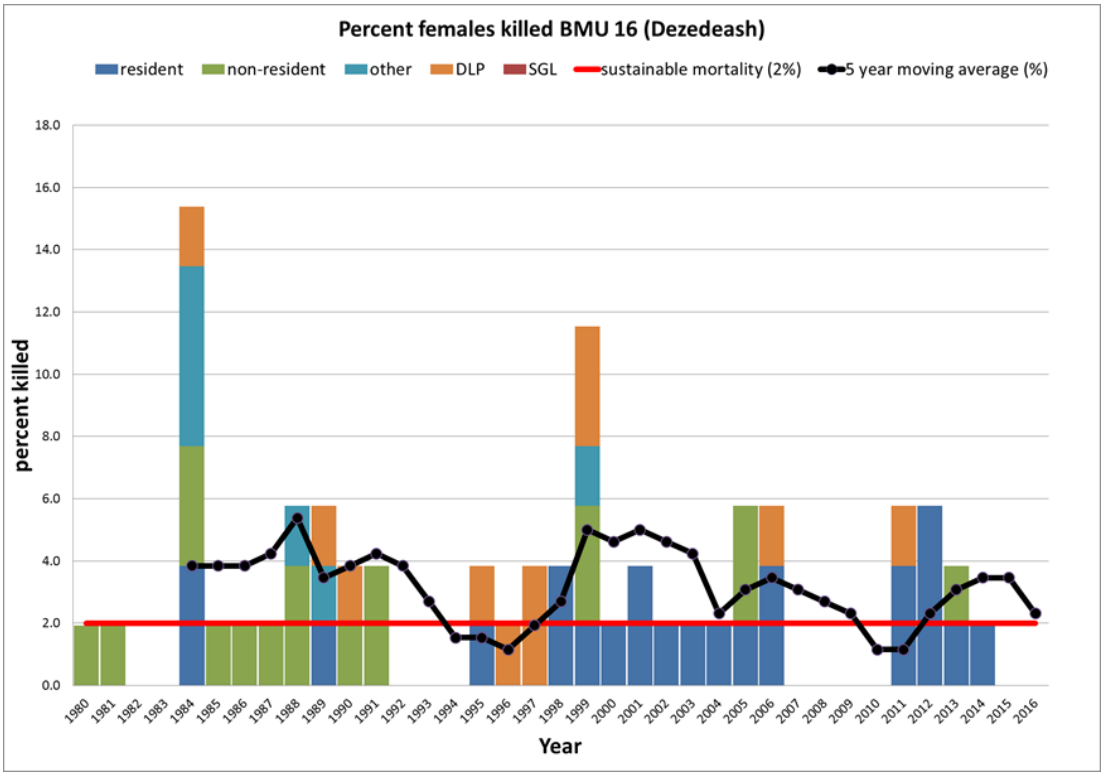
In the North Ogilvie (2), Pelly (15), and Arkell (17) BMUs, 5 year average moving mortality exceeded 2% at least once since 2012:





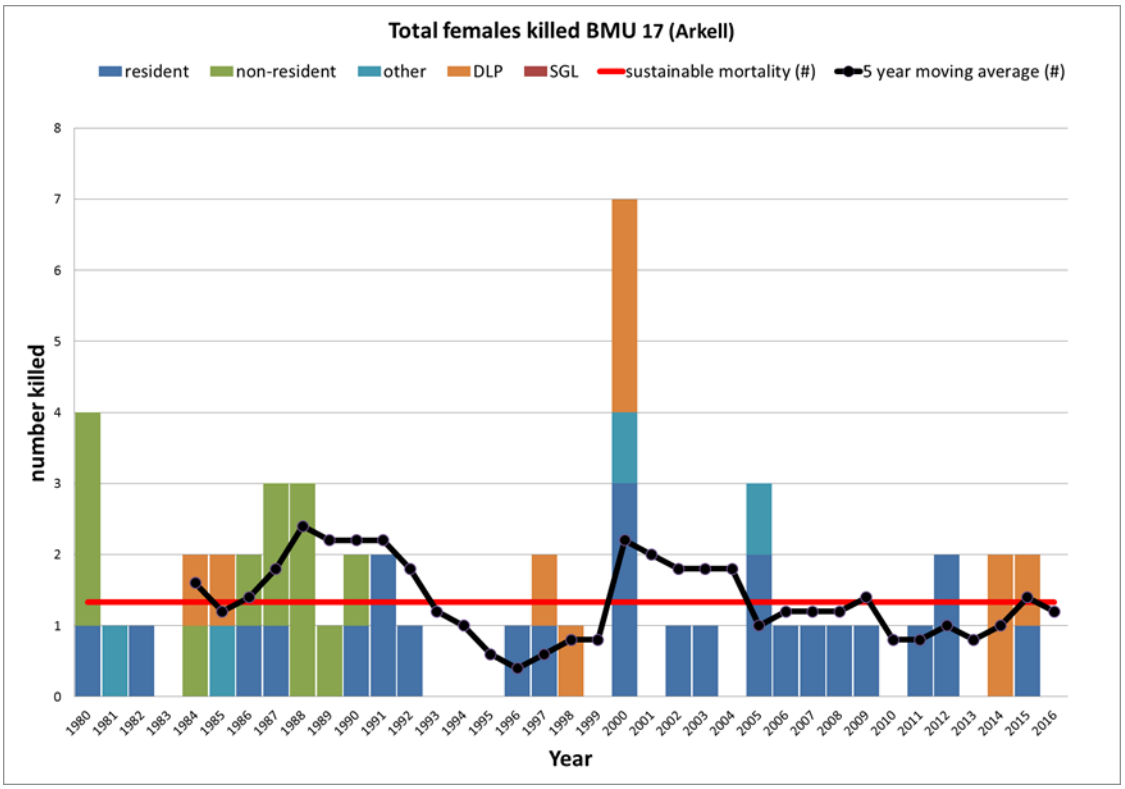


In the Dezadeash BMU, this rate has exceeded 2% every year since 2012:



It is also evident that mortality can be quite variable from one year to the next; for example, there was no recorded female mortality in the Arkell BMU in 1999 or 2001, but more than 10% of the estimated female population was removed in 2000 (possibly due to the fencing of the Whitehorse landfill). Trends since 1980 also reflect changes in management regime, which would either favour bear conservation (e.g., change in the outfitter quota systems2 to the current sex ratio system in 2005) or a more liberalized harvest (e.g., increase in resident and non-resident access to bears in GMZ 5,7, and 9 between 1984/85 and 2001/02).

Another factor to consider when examining mortality trends is that the estimated number of bears in most BMUs is relatively small. Consequently, one extra mortality can result in exceeding sustainable mortality in any given year, as shown for the Arkell BMU:



Spatial distribution of mortality (territorial perspective)

Long term trends indicate that total, male, and female mortality is less likely to exceed sustainable mortality rates in most BMUs than in the past. However, some areas of concern do exist in the North Ogilive (2), Glenlyon (14), Pelly (15), Dezedeash (16), Arkell (17), and Southern Lakes (18) BMUs, where female mortality has met or exceeded 2% at least once in the last 5 years (based on 5 year moving averages). Five of these six BMUs are found in the Southern Yukon (Figure 16). This suggests the Southern Yukon should be a continued focus of grizzly bear management and monitoring actions, which supports earlier perspectives (Southern Lake Wildlife Coordinating Committee 2012).

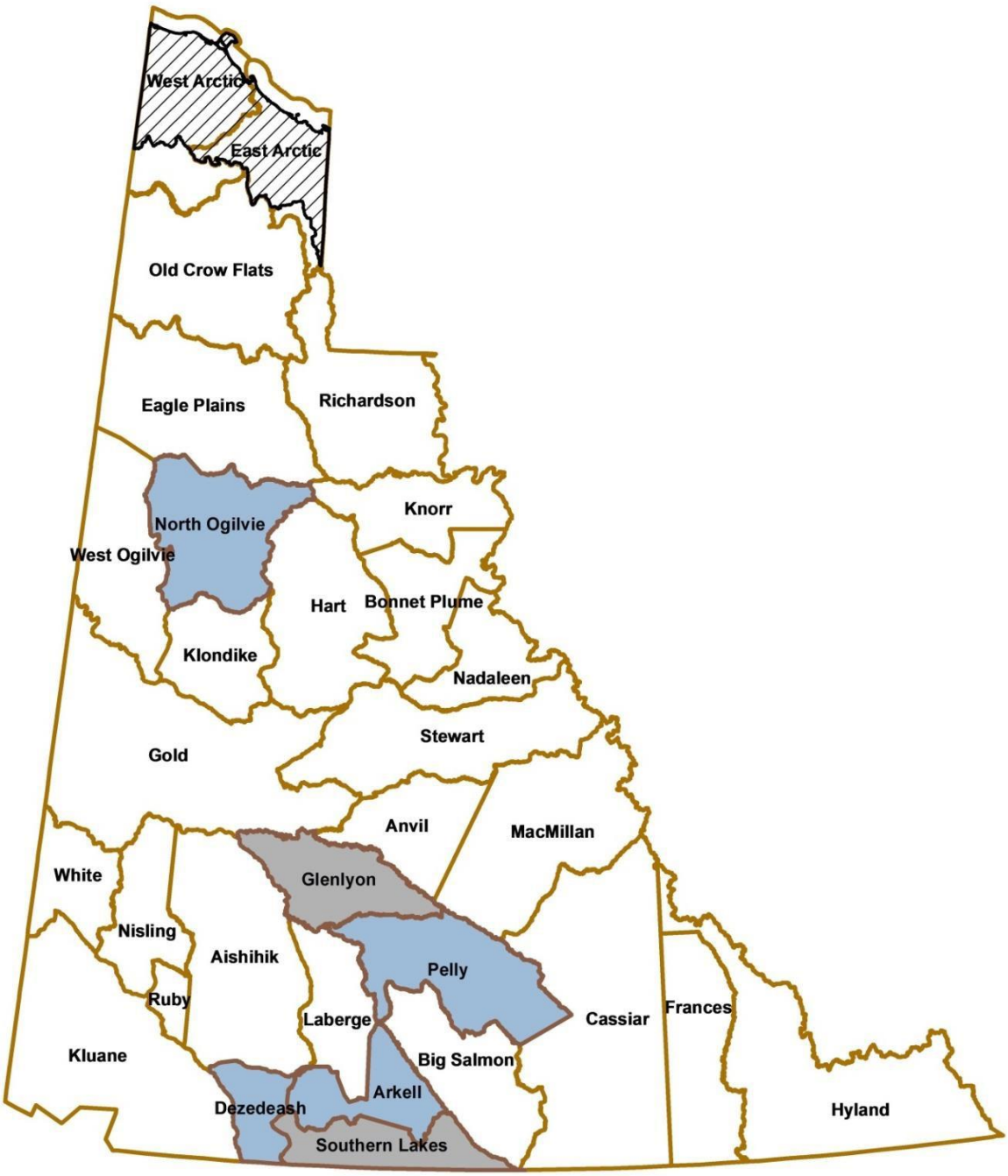


Figure 16. Areas where female mortality has met or exceeded sustainable rates between 2012 and 2016 (based on 5 year moving averages). Female mortality has exceeded 2% at least once in the North Ogilvie, Pelly, Arkell and Dezedeash BMUs (highlighted in blue); in the Dezedeash BMU, mortality consistently exceeded 2%. It was at 2% at least once in the Glenlyon and Southern Lakes BMUs (highlighted in grey). Note that harvest is managed differently for bears that are within BMUs in the Yukon North Slope (predominantly the West Arctic BMU [minus Vuntut National Park] and East Arctic BMUs).

More generally, most grizzly bear mortality occurs in BMUs in the southwestern and central Yukon (Figure 17). On average, the number of grizzly bears killed per 1,000 km^2 (mortality density) each year between 2006 and 2016 was highest in the Dezedeash (16) and Ruby (12) BMUs, followed by the Arkell (17) BMU. Mortality density was also higher (0.31-0.40 bears/1000 km^2) in the Glenlyon (14), Southern Lakes (18), Pelly (15), Bonnet Plume (5) and Nadeleen (6) BMUs.

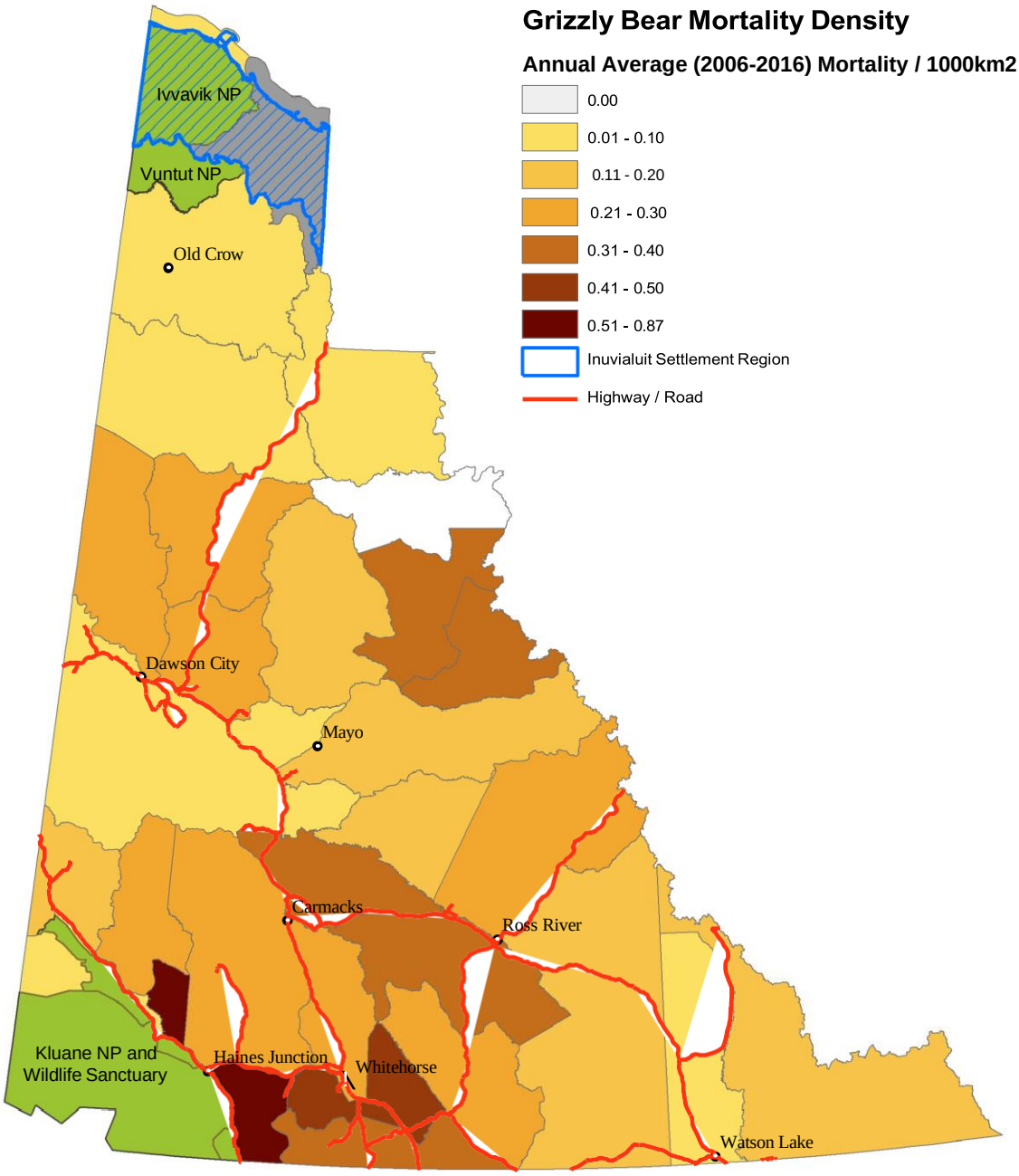


Figure 17. The amount of grizzly bear mortality per 1,000km^2 within BMUs from 2006 and 2016. Licensed harvest is closed in Ivvavik and Vuntut National Parks, and Kluane National Park and Wildlife Sanctuary. ISR is managed differently so mortality density is not reported for BMUs in this area.

These mortality patterns may in part reflect grizzly bear densities (i.e., hunters are more successful in areas with more bears; conflicts may be more likely in areas with more bears). For instance, grizzly bear density estimates in 31 BMUs range from 8.4 to 40.0 bears per 1,000 km^2 based on Smith and Osmond-Jones (1990) (average 15.8 bears per 1,000 km^2; the highest density is within the Kluane BMU) (see Population estimates for Bear Management Units on Page 8). Estimated density in the Dezadeash and Ruby BMUs is 22.8 and 20.7 bears per 1,000 km^2, the second and third highest densities respectively. Estimated density in the Arkell BMU is 17.6 bears per 1000 km^2 (fifth highest estimated density).

Patterns for female and total mortality may also represent accessibility (roads and highways) or human population density, which are higher in the southwest and central Yukon. Mortality is expected to be higher for grizzly bears in more easily accessible areas and in areas of high human density (e.g., Maraj 2007; COSEWIC 2012). This suggests there should be ongoing support for access and attractants management in these areas, as part of overall approaches to grizzly bear conservation and management.

Other trends in mortality for BMUs outside the ISR

Harvest over time by hunter type

Between 1980 and 2016, an average of 79 grizzly bears were harvested each year in BMUs outside the ISR (range 50 to 126 bears)

- 30, or 38% of grizzly bears were harvested by residents
- 49, or 62% of grizzly bears were harvested by non-residents (which includes special guided licenses).

The number of bears harvested by residents and non-residents has declined since 1980; this trend is driven more by changes in non-resident harvest (Figure 18). The success rate of non-resident hunters declined from 22% in the early 1980s to 9% in the early 2010s; resident harvest has also declined, though to a lesser extent (Milligan 2018; Figure 19). Changes in harvest patterns are consistent with the desire to reduce female mortality (see Impacts of changes to grizzly bear hunting regulations on Page 29).

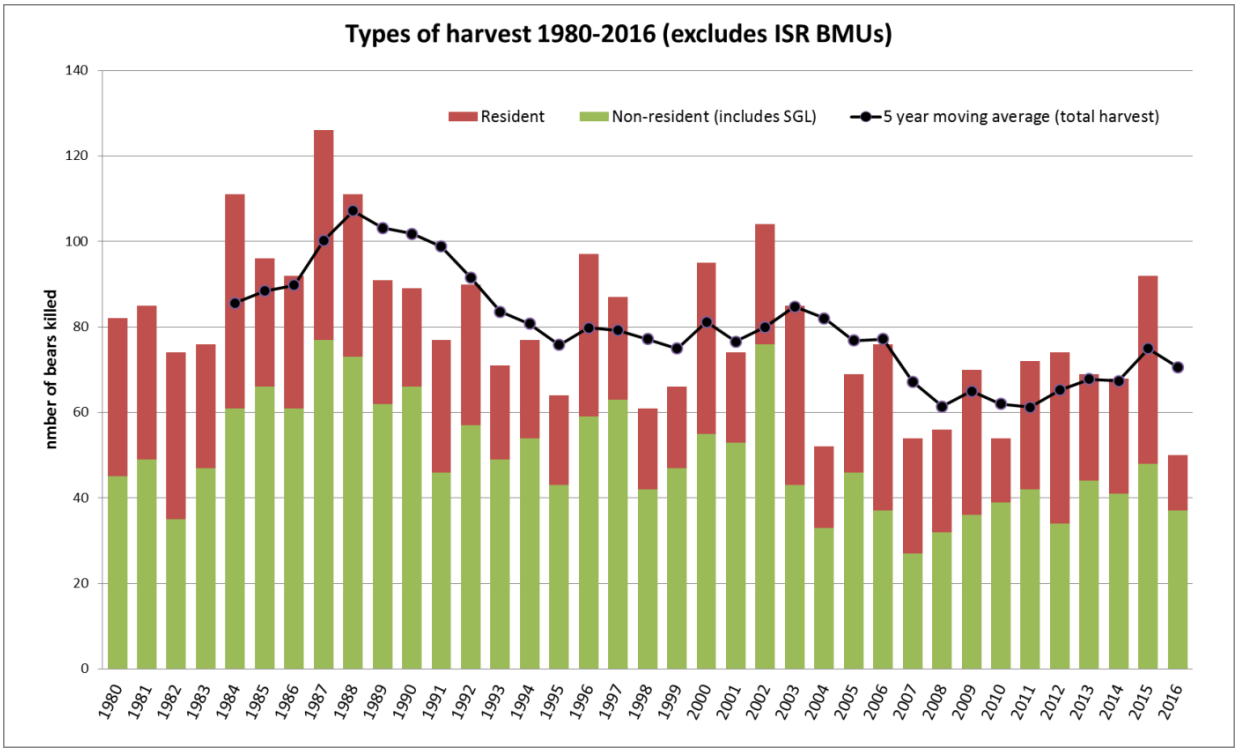


Figure 18. Licensed harvest trends between 1980 and 2016.

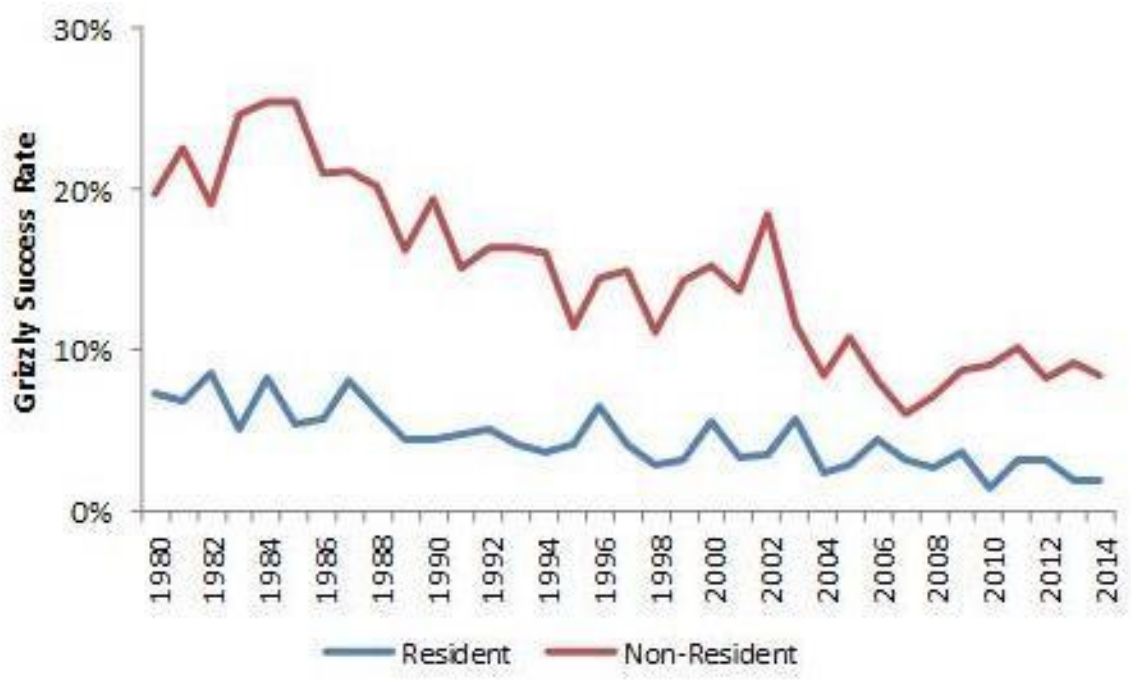


Figure 19. The percentage of hunters with a grizzly bear seal that successfully harvested a grizzly bear from 1980 to 2014 (Milligan 2018).

The trends in harvest suggest a decrease in hunter success as the number of grizzly bear seals purchased has steadily increased over the last 30 years. However, not all hunters who obtain a seal plan to hunt grizzly bears. Between 1980 and 2014, a yearly average of 995 licensed hunters obtained a seal to hunt grizzly bears (Milligan 2018; Figures 20 and 21). Sixty-four percent of these seals were sold to resident hunters (Milligan 2018), however, a 2013 hunter effort survey indicated only 25% of resident hunters who purchased a grizzly bear seal actually planned to hunt, with the remaining 75% having obtained the seal in case of a bear conflict (Sawatzky 2013). The number of grizzly bear seals has more than doubled since 1980, primarily due to an increase in resident hunters.

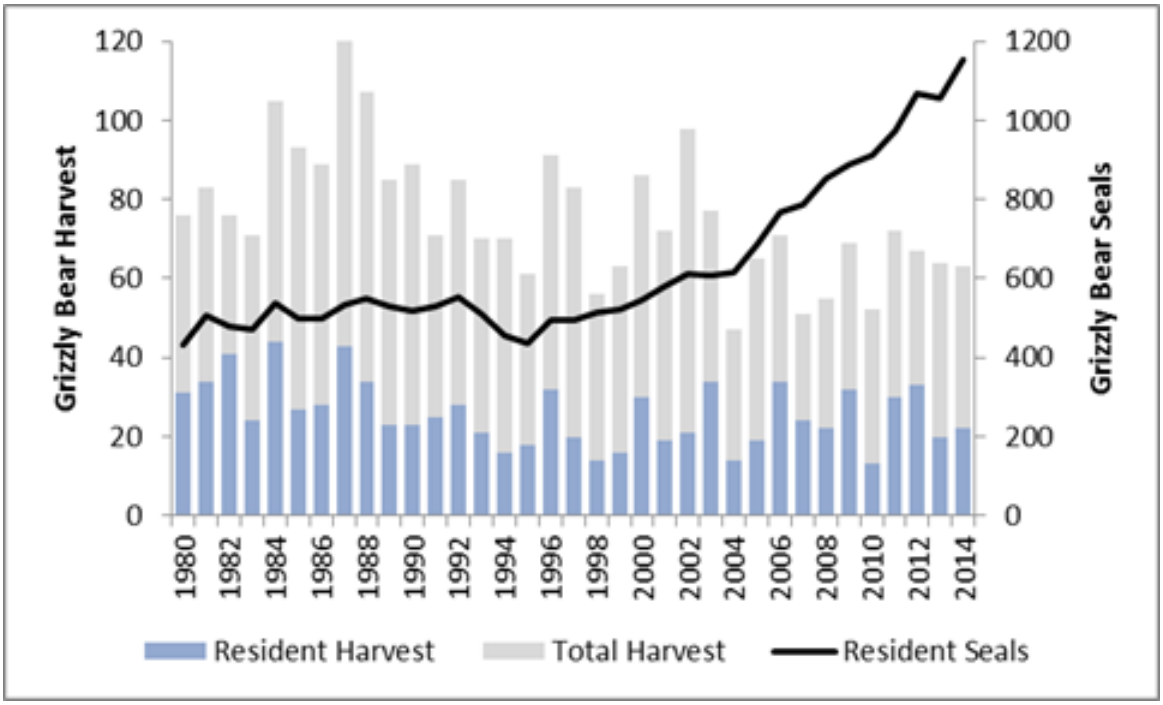


Figure 20. Number of resident grizzly bear seals issued and harvest by residents and total licensed harvest from 1980 to 2014 (Government of Yukon, unpublished results).

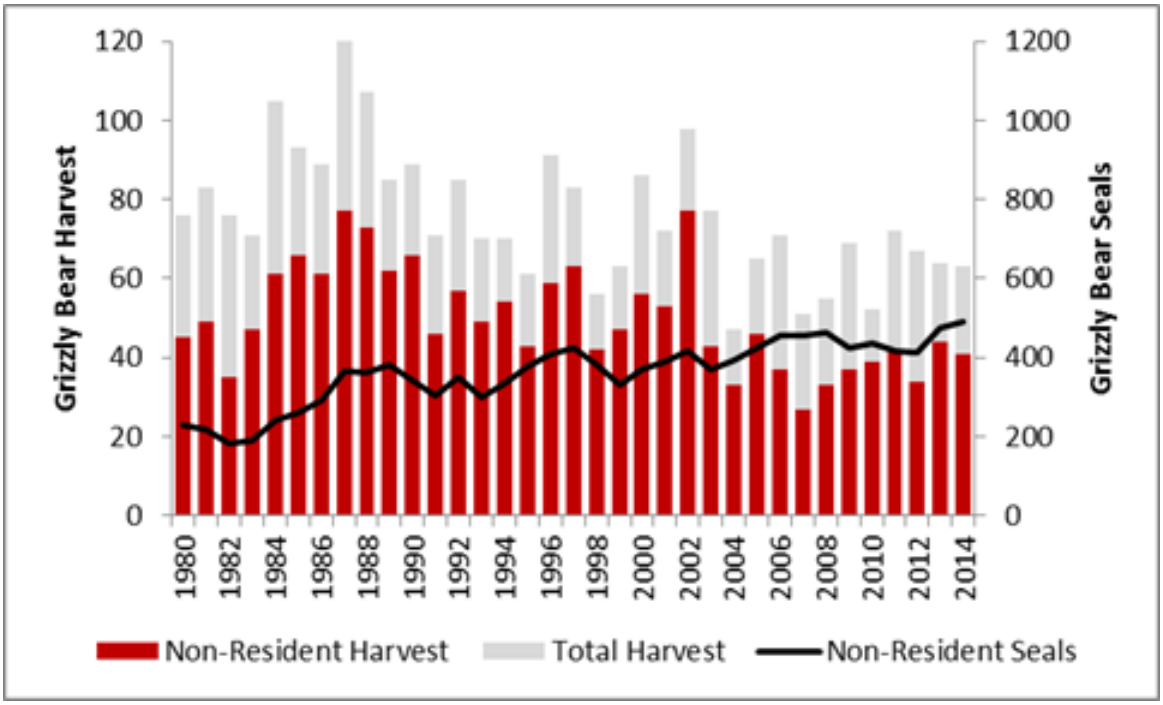


Figure 21. Number of non-resident grizzly bear seals issued and harvest by non-resident hunters and total harvest from 1980 to 2014 (Government of Yukon, unpublished results).

Some of this increase stems from residents wanting to have a seal in case they need to kill a grizzly bear in defense of life and property. Results from a 2013 hunter effort survey indicate that 25% of resident hunters with a seal planned to hunt grizzly bears while the remaining obtained a seal in case there was a conflict with a bear (Sawatsky 2013). Of those 25% that planned to hunt a bear, 69% were interested in the hide and/or the bear as a trophy, while 18% hunted for food.

Age and sex composition of harvest

Between 1980 and 2016, an average of 34% (range 22% to 45%) of grizzly bears harvested each year by residents and non-residents were females (which includes bears of unknown sex) (Figure 22). An annual average of 66% (range 55% to 78%) of resident and non-resident harvest was male.

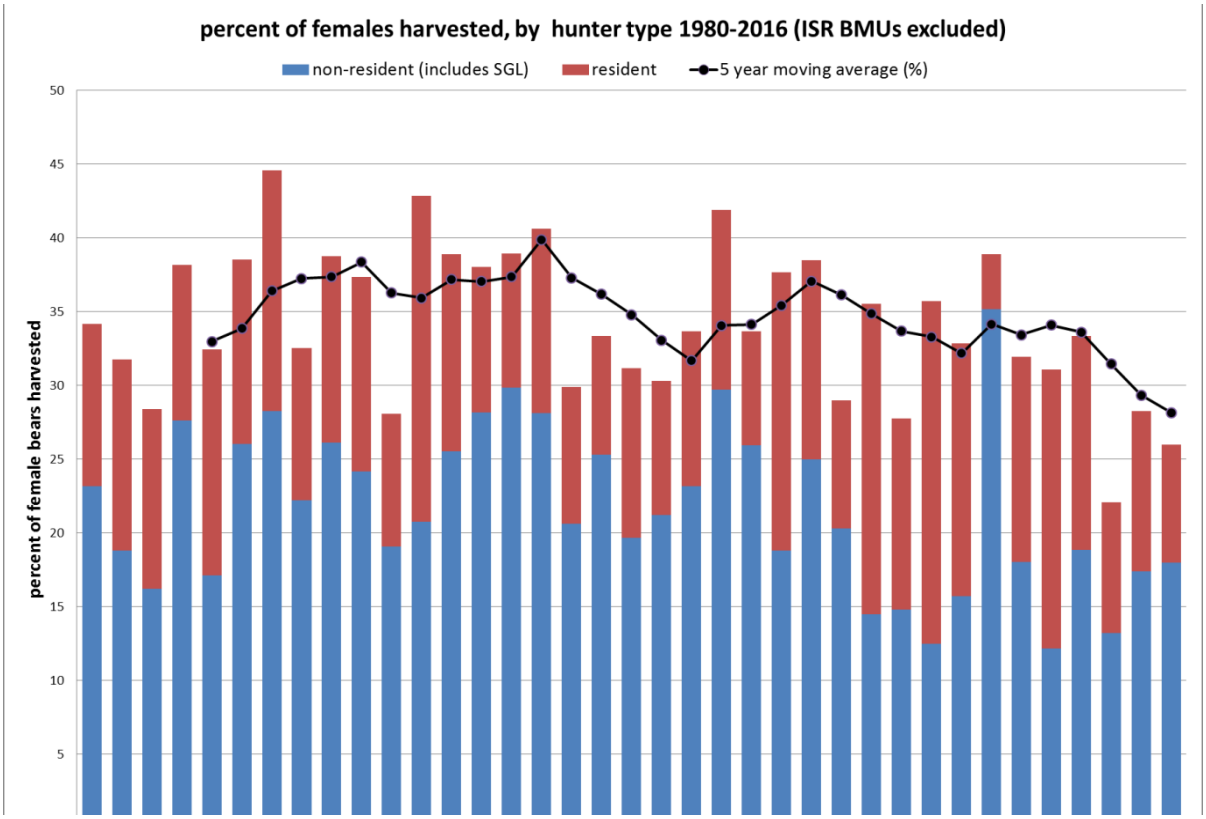


Figure 22. Percent of the grizzly bear licensed harvest that was female from 1980 to 2016.

Between 1980 and 2016, the oldest male grizzly bear harvested was 37 and the oldest female harvested was 34. A little less than 1/3 of harvested grizzly bears were subadults (i.e., 30% of all females and 28% of all males harvested were 4 years or younger; Figure 23). Subadult males tend to use "riskier habitats" relative to other age/sex cohorts, so are more likely to be harvested (i.e., subadult males are more likely to be found in areas near human activity). Subadult females are unlikely to have cubs (females don't typically reproduce until they are 4 or

older; Schwartz et al. 2003a). This makes it harder to distinguish this sex and ageclass from males who are more vulnerable to harvest.

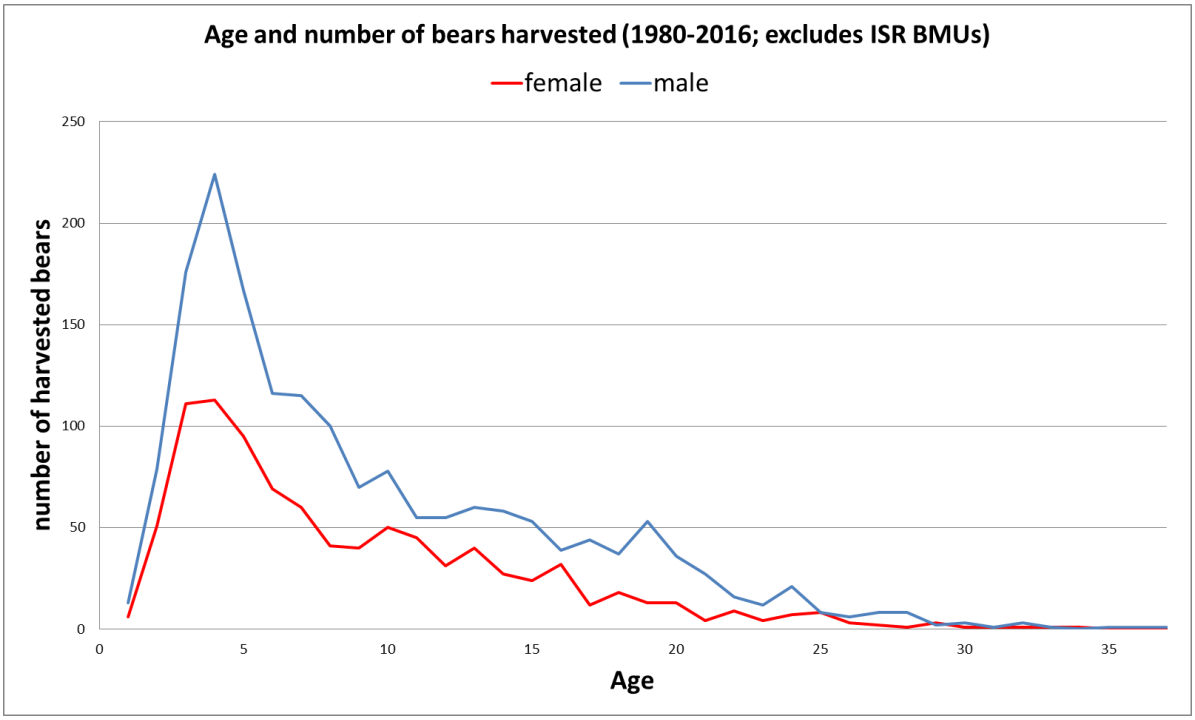


Figure 23. Age composition of grizzly bears harvested by residents and nonresidents from 1980 to 2016.

Spring versus fall harvest

Between 1980 and 2016, 73% of grizzly bears harvested by residents and 83% of grizzly bears harvested by non-residents were taken in fall (80% overall), primarily in September (Figure 24).

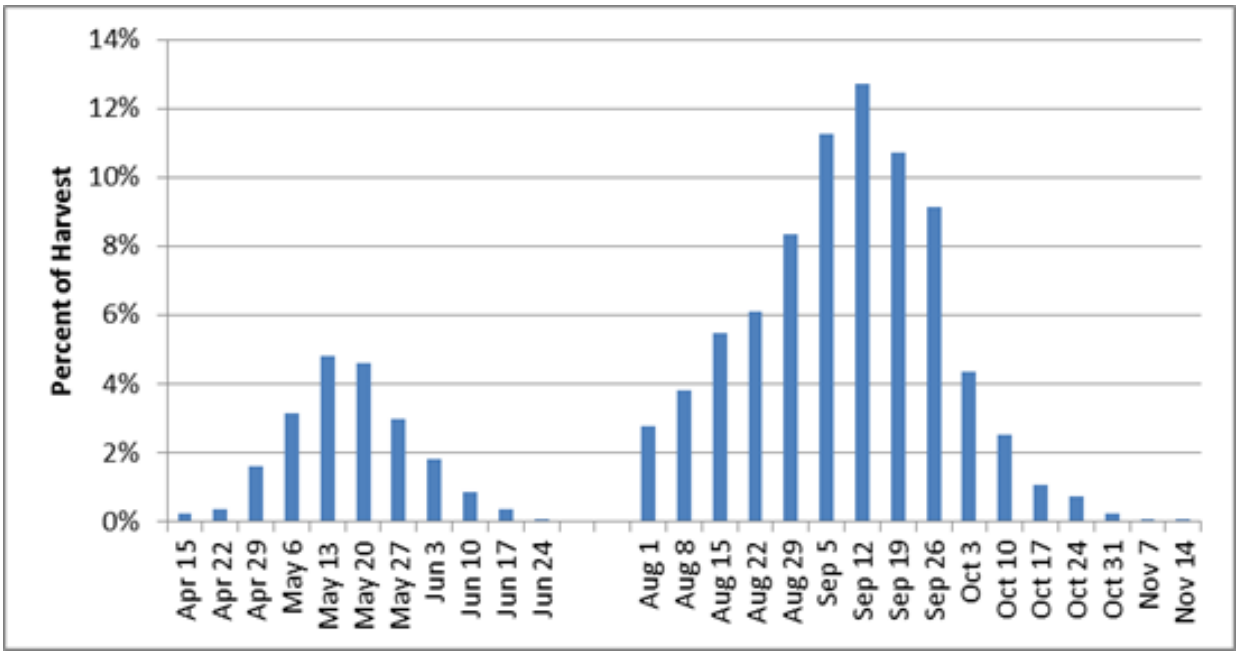


Figure 24. Proportion of licensed grizzly bear harvest in one week increments over the hunting season.

Sex of harvest – while the majority of both fall and spring harvest is male, more females are harvested in fall (Table 6); this pattern is consistent for residents and non-residents (Table 7).

Table 6. Sex composition of fall and spring harvest

Hunting season	% females	% males
Fall	38	62
Spring	22	78

Table 7. Sex composition of fall and spring resident and non-resident harvest

Hunting season	% females	% males
Fall		
resident	35	65
non-resident	39	61
Spring		
resident	27	73
non-resident	16	84

Composition of harvest – resident and non-resident hunters harvested more adult males than any other sex/age class in both seasons (Figures 25-27). More adult females – and fewer adult males – are taken in fall than spring. The large male component of spring harvest is believed to result from sex-specific behaviours. Although the overall timing of den exit depends on spring weather conditions, males leave dens earlier than females and females with young. Females and females with young often remain in dens until mid-late May and early June at which point, the majority of spring hunting is over. In addition, females who have cubs at den exit (during

spring harvest) may not have those cubs during the fall harvest (cubs may die or older cubs may leave the family unit). Because females with young are protected from harvest, fewer females are available for harvest in the spring.

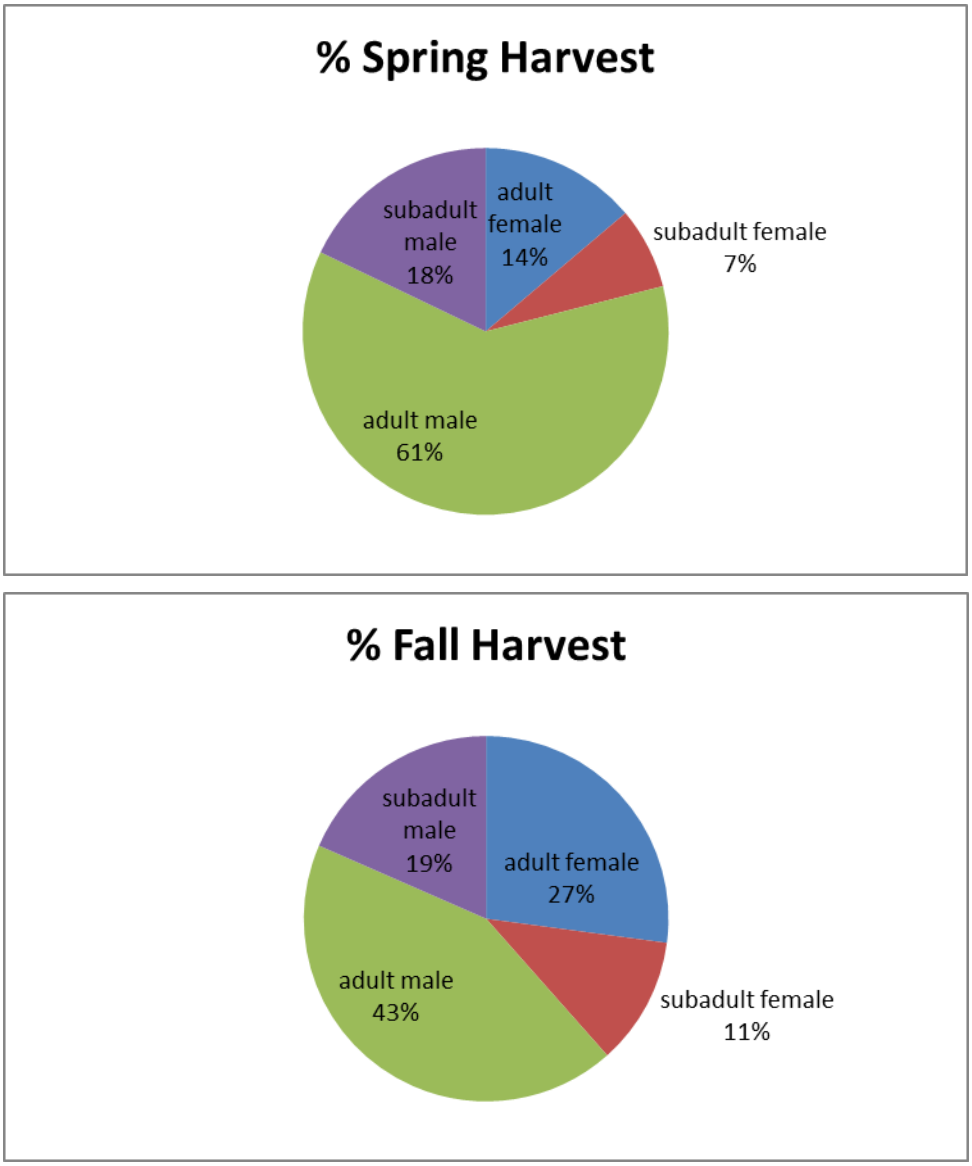
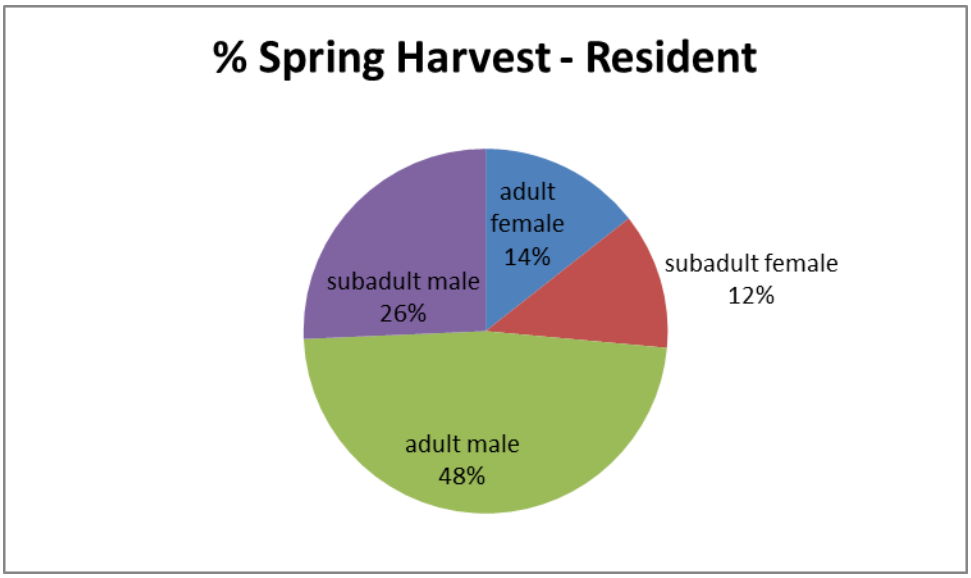


Figure 25. Percent of resident and non-resident harvest comprised of each sex/age class between 1980 and 2016. Subadult bears are those who are 4 years of age or younger and adult bears are those who are 5 years of age or older.



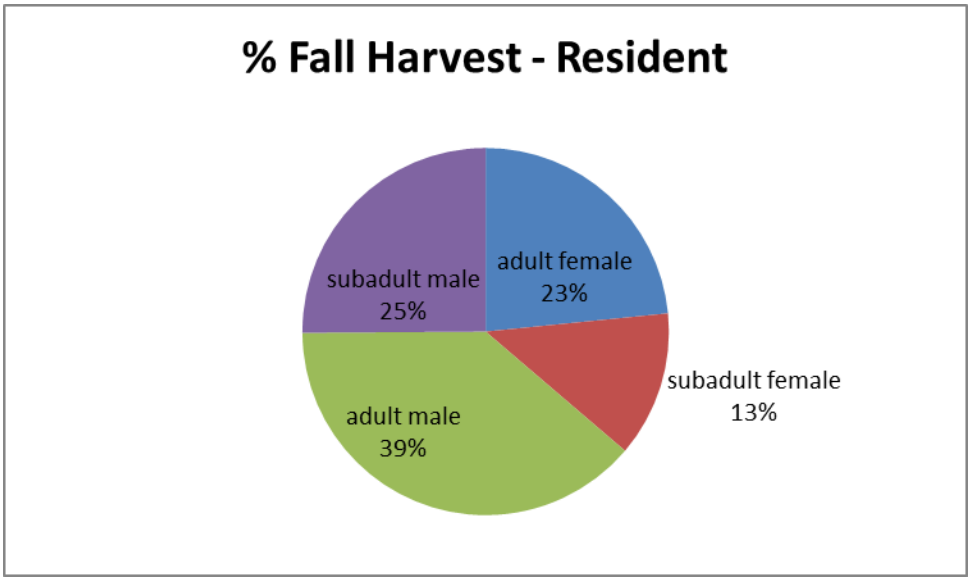
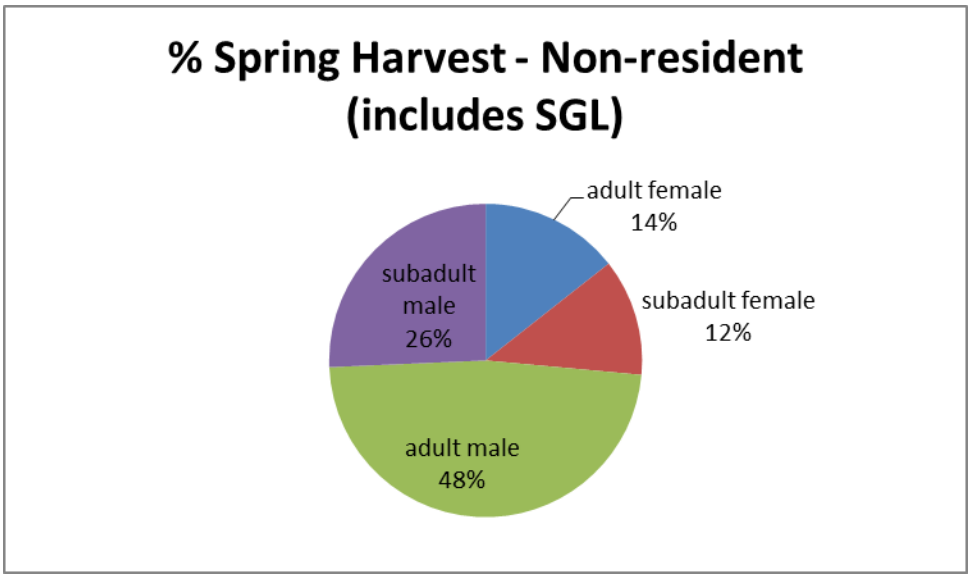


Figure 26. Percent of resident harvest comprised of each sex/age class between 1980 and 2016. Subadult bears are those who are 4 years of age or younger and adult bears are those who are 5 years of age or older.



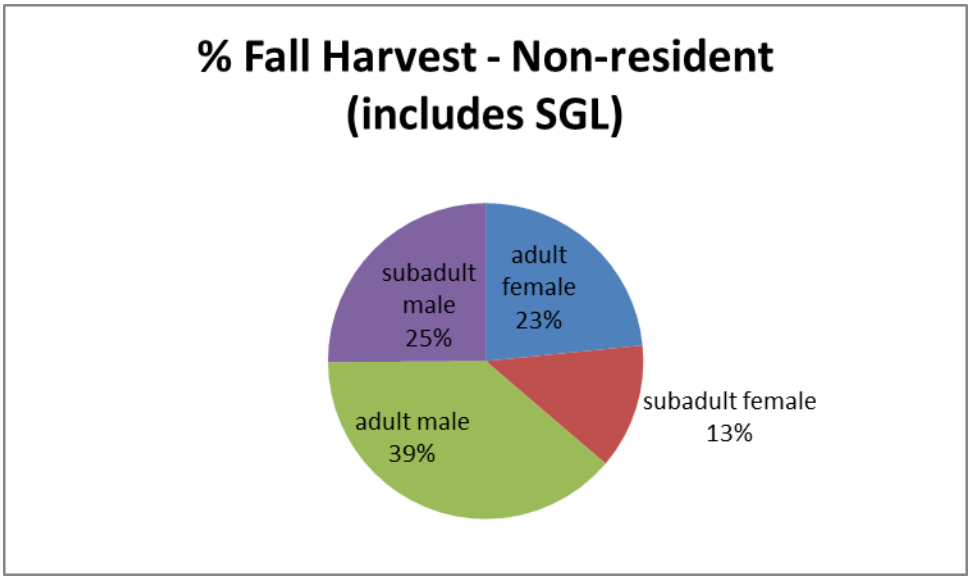


Figure 27. Percent of non-resident harvest comprised of each sex/age class between 1980 and 2016. Subadult bears are those who are 4 years of age or younger and adult bears are those who are 5 years of age or older.

Defence of life and property kills

Bears are killed in defence of life or property (DLP) when non-lethal options to deter the bear have been exhausted. An average of 11 (range 4 to 23) grizzly bears were reported as DLP kills each year between 1980 and 2016, of which 4 (range 1 to 15) are on average killed by conservation officers and 7 (range 1 to 14) on average are killed by residents (Figure 28). Kills reported as DLPs have declined since the early 2000s, possibly a result of improved waste management (for example; fencing of the Whitehorse landfill). However, some resident harvest is believed to be DLP kills so these reports could be biased low.

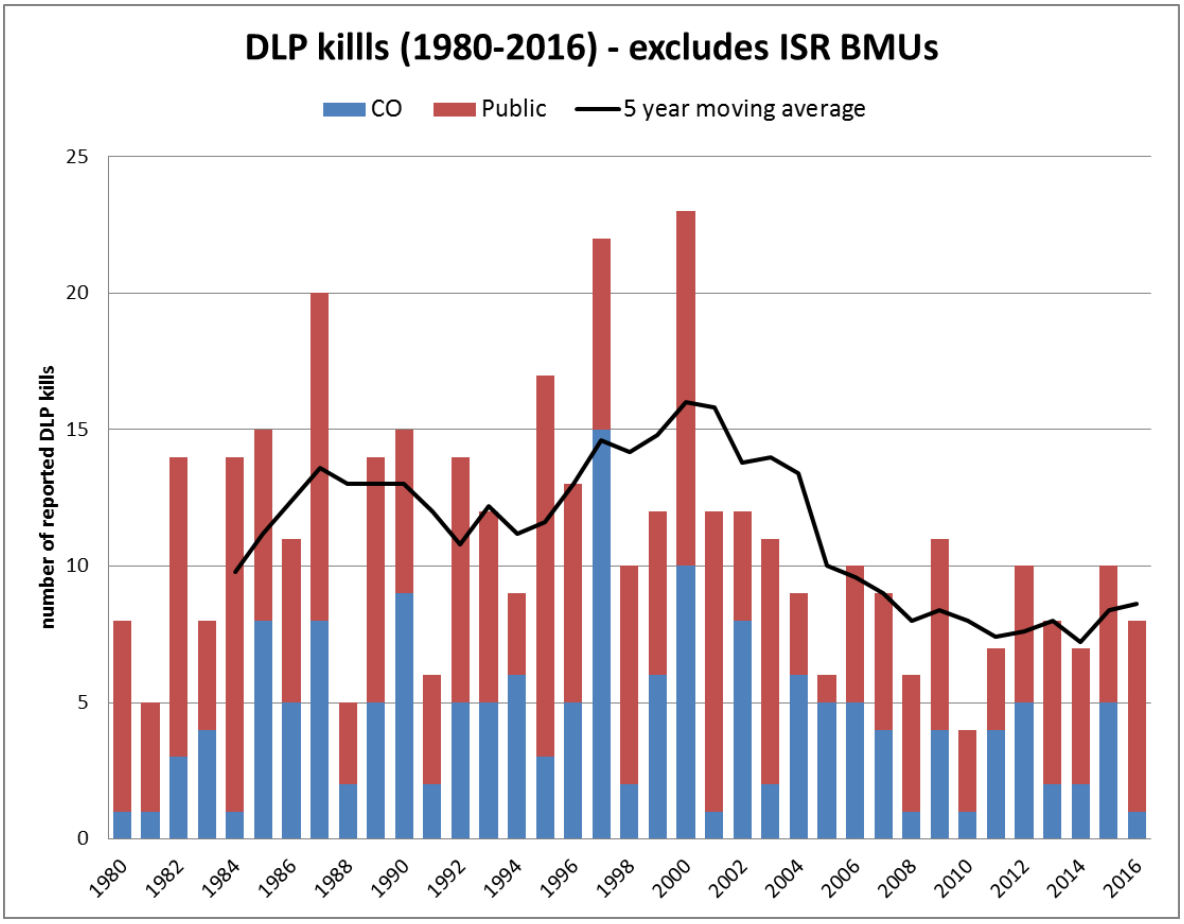


Figure 28. DLP kills reported between 1980 and 2016.

Based on known sex, 65% of DLP kills are male and 35% are female. When broken down by age and sex, more were adult males than any one other age/sex class (Figure 29). More DLP kills occur in GMZs 5 and 7 when compared to other GMZs (Figure 30).

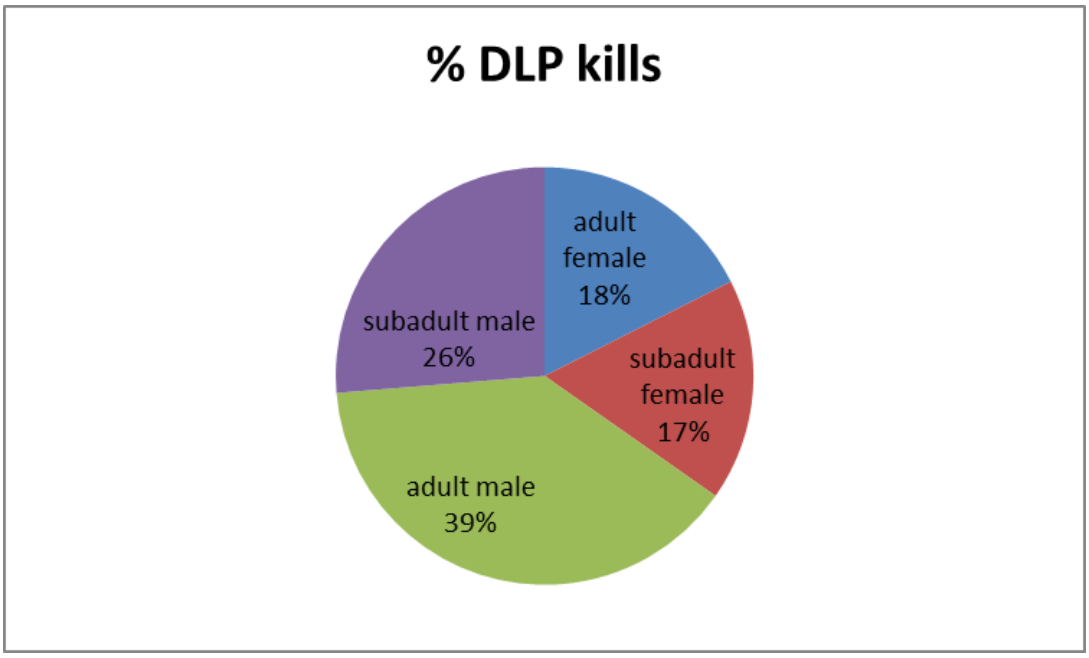


Figure 29. Sex and age composition of defense of life and property (DLP) kills (1980 to 2016).

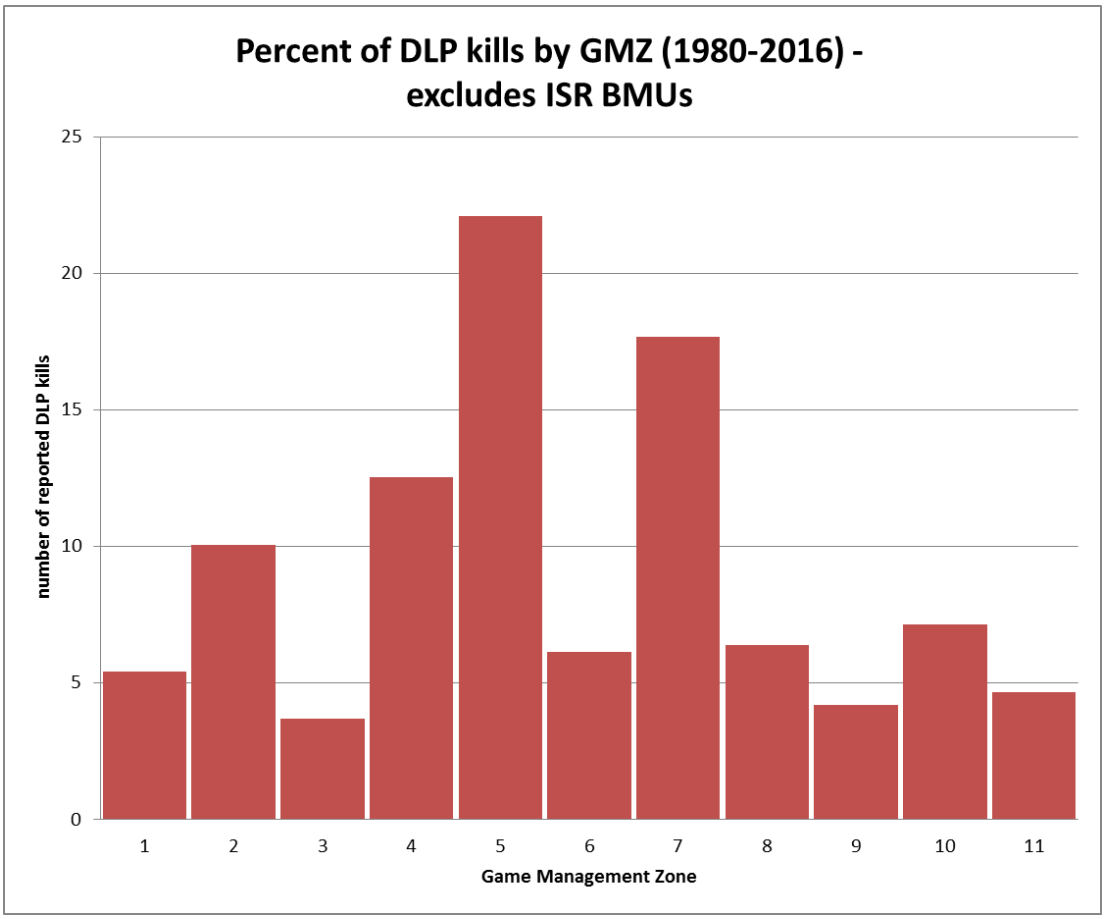


Figure 30. Percent of DLP kills by Game Management Zone between 1980 and 2016.

Other types of mortalities

Between 1980 and 2016, 2% (76) of reported kills in BMUs outside of the ISR were classified as “other”. Of these “other kills,” 28% (21) were bears found dead where cause of death could not be verified. 41% (31) were accidental research kills and illegal kills, and 32% (24) were reported as roadkill. Based on EDI (2015), the majority of vehicle collisions with grizzly bears occur on the Alaska Highway, between Teslin and Whitehorse. The South Klondike Highway (south of Whitehorse) is also identified as a moderate collision area.

Managing mortality risk

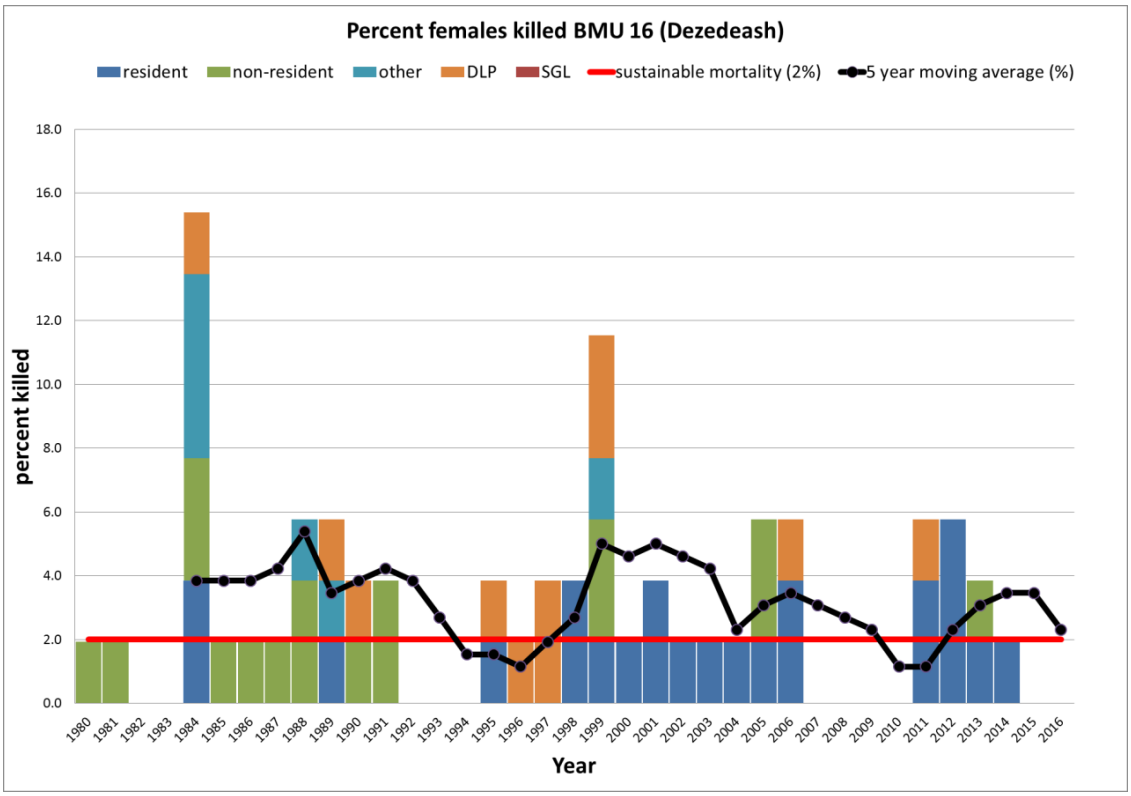
Managing mortality risk will help ensure grizzly bears persist in the future. Risk of unsustainable mortality in the Yukon is considered low:

- Since 1980, there has been a decrease in female mortality both at the territory wide scale and within individual BMUs (acknowledging there are still concerns about unsustainable mortality in some BMUs, particularly in the southern Yukon). Current harvest management is designed to minimize female mortality:
    - The non-resident quota system ensures female mortality is limited to 2% and encourages male harvest if all female bears in quota are taken. Non-residents aren't able to harvest a bear if other types of mortality in the BMU is too high (e.g., resident harvest, DLPs).
    - Cubs and females with cubs are protected from harvest.
- Since 2001/02, resident harvest has been restricted to one bear every 3 licence years; this has resulted in a more conservative grizzly bear harvest.
- There is no indication, based on 36 years of harvest trend data, that all outfitters and all residents will harvest the maximum number of bears available to them in any given year. Average annual harvest since 1980 is 79 bears per year (page 42), most of which are males, and much below what actual harvest could be when considering the number of resident seals issued and available quota held by outfitters.

BMUs of concern are identified by working closely with partners and using all sources of available knowledge (traditional, local, and scientific) to identify trends in grizzly bear populations, harvest and other mortality. Similar approaches would be taken to mitigate unsustainable mortality in other BMUs. Where mortality is deemed to be above sustainable rates (particularly for females), an evaluation is needed to determine whether the cause is harvest or other factors (e.g., changes in food availability like salmon; impacts of development on bear use of an area; increase in human-wildlife conflicts).

Adjustment to outfitter quotas can be used to ensure overall mortality within the BMU is sustainable. These changes are implemented through the three year quota review undertaken by the Government of Yukon. Adjustments to resident harvest would require a regulation change under the *Wildlife Act*. Where high mortality is due to defense of life and property kills, the Government of Yukon works with individuals, communities, or proponents to reduce bear attractants to avoid preventable bear kills (e.g., better waste management; require electric fencing of chicken coops).

For example, average female mortality has exceeded 2% five times in the last five years in the Dezedeash BMU:



Resident harvest has recently increased in the Dezedeash BMU; however, it is unclear if this is a result of increased defense of life and property kills or an actual increase in resident harvest. Strategies for mitigating unsustainable mortality have been implemented, including reducing the non-resident quota and working with parties in the Dezedeash BMU to minimize bear attractants. If mortality continues to remain over 2%, other strategies will need to be considered (e.g., reducing resident harvest).

Appendix 1: Considerations for future monitoring and harvest management work for the Yukon

Future grizzly bear monitoring program considerations:

- Further work is needed to more explicitly define a bear management unit, based on biological information and existing management units. For example, bear management units could be a collection of game management subzones that best represent a bear population, similar to Moose Management Units (MMUs).
- Much of the population size and trend information for grizzly bears in the Yukon has not been verified. However, current approaches to obtaining this information are expensive and logistically demanding. Future work should explore options for establishing grizzly bear population size and trend in a cost-effective manner that can be repeated regularly given capacity of existing program areas.
- In the absence of an empirically based study, existing population estimates for ecoregions could be revisited and revised based on updated knowledge of harvest trends, habitat effectiveness, land disturbance, current carrying capacity, etc.
- Areas of conservation concern should receive monitoring priority (e.g., the Dezedeash BMU; other BMUs where female mortality has more recently met or exceeded sustainable mortality rates).

Future grizzly bear harvest management program considerations:

- Use updated population models to establish sustainable harvest rates depending on population status (size and trend), consideration of other mortality factors (defense of life and property kills; conflict kills, vehicle kills, etc.) and how recent or extensive the population information is.
- Investigate harvest data to better understand how harvest monitoring can be used to identify areas of management concern (e.g., trends in sex and age of harvest, similar to the updated sheep harvest modeling) (e.g., McLellan et al. 2016).
- Investigate how harvest is managed in other jurisdictions and apply to the Yukon, as appropriate (e.g., accounting for unreported mortality like wounding loss and poaching, managing harvest based on predicted habitat effectiveness, etc.).

Future monitoring and management actions required continued collaboration with First Nation governments, RRCs, HTCs, communities, WMAC (NS), and the YFWMB to ensure programs

are robust, incorporate all sources of knowledge, and ensure long term stewardship of the Yukon's grizzly bear populations. Appendix 2: Suggestions for a Monitoring Program[2]

Goals of a population inventory and monitoring pertain to:

1) regulation of any legal harvest
2) minimizing human bear conflicts and resulting mortality
3) broad-scale fragmentation of habitat and populations leading to decreased population resilience and range contraction
4) the degradation of quality habitat and its effectiveness in supporting a healthy and productive local population

Objectives of population inventory and monitoring should be:

1) estimating absolute population size
2) understanding population trend and demography
3) predicting and understanding spatial distribution and influential factors
4) characterizing and understanding population connectivity and fragmentation

Approaches, Methods and Design Considerations:

1) Population estimation involves mark-recapture estimates
2) Population distribution can be inferred from detection data characterizing some surrogate to density, such as detection frequency, and environmental factors that directly or indirectly influence the productivity and persistence of bear populations. This approach is most relevant when sampling has been conducted at scales of regional population distribution (typically 1000km^2).
3) Population connectivity is best addressed through genetic sampling across broad, regional landscapes. However, the resolution at which sampling is systematic will influence the resolution at which patterns of genetic and demographic connectivity can be inferred and explained.

Sampling Protocol and Design Considerations

1) Field Protocol – For field sampling, the bait station/scent station and barbed-wire enclosure is the primary technique for bear hair-snag sampling.
2) Spatial Considerations – Typically, sampling distribution is controlled by grid cells.
3) Temporal Considerations – Spring to early summer is generally the most appropriate season for hair-snag sampling.

[2] From Apps (2010).

4) Explanatory covariates – Factors should be tracked that potentially influence spatial and temporal variability in detection rates and demographic trends and allele distribution. These may be environmental or biological covariates.

Population Estimation and Monitoring – Alternate Approaches and Specific Considerations

1) Alternate Approaches – Mark-resight methods may be deployed in some situations. This typically requires that some portion of the population be collared.

2) Radio Telemetry versus DNA Mark-Recapture for Trend Monitoring – There are limitations to both methods. Telemetry studies provide real estimates of survival and population trend, but may require long-term use but are not as good for estimating immigration and emigration. Appendix 3: Comparison of predicted density estimates based on Smith and Osmond Jones (1990) and Mowat et al. (2013)

Table A3-1. Predicted grizzly bear densities and kill rates for Yukon Bear Management Units; from Mowat et al. 2013. Best fit models predicted densities based on terrestrial productivity (loosely, vegetation cover, indices of human use of the landscape and, an index of topographic ruggedness). 1995 to 2004 kill rates were based on predicted densities.

Name	Area (km^2)	Predicted density (bears per 1,000 km^2)	LCL	UCL	Population size	Human caused kill 1995-2004	Kill rate
Aishihik	22,898	19.1	1.0	43.2	436	83	1.9%
Anvil	9776	24.9	3.8	45.9	243	20	0.8%
Arkell	7537	9.2	-12.7	29.3	69	41	5.9%
Big Salmon	13,115	17.3	-6.0	35.7	227	35	1.5%
Bonnet Plume	10,664	30.7	7.8	50.3	328	46	1.4%
Cassiar	35,572	27.1	3.2	44.9	965	45	0.5%
Dezedeash	4564	17.6	-2.4	39.4	80	48	6.0%
Eagle Plains	22,736	29.7	7.9	50.3	676	1	0.0%
East Arctic	9372	19.5	-1.1	41.1	182	4	0.2%
Frances	13,149	10.9	-10.3	31.3	144	8	0.6%
Glenlyon	9851	12.4	-6.5	35.4	122	35	2.9%
Gold	36,448	19.1	-0.2	41.8	696	36	0.5%
Hart	17,974	30.9	9.2	51.4	556	31	0.6%
Hyland	28,359	16.1	-3.3	39.0	457	27	0.6%
Klondike	9669	30.4	9.0	51.0	294	31	1.1%
Kluane	11,239	25.6	3.4	55.7	287	18	0.6%
Knorr	10,294	28.9	5.7	47.7	298	1	0.0%
Laberge	8308	0.0	-22.9	19.6	0	29	0.0%
MacMillan	21,781	30.4	6.4	48.0	661	48	0.7%
Nadaleen	8257	31.4	9.0	51.4	259	46	1.8%
Nisling	8883	21.8	3.9	46.9	194	43	2.2%
North Ogilvie	14,863	30.5	9.6	51.9	453	40	0.9%

Old Crow Flats	22,926	21.0	-0.7	41.1	481	19	0.4%
Pelly	15,296	23.5	0.5	42.2	359	39	1.1%
Richardson	17,862	28.8	4.1	46.1	515	5	0.1%
Ruby	2079	26.4	8.8	52.1	55	8	1.5%
Southern Lakes	7282	8.5	-12.0	30.0	62	25	4.0%
Stewart	19,603	28.8	6.8	48.4	565	60	1.1%
West Arctic	13,878	16.9	-1.9	40.5	234	1	0.0%
West Ogilvie	14,361	26.6	7.0	49.0	382	51	1.3%
White	7311	16.4	-0.6	41.7	120	20	1.7%
Total					10,404	944	

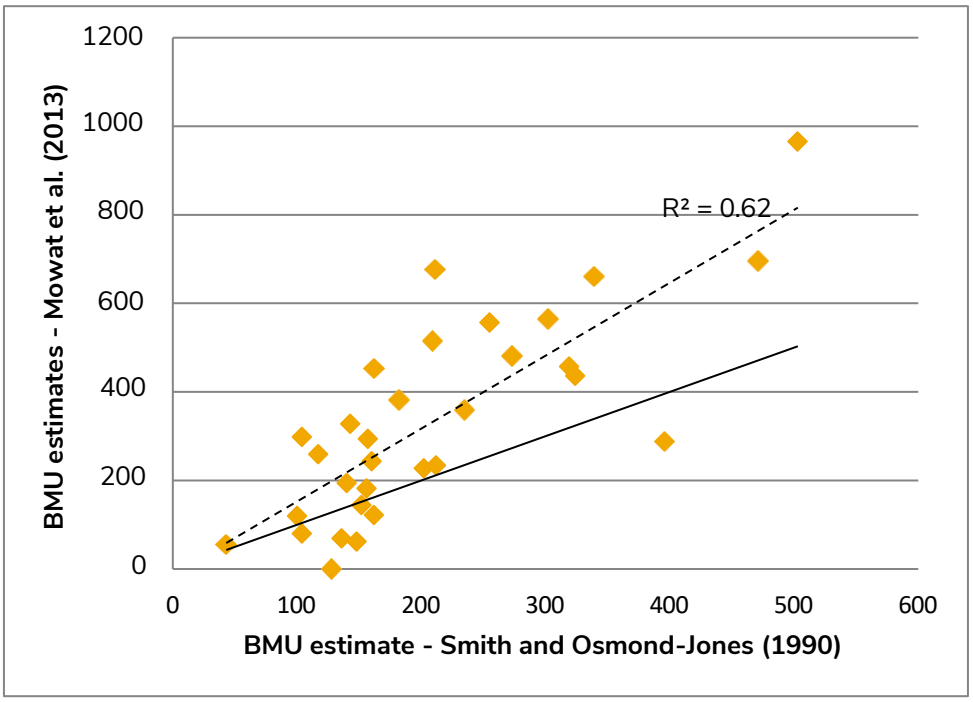


Figure A3-1. Correlation between population size estimates for Bear Management Units (BMUs) based on Smith and Osmond Jones (1990) and Mowat et al. (2013). The solid line represents those BMUs with 100% agreement between Mowat et al. (2013) and Smith and Osmond Jones (1990).

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