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Status of thinhorn sheep in Game Management Zone 5

2014-2016

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Key Findings

- A broad-scale survey of thinhorn sheep in GMZ 5 was conducted during the summers of 2014 to 2016.
- Across all of GMZ 5, 3, 766 sheep were observed, 3,011 of which were non-lambs.
- The only previous comprehensive survey of GMZ 5 occurred in 1974. Current sheep numbers in GMZ 5 are similar to those observed in 1974 (i.e., 3,780 total sheep, 3,160 non-lambs).
- Based on results from this survey, fifteen sheep management units were identified. Identified management units form the framework for which future monitoring and management of sheep across GMZ 5 should be considered.
- At the present time, licensed harvest in most of GMZ 5 is within recommended sustainable levels. However, harvest levels in the Brooks Arm management unit exceed the 4% guideline.

List of Abbreviations

AK	Alaska
CAFN	Champagne and Aishihik First Nations
GMS	Game Management Subzone
GMZ	Game Management Zone
KFN	Kluane First Nation
KDFN	Kwanlin Dün First Nation
LSCFN	Little Salmon/Carmacks First Nation
OA	Outfitting Area
PHA	Permit Hunt Authorization
SFN	Selkirk First Nation
TH	Trondek Hwech'in First Nation
TKC	Ta'an Kwäch'än Council
WRFN	White River First Nation

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Contents

Introduction

Game Management Zone (GMZ) 5 in southwest Yukon (Figure 1) has some of the highest densities of thinhorn sheep in Yukon (Barichello et *al.* 1989). Sheep in this area are the Dall's subspecies (*Ovis dalli dalli*) of thinhorn sheep (Sim et *al.* 2016). Southwestern GMZ 5 is also adjacent to the highest human population in Yukon centered on Whitehorse, leading to higher harvest pressure relative to many other areas in Yukon (Hoefs 1980). Westfall (2013) reported that GMZ 5 was the second most popular zone for resident sheep hunting in Yukon. Increasing interest in harvesting sheep (Westfall 2013) coupled with increasing accessibility to sheep populations (e.g., Champagne and Aishihik Traditional Territory Fish and Wildlife Planning Team 2016) has led to concern regarding the sustainability of harvest here. Additionally, concerns have arisen regarding the shifting of harvest pressure westward following the placement of additional Game Management Subzones (GMSs) in eastern GMZ 7 on a PHA in the early 2010s (Champagne and Aishihik Traditional Territory Fish and Wildlife Planning Team 2016).

From 2014 to 2016, the Government of Yukon conducted broad-scale surveys of Dall's sheep to assess their status across GMZ 5. The objectives of this survey were to assess abundance, population productivity (i.e., lamb production), adult sex ratio, and ram composition. An additional objective was to incorporate this broad-scale survey data into delineation of biologically meaningful management units. This information will be used to assess the current sustainability of harvest across GMZ 5. The last comprehensive survey of sheep in GMZ 5 was in 1974 (Hoefs 1975).

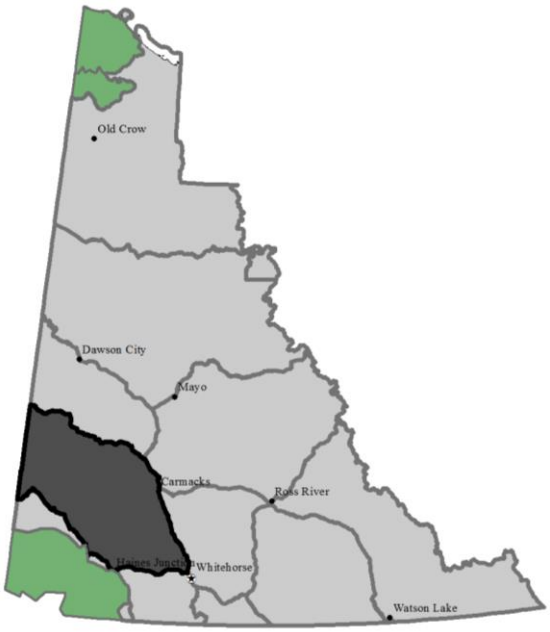

Figure 1. Distribution of Yukon's Game Management Zones. Game Management Zone 5 is shaded dark grey. National Parks are shown in green.

Game Management Zone 5

GMZ 5 (Figures 1 and 2) located in southwest Yukon is one of 11 GMZs distributed across Yukon. It encompasses approximately 49,395 km^2 and is topographically dominated by several mountain ranges including the Dawson, Nisling, and Ruby Ranges and the Nutzotin Mountains. Except for three GMSs, it is bordered to the north and south by the Yukon River and Alaska Highway, respectively. To the west and east it is bordered roughly by the Alaska (AK) border and the North Klondike Highway, respectively.

Administratively there are 51 GMSs in GMZ 5 (Figure 3). GMZ 5 is located in the traditional territories of CAFN, KFN, KDFN, LSCFN, SFN, TH, TKC, and WRFN (Figure 2). Category A and B

First Nation Settlement Lands are distributed throughout GMZ 5 (Figure 4). The Kluane Wildlife Sanctuary is located adjacent to GMZ 5 along its southern edge (Figure 2).

Currently there are four active Outfitting Areas (OA) in GMZ 5 (Figure 3). One GMS (5-50) is currently under a PHA with 6 permits issued annually since 2009. All other GMSs in GMZ 5 are open to licensed harvest.

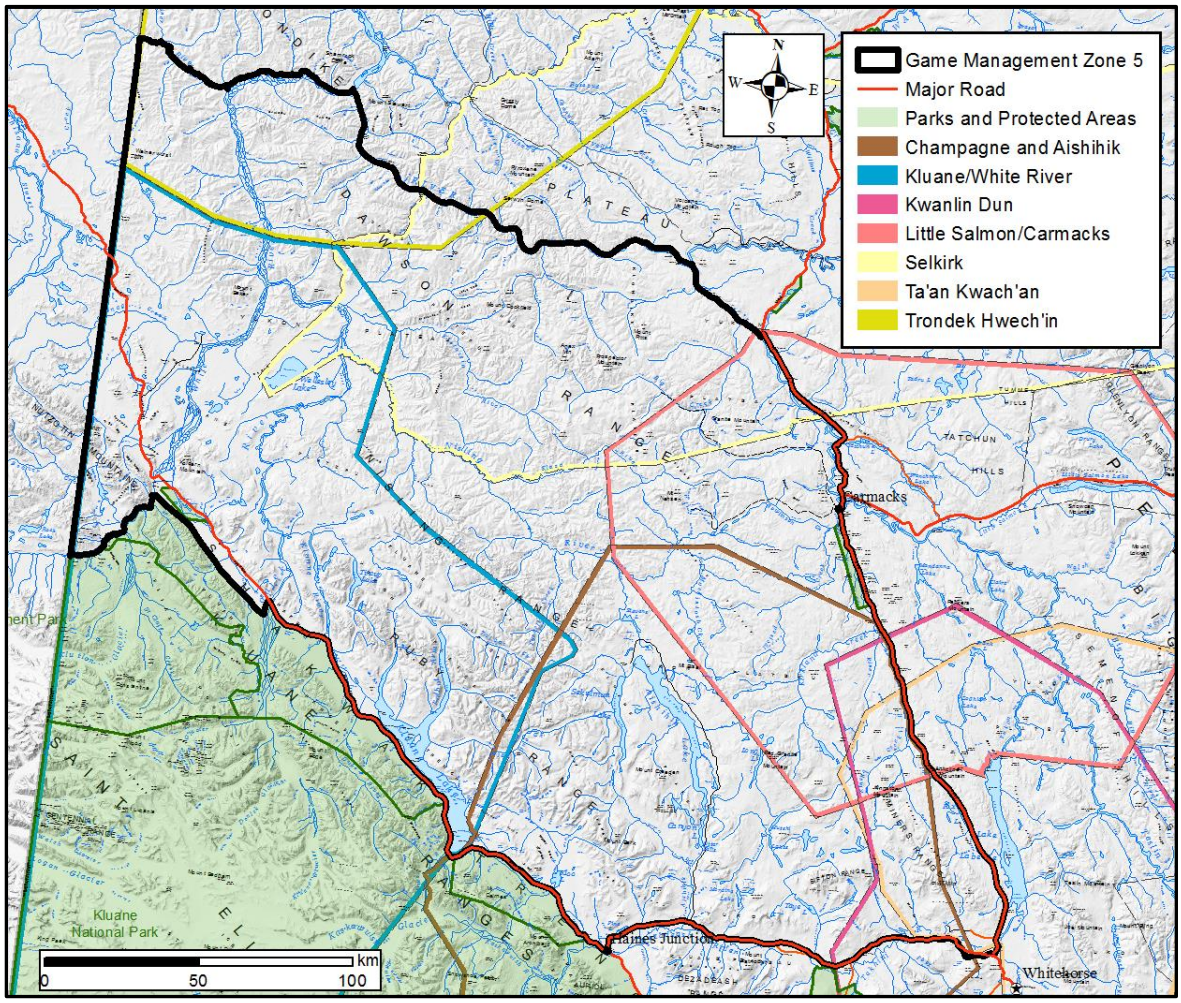

Figure 2. First Nation traditional territories and parks and protected areas located in Game Management Zone 5.

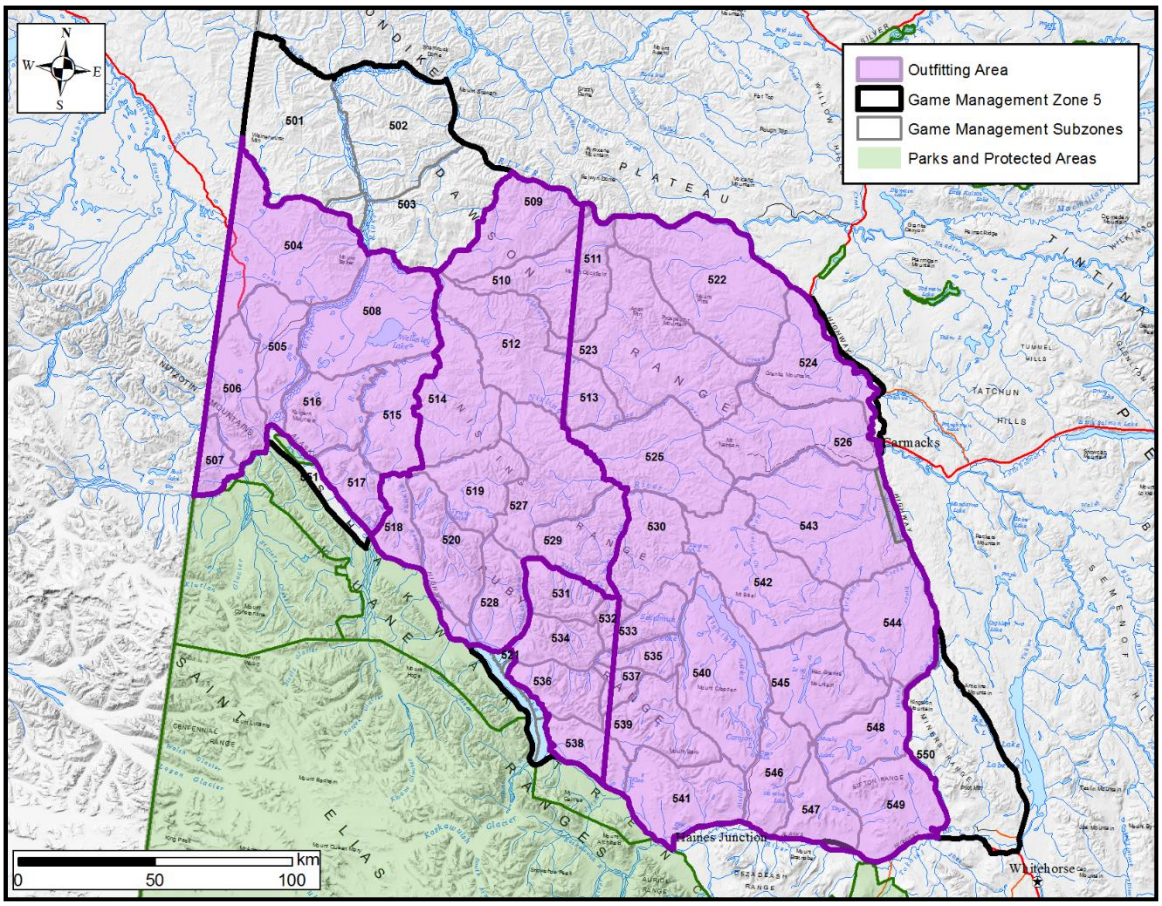

Figure 3. Distribution of GMSs and OAs within Game Management Zone 5.

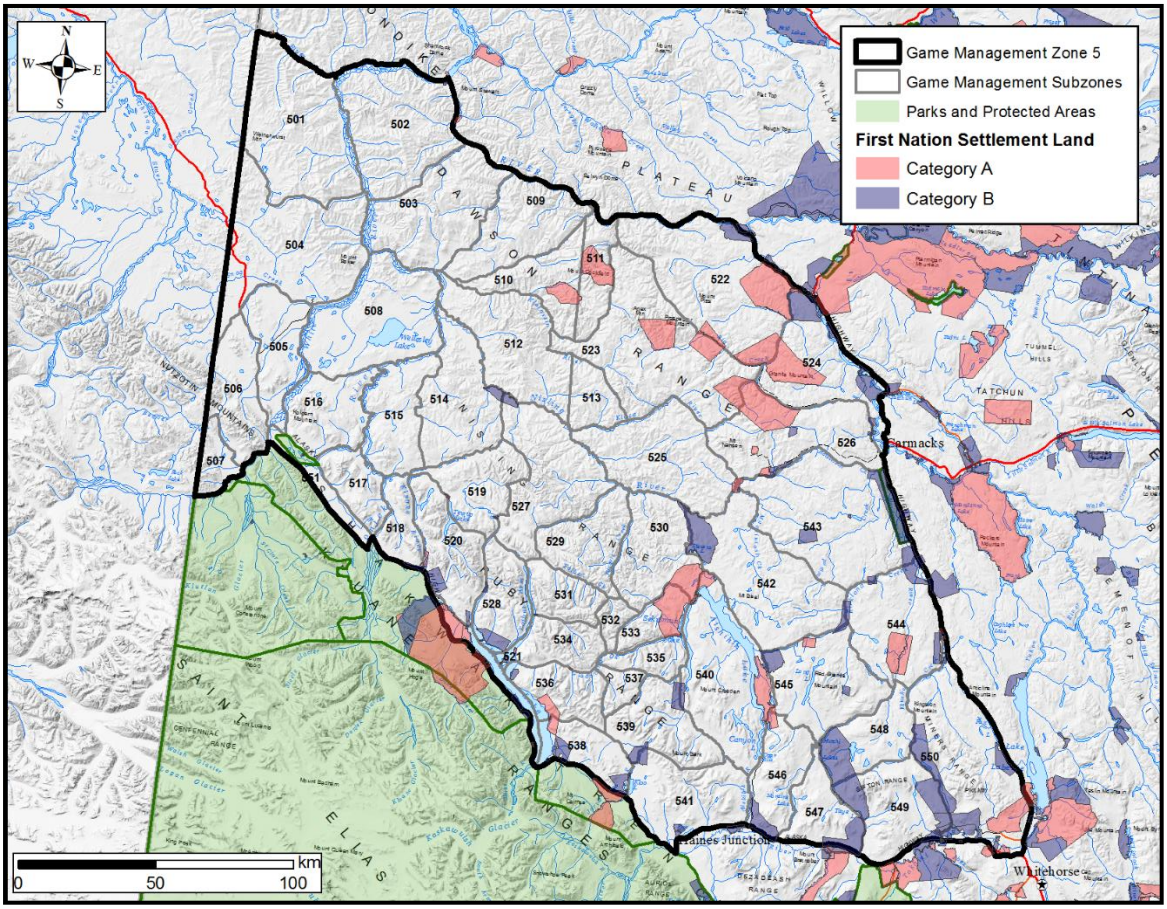

Figure 4. First Nation Settlement Lands in Game Management Zone 5.

Ecologically, GMZ 5 is located entirely within the Boreal Cordillera ecozone (Yukon Ecoregions Working Group 2004). The northern portion of GMZ 5 occurs within the Klondike Plateau ecoregion while the south-central portion lies within the Ruby Ranges ecoregion. The eastern edge of GMZ 5 is found in the Yukon Plateau-Central ecoregion, and the southeast corner falls within the Yukon Southern Lakes ecoregion. The southwest corner of GMZ 5 falls within the Saint Elias Mountains ecoregion (Figure 5; Smith *et al.* 2004). The majority of GMZ 5 drains into the Yukon River, with a small area in the south-central portion draining into the Alsek River.

GMZ 5 maintains an intact multi-predator/multi-prey community with large mammals including moose (*Alces alces americanus*), mule deer (*Odocoileus hemionus*), grizzly bear (*Ursus arctos*), black bear (*U. americanus*), and wolf (*Canis lupus*). Four Northern Mountain caribou (*Rangifer tarandus caribou*) herds are found within GMZ 5 (Aishihik, Chisana, Klaza, and Kluane). Additionally, in the northwest portion of the GMZ, the larger migratory Fortymile and Nelchina herds (*R. t. granti*) can occur, typically during the winter months. Mountain goats (*Oreamnos americanus*) are sparsely distributed primarily in areas adjacent to the Kluane Game Sanctuary along the southwest edge of GMZ 5. The Aishihik wood bison (*Bison bison athabascae*) occurs in the south-central portion of GMZ 5 and elk (*Cervus elaphus*) are found in the southeast corner. Across GMZ 5 there is a considerable elevation gradient, with a mean elevation of 1,025 m above sea level and a range of 302 to 2,322 m. Fires are generally common throughout northern portion of GMZ 5 with larger historical

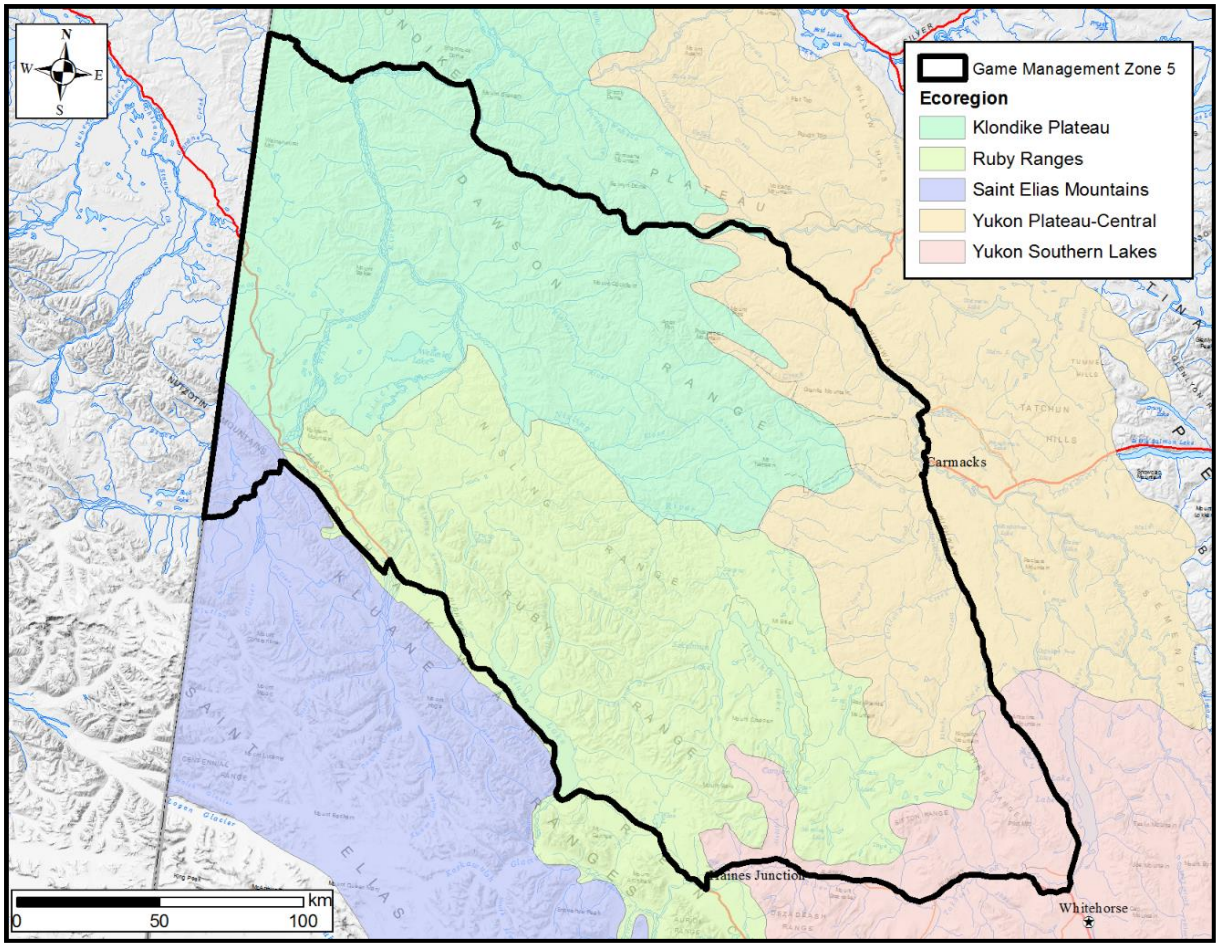

Figure 5. Ecoregions located within Game Management Zone 5.

fires also occurring in the southeast corner (Figure 6). While the periphery of GMZ 5, except for the north, is within more intensive fire management zones (i.e., fires are generally extinguished), the majority of the zone is in a wilderness fire management area and natural fires are typically left to burn as per the 2003 Yukon Fire Management Zones Directive. The climate of GMZ 5 is generally arid to continental with average precipitation of roughly 300 to 500 mm in the north and 250 to 300 mm in the south, and mean January and July temperatures of -23°C to -35°C and 7 to 15°C, respectively (Yukon Ecoregions Working Group 2004). Detailed descriptions of the vegetation, geology, and physiography of GMZ 5 can be found in Smith et al. (2004). Human land use disturbance in GMZ 5 is generally localized to several key areas (Figure 7) in the Dawson and Ruby Ranges. This consists primarily of quartz and placer mining exploration and its related activities (e.g., drilling, helicopter access).

A number of monitoring and management initiatives have occurred in GMZ 5 since the late 1970s. Sheep were monitored during wolf removal activities in the Ruby Range in the 1990s, with no effect of wolf removal detected for the population (Hayes et al. 2003). Sheep in the Ruby Range have also been the focus of highly regular monitoring activities, with surveys occurring roughly every three years. These sheep were historically used as an informal “bellwether” population to gauge the status of sheep across Yukon. To address high levels of mineral exploration in the Dawson Range, a sheep range assessment (Hayes 2016)

was completed to summarize existing knowledge regarding sheep in that area and to identify conservation measures to reduce potential impacts caused by development.

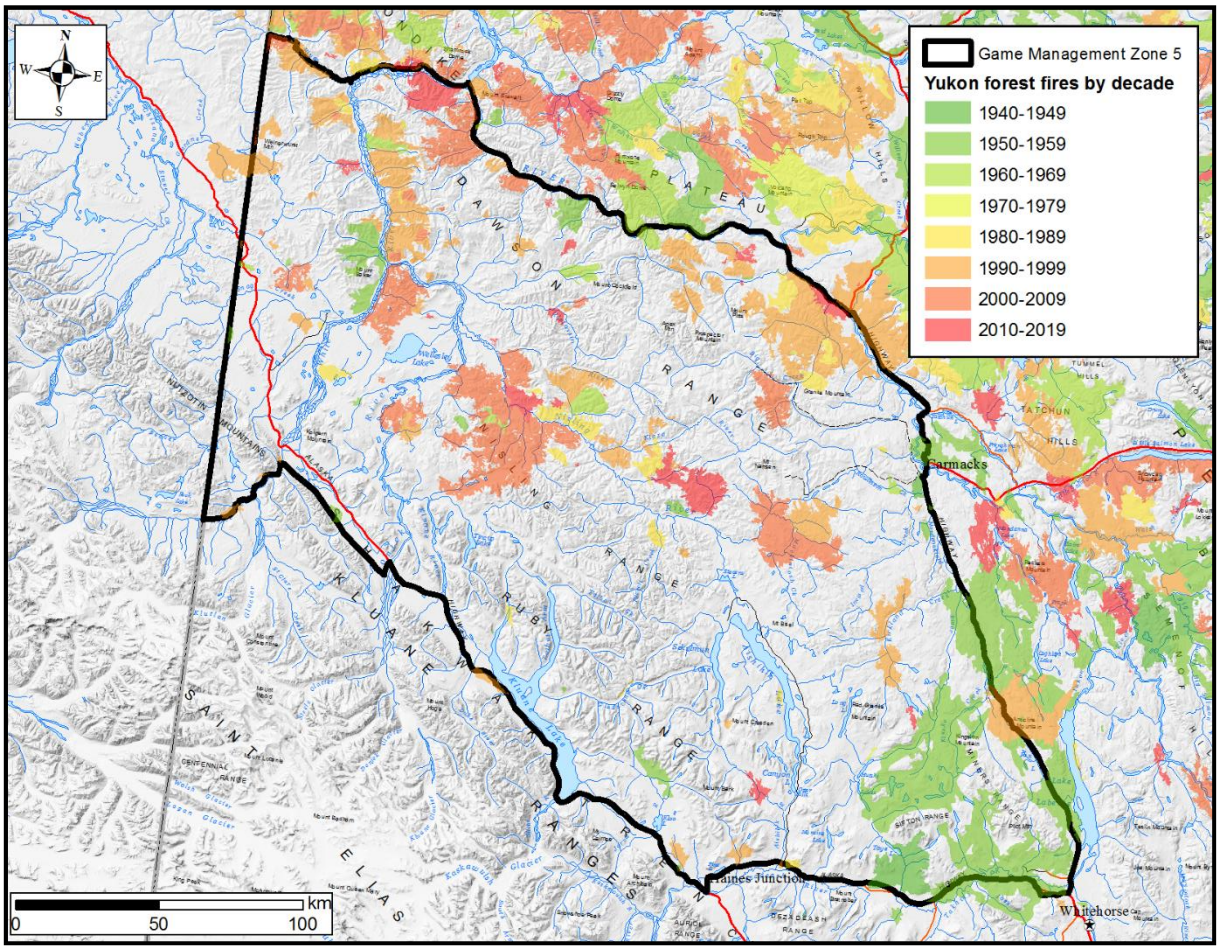

Figure 6. Distribution and ages of forest fires in Game Management Zone 5.

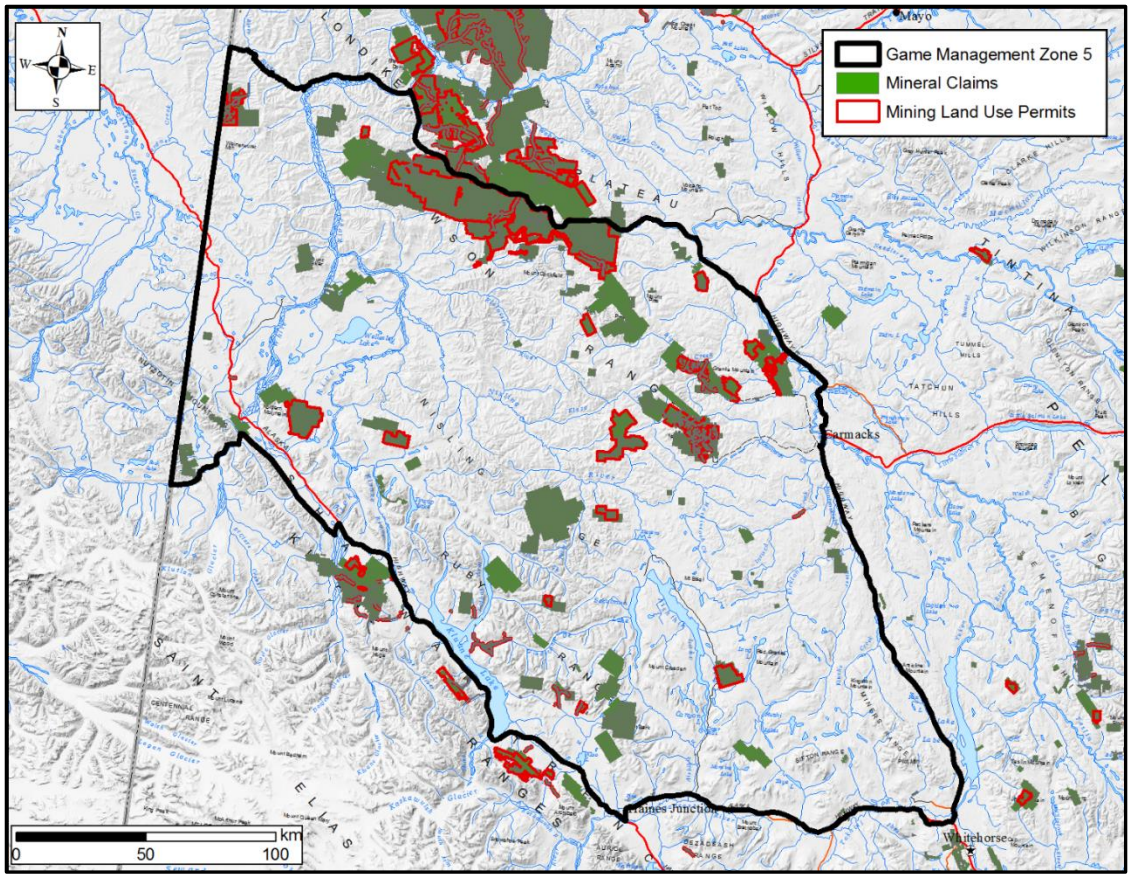

Figure 7. Distribution of mining land use permits and active mineral claims in Game Management Zone 5.

Methods

Aerial Surveys

Between mid-June and mid-July of 2013 thru 2016, sheep in GMZ 5 were aerially surveyed via helicopter (Bell 206B [Jet Ranger]) following methods described by Hoefs and Barichello (1985). The basic survey unit was typically a GMS (i.e., a relatively discrete mountain block) within which all high elevation habitat, typical Dall's sheep summer range (Hoefs and Cowan 1979, Roffler *et al*. 2016a), was surveyed. Surveys were designed to ensure geographic closure such that, when at all possible, a single GMS could be completed within one trip to reduce the chance of double-counting or missing animals that may have moved while the helicopter was out of the survey area. Three observers were present on all surveys with the helicopter "contouring" a mountain block in a counter-clockwise direction. Aircraft speeds typically ranged from 100 to 120 km/hour, but this could vary depending on wind and terrain conditions. The altitude of the helicopter also varied depending on wind and terrain conditions.

The same navigator/primary classifier was present on all surveys except for those occurring in the Dawson Range and Nisling River. During those surveys a separate navigator/primary classifier was present throughout. When a sheep group was located, its total size was tallied and animals classified. The survey method used here was a total minimum count, thus results are not corrected for sightability (Udevitz *et al*. 2006). Rams were classified based on their horn curl size into half, three-quarter, or full curl categories. If present, younger one-quarter curl rams were also classified as such. While there is variability in the ages of rams having different horn curl sizes due to annual differences in horn growth (Hik and Carey 2000), roughly speaking one-quarter curl rams are ages 1-2, half curl rams are ages 3-4, three-quarter curl rams are ages 5-6, and full curl rams are ≥7 years of age (Barichello *et al*. 1987). The number of lambs was also recorded and yearlings, ewes, and young rams were classified as nursery sheep (i.e., ewe-like sheep). Young (one-quarter curl) rams are typically found in these nursery groups and are often indistinguishable from ewes when classified from the air and were not further distinguished to avoid added disturbance on these animals. Thus, the nursery sheep class does not represent solely reproductive females. Classifying nursery sheep in this manner is typical of management agencies elsewhere (e.g., Strickland *et al*. 1992, Marshall 2005, Mitchell *et al*. 2015).

Data from each GMS was summarized to include a total count of all animals, a count of non-lambs, a ram:nursery sheep ratio, and a lamb:nursery sheep ratio. Because one-quarter curl rams are typically found in nursery groups, all one-quarter curl rams observed in a GMS were included in the nursery sheep category to ensure consistency in the calculation of demographic ratios. The ram:nursery sheep ratio is an index (i.e., an indicator but not a true measure) of the sex ratio of the population. Because nursery sheep include young males it cannot be interpreted as a true sex ratio and will be biased low relative to the true population sex ratio. Likewise, the lamb:nursery sheep ratio is an index of lamb productivity and is also biased low relative to, for example, a lamb:ewe ratio. Nevertheless, while these ratios do have biases associated with them (Festa-

Bianchet 1992), they can still be useful for monitoring and comparative purposes.

Management Units

One of the objectives of this survey was to identify biologically meaningful management units (Moritz 1994, Funk et *al*. 2012) on which management and monitoring decisions can be made (e.g., Zannèse et *al*. 2006). Historically, GMSs were typically used as the basic unit of management. However, in many situations a single GMS is not reasonable to consider as an appropriate management unit due to their small size, lack of geographic closure, or other knowledge of sheep movements.

Two lines of evidence were used to identify management units as described in Hegel and Russell (2018) for GMZ 7: survey (i.e., demographic) data and geographic closure (i.e., terrain features). From a population perspective, we considered an appropriate management unit as one in which variability in sheep numbers was primarily driven by births and deaths, rather than immigration and emigration (Murray 2002, Turchin 2003). While recognizing that immigration and emigration among identified management units may occur, units were delineated such that this movement, and changes in population size arising from it, would be deemed negligible relative to births and deaths.

To begin, a GMS was considered the smallest unit and individual GMSs were not split. Adjacent GMSs were then assessed for possible grouping based on the lack of natural movement barriers across GMS borders (e.g., rivers, deep and long valleys; Roffler et *al*. 2016b), and based on observed ram:nursery sheep ratios and non-lamb survey counts. Historical data were also considered in this assessment when available. Typical ram:nursery sheep ratios in unharvested sheep populations are >50 rams:100 nursery sheep (Hoefs and Mayer 1983), and lower (e.g., ~40 rams:100 nursery sheep) in harvested populations. Given lower survival and longevity of males (Toïgo and Gaillard 2003), there are generally always fewer males than females in ungulate populations. Thus, large departures from these typical ram:nursery sheep ratios indicated either rams or nursery sheep were missed, or a single GMS did not represent the population. Examples of large departures from expected ram:nursery sheep ratios (i.e., ratios reflective of a biologically realistic management unit) include situations with >80:100, or conversely, situations such as <30:100.

To rule out sheep being missed during the survey, results from previous surveys were assessed to examine historical consistency, and a GMS was examined with respect to its degree of connectivity to adjacent GMSs. If a GMS was relatively isolated and previous surveys generally indicated higher sheep numbers, this could indicate that missed animals were the likely cause of this ram:nursery sheep ratio departure. When deemed appropriate to group GMSs, adjacent subzones with a high degree of connectivity were grouped and the ram:nursery sheep ratio and total count of non-lamb sheep recalculated. Non-lamb counts are used rather than total counts because of the high degree of annual variability in the lamb cohort size; there may also be considerable lamb mortality from the time of the survey to one year of age (Jorgenson 1992, Gaillard et *al*. 1998). Thus, non-lamb counts are a more stable indication of the size of a sheep population. These recalculated values were then compared to previous survey results from the grouped GMSs. If a group of GMSs yielded a biologically realistic ram:nursery sheep ratio and provided generally similar numbers of non-lamb sheep, recognizing that some degree of annual fluctuation in non-lamb numbers is expected, this group of GMSs was identified as a management unit.

Management units were identified regardless of harvest management strategy or land tenure or administration.

Survey results and harvest rates are presented by GMS and according to the newly identified management units, which are named based on local landmarks or features.

Licensed Harvest Rates

Within each GMS and management unit, the average annual licensed harvest rate during 2012 to 2016 was calculated. A five-year period was used as it was deemed to represent current conditions while also accounting for annual variability in the number of sheep harvested and is consistent with recently updated sheep management guidelines (Government of Yukon 2018). Harvest rates are based on the number of sheep harvested by licensed hunters divided by the non-lamb count within a GMS or management unit. The value used for the non-lamb count was calculated from the results of either the 2015 or the 2016 survey. Where surveys were carried out in the same area in both years, the 2016 results were used to calculate harvest rate. Harvest rates do not include First Nation subsistence harvest, which is not required to be reported. A full curl ram harvest rate of no more than 4% of the non-lamb population is considered sustainable for populations that have been surveyed (Environment Yukon 2018). If harvest rates approach 4 % (i.e., 3%-4%), additional information may be required to assess if harvest pressure is expected to increase over time (Environment Yukon 2018). This guideline is in place to ensure the harvest of rams does not adversely impact the age structure of sheep populations and was developed to account for not all individuals in a population being observed during surveys.

Results

Through the summers of 2014 to 2016 (and 2013 in the Nisling unit) nearly all of GMZ 5 was surveyed where sheep may occur. During these surveys, we attempted to survey all GMSs known to have sheep. However, given resource limitations, priority was given to those known, or believed, to have consistent sheep numbers in them. A number of GMSs were not surveyed as they were characterized by low elevation, non-mountainous terrain not consisting of suitable sheep habitat. Thus not all GMSs were surveyed. Those on the periphery of identified management units may maintain small or transient groups of sheep. Future monitoring efforts may serve to refine the identified management units. These GMSs are often identified by low and inconsistent sheep harvest. Roughly 13,900 km of survey tracks were flown over approximately 106 hours. Across all years, a total of 3,766 sheep were observed, 3,011 being non-lambs (Table 1). The only comparable survey of GMZ 5 occurred in 1974 (Hoefs 1975) in which 3,780 sheep were observed, 3,160 being non-lambs.

The recent average annual (2012 to 2016) licensed harvest in GMZ 5 was 65.6 sheep per year (Figure 9). This yields a broad-scale annual average licensed harvest rate of 2.2%. However, harvest rates based on identified management units vary significantly (see below). Slightly more than half (52%) of this harvest is from non-resident hunters. This near-parity between resident and non-resident hunters in recent years is a new occurrence due primarily to a drop in non-resident harvest (Figure 9).

Table 1. Broad-scale Dall's sheep counts and population ratios for GMZ 5 (2013 to 2016).

Parameter	GMZ 5
Total count	3,766
Non-lamb count	3,011
Lambs	755
Nursery sheep	2,084
Rams	927
Lamb:nursery sheep ratio	36:100
Ram:nursery sheep ratio	45:100

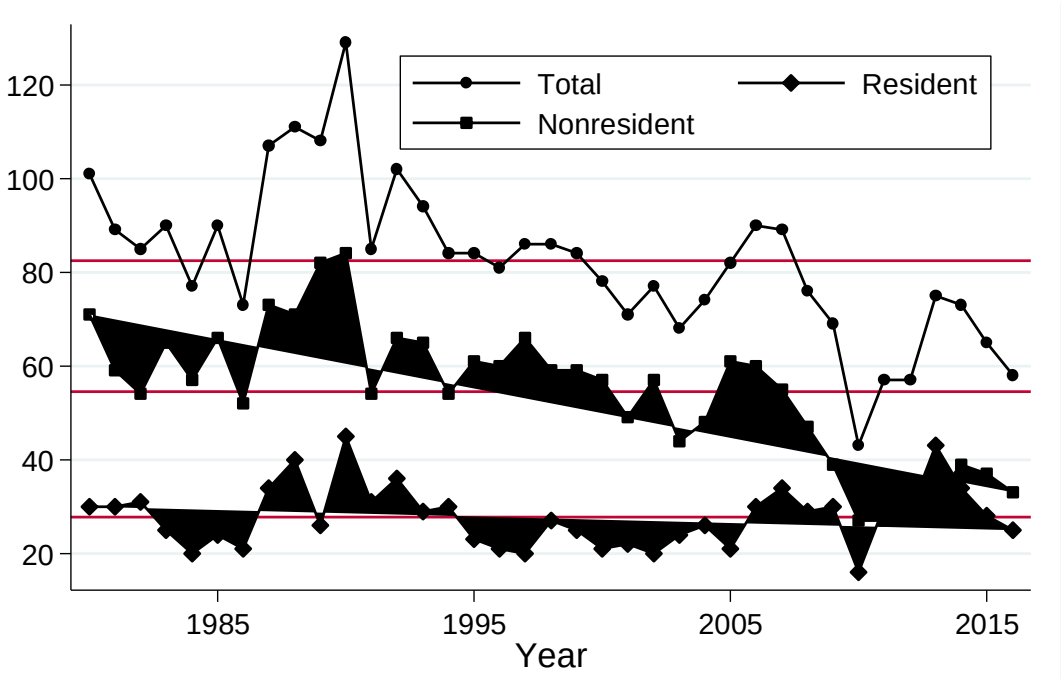

Figure 8. Long-term (1980 to 2016) annual licensed sheep harvest in GMZ 5. Red horizontal lines indicate long-term average harvest levels for, from the bottom to the top, resident, nonresident, and total harvested sheep.

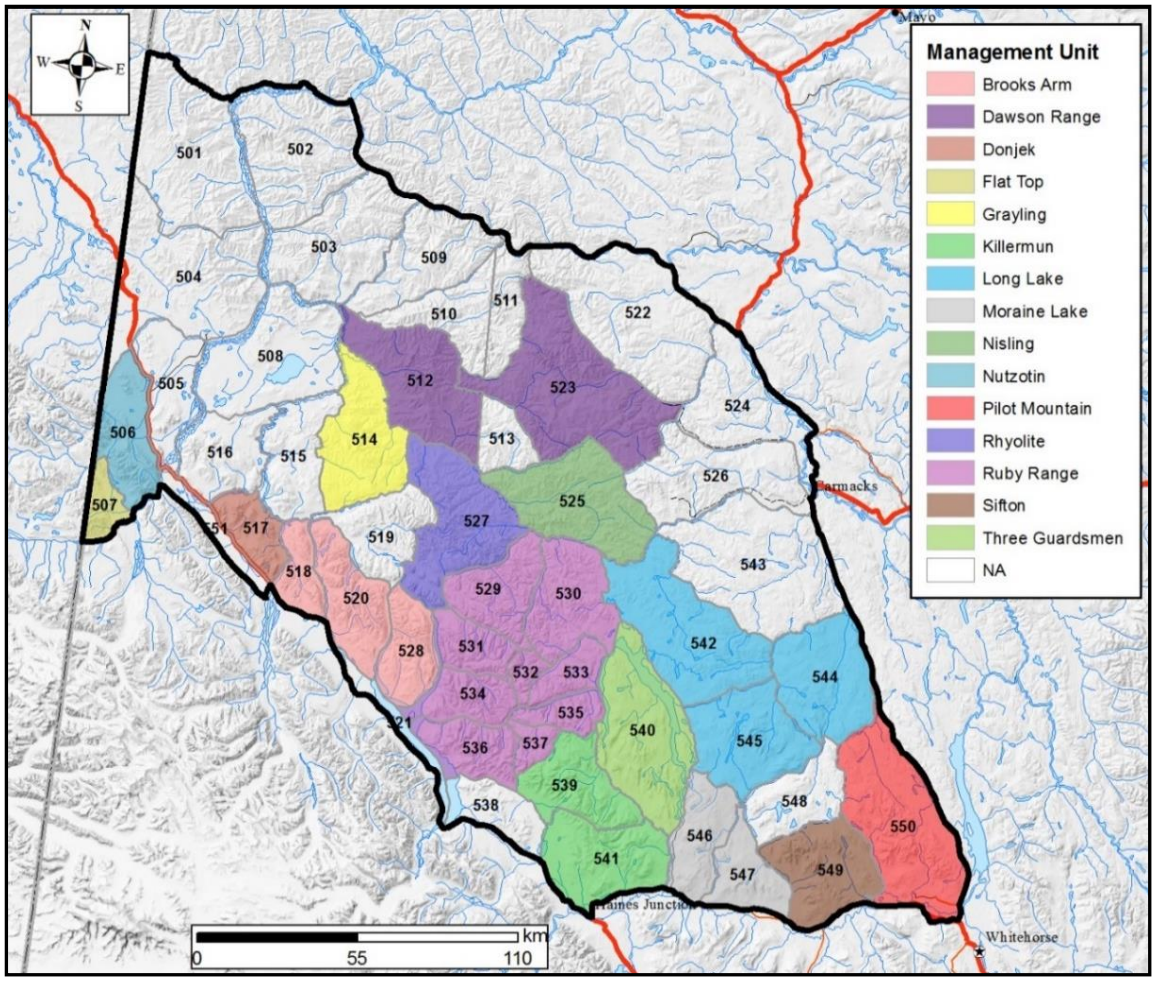

Figure 8. Fifteen identified management units in GMZ 5. NA indicates an area does not consistently maintain sheep and is not a management unit. GMSs within each management unit across GMZ 5 are also labelled.

Management Units

Fifteen management units were identified across GMZ 5 (Figure 10). A number of GMSs, particularly in the northern portion of GMZ 5, were not assigned to a unit as there is little or no evidence that these subzones consistently maintain sheep. Areas within GMZ 5 not represented by a management unit (e.g., the northwest and northeast corners) are generally low elevation, non-mountainous areas not consistent with sheep habitat.

Nutzotin (GMS 5-06) and Flat Top (GMS 5-07)

Sheep in the Nutzotin (GMS 5-06) and Flat Top (GMS 5-07) management units were surveyed during the summer of 2016 (Table 2; Figure 11). This was the first time sheep in these areas had been formally surveyed by the Government of Yukon since 1974 (Hoefs 1975). Given the forty year timespan between surveys, making inferences regarding trends in the status of these sheep is not advised. Sheep in both units are transboundary in nature, crossing the international border into Alaska (Wrangell-St. Elias National Park) where they are also harvested. The Nutzotin unit is bounded by the Shakwak Trench and Alaska Highway to the north and east, and the White River to the southeast. The Flat Top unit is bounded by the White River to the east. Separation

between the two units is realized by a large valley centered around Tchwawsahmon Lake. Quartz mineral claims are located throughout each unit (Figure 11) and both units have experienced considerable mineral exploration over the past several years.

Sheep numbers in both units are high (Tables 2 and 3). Current licensed harvest rates are 1.6% and 0.35% in the Nutzotin and Flat Top units, respectively. Harvest in both units has historically been higher than present levels, particularly in the Flat Top unit where licensed harvest has declined dramatically since the 1980s and 1990s (Table 4; Figure 12). GMS 5-05 was not surveyed in 2016. It was surveyed in 1974 with no sheep observed (Hoefs 1975). Historically there have been sheep (n = 4) harvested from this GMS from 1980 to 2016. Sheep found in this GMS are likely members of the Nutzotin unit that have crossed the Alaska Highway, possibly along either the White River or Sanpete Creek. The small harvest in this subzone and lack of sheep records here make it doubtful if this GMS maintains a large number of animals. Given its proximity to the Alaska Highway, if large and consistent numbers of sheep were occurring in GMS 5-05 it is likely that harvest here would be greater.

Table 2. 2016 survey results for the Nutzotin and Flat Top management units.

	Nutzotin (5-06)	Flat Top (5-07)
Non-lamb count	292	337
Lamb:nursery sheep ratio	49:100	43:100
Ram:nursery sheep ratio	55:100	60:100

Table 3. Historical summer survey results for the Nutzotin and Flat Top management units.

	Non-lamb count		Ram:nursery sheep ratio	
Area	2015	1974	2015	1974
Nutzotin (5-06)	292	162	55:100	64:100
Flat Top (5-07)	337	614	60:100	38:100

Table 4. Licensed sheep harvest in the Nutzotin and Flat Top management units (2012 to 2016).

Area	2016	2015	2014	2013	2012
Nutzotin (GMS 5-06)	6	4	6	4	4
Flat Top (GMS 5-07)	1	0	1	3	1

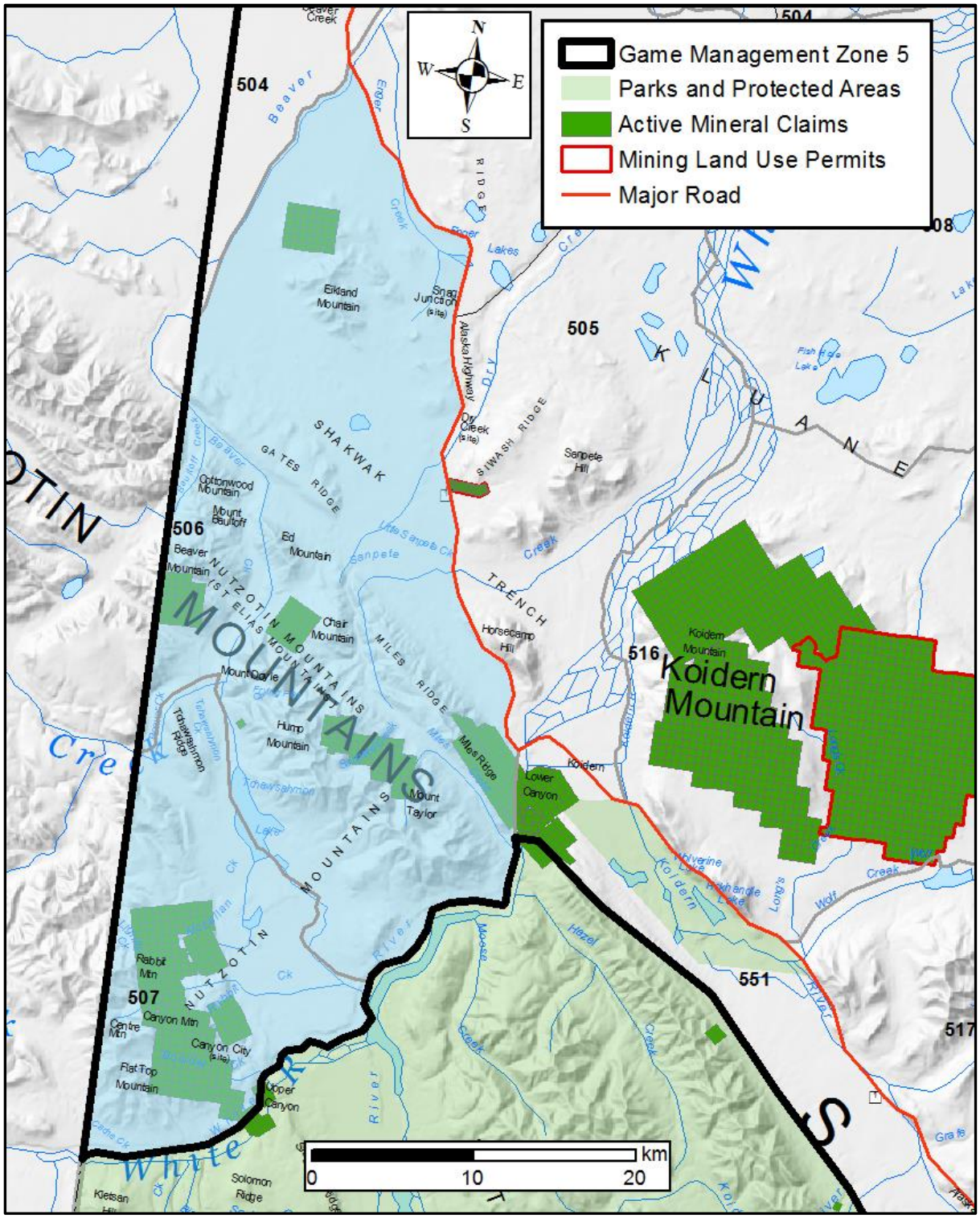

Figure 9. Location of the Nutzotin (GMS 5-06) and Flat Top (GMS 5-07) management units.

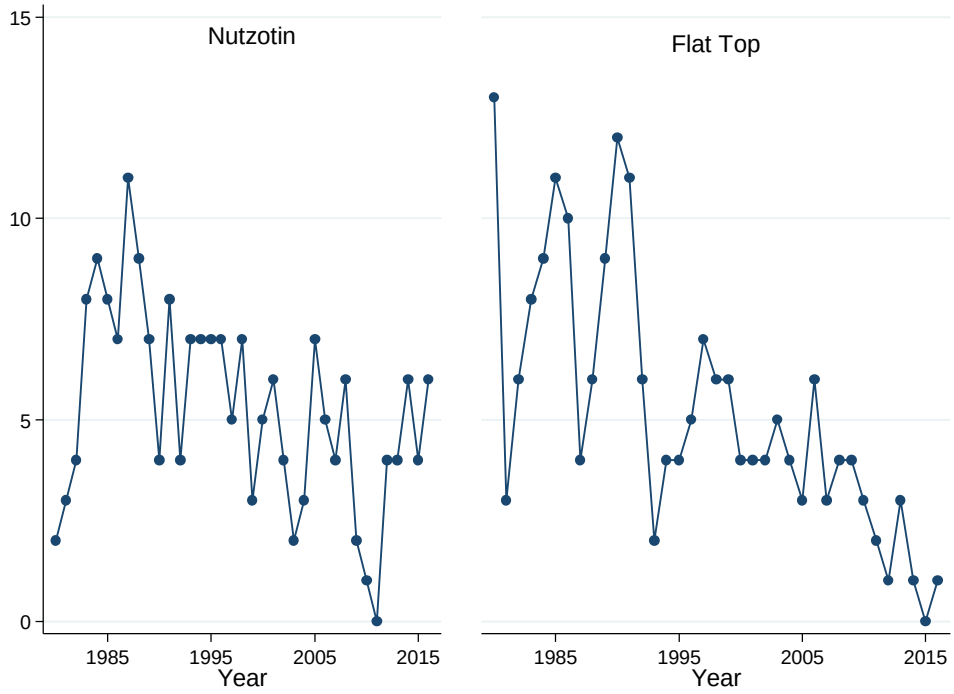

Figure 11. Long-term (1980 to 2016) licensed sheep harvest in the Nutzotin and Flat Top management units.

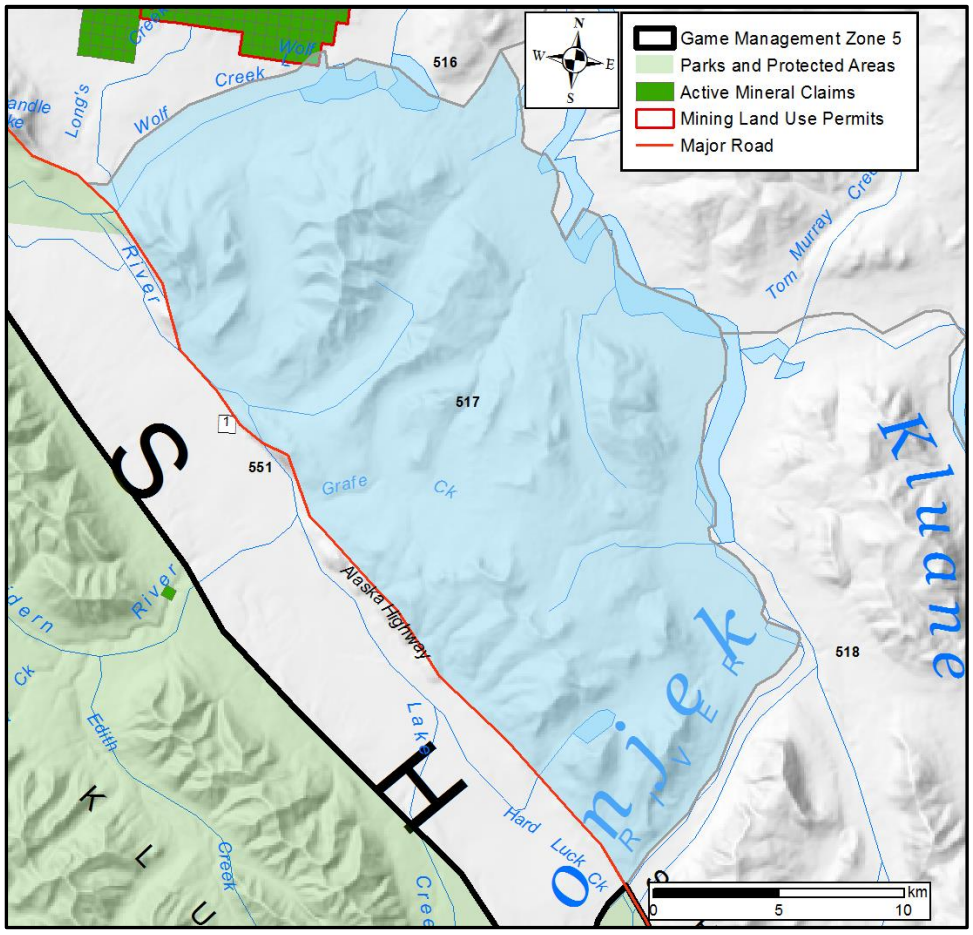

Figure 12. Location of the Donjek management unit.

Donjek (Game Management Subzone 5-17)

The Donjek management unit, named after the Donjek River adjacent to it, consists of GMS 5-17 (Figure 13). Closure is obtained by the Alaska Highway (and Shakwak Trench) to the south and west. To the north is generally unsuitable sheep habitat except perhaps along the southern boundary areas of GMSs 5-15 and 5-16. The ram:nursery sheep ratio is slightly lower than expected for a biological population, suggesting either rams were missed during the survey, or closure to the north is weak (Table 5). Historical non-lamb counts are generally lower with that observed in 2015 (Table 6). The sparseness of historical survey data and lack of movement data make a definitive assessment of unit boundaries difficult. GMSs 5-15 and 5-16 were not surveyed in 2015 as they were deemed low priority subzones due to lack of sheep during previous surveys and low harvest levels. It is possible that sheep belonging to the Donjek management unit occur there.

Since 1980, two sheep have been harvested by licensed hunters in GMS 5-15 and three in 5-16 and no sheep were observed in either GMS in 1974 (Hoefs 1975). Harvested sheep were generally taken along GMZ boundaries on the Donjek and Kluane Rivers.

The current annual average licensed harvest rate for the Donjek unit is 3.6%, with recent harvest being relatively variable (Table 7). The unit is bordered by the Alaska Highway and is accessed via both the Donjek and Kluane Rivers.

Table 5. 2015 survey results for the Donjek management unit.

	GMS 5-17
Non-lamb count	83
Lamb:nursery sheep ratio	35:100
Ram:nursery sheep ratio	26:100

Table 6. Historical summer survey results for the Donjek management unit.

	Non-lamb count			Ram:nursery sheep ratio		
Area	2015	1993	1974	2015	1993	1974
GMS 5-17	83	52	24	26:100	37:100	118:100

Table 7. Licensed sheep harvest in the Donjek management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-17	0	5	0	5	5

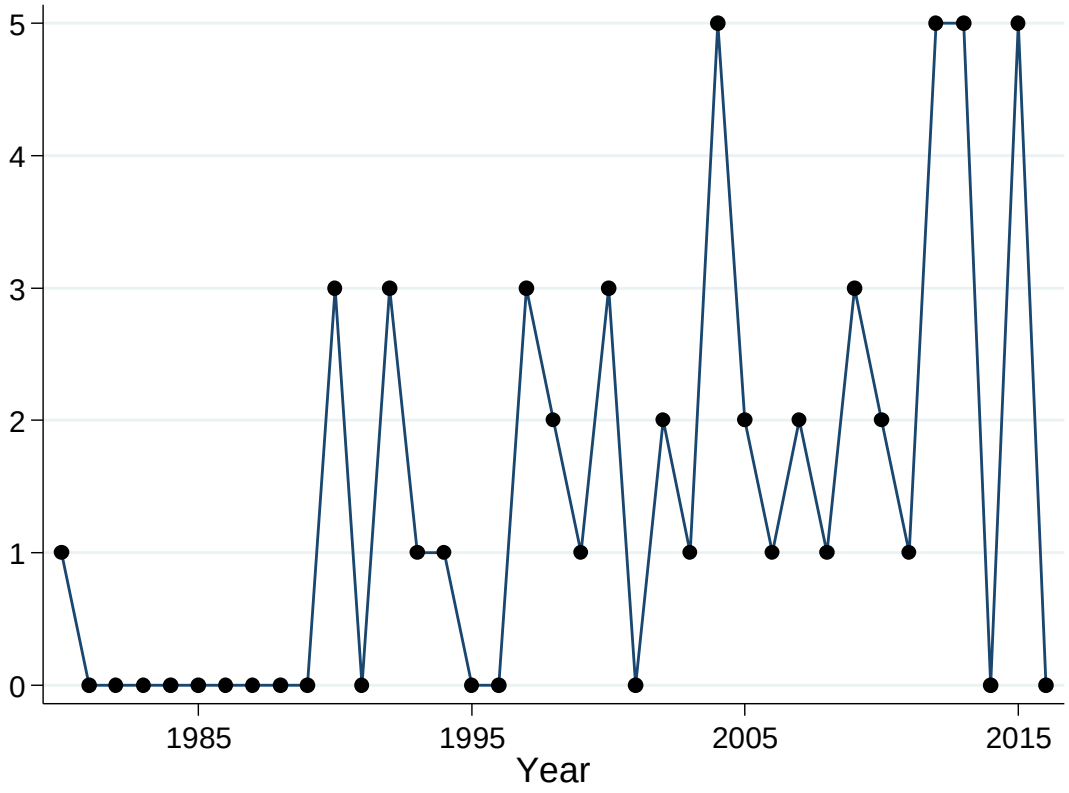

Figure 13. Long-term (1980 to 2016) licensed sheep harvest in the Donjek management unit.

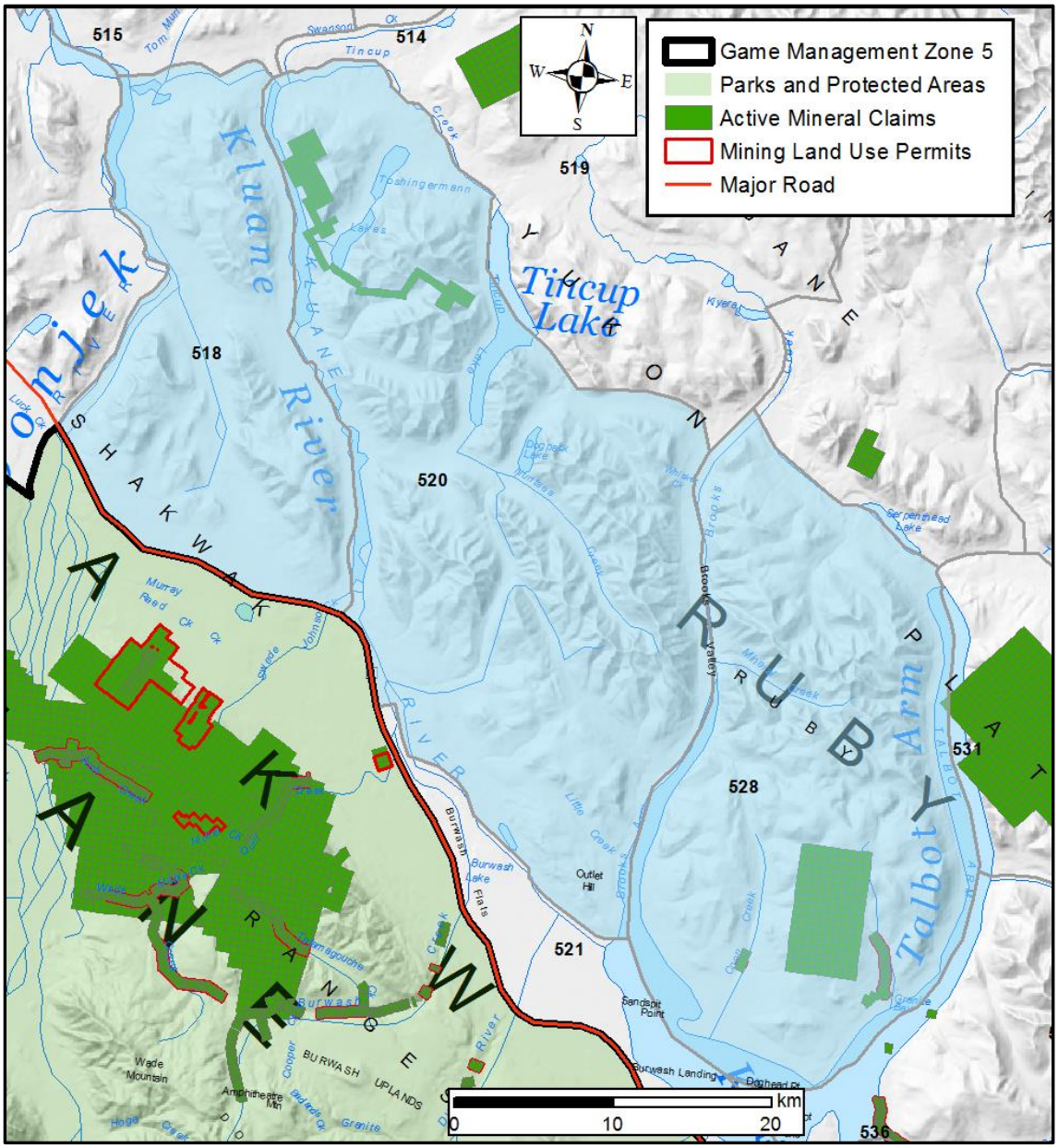

Figure 14. Location of the Brooks Arm management unit.

Brooks Arm (Game Management Subzones 5-18, 5-20 and 5-28)

The Brooks Arm management unit consists of GMSs 5-18, 5-20 and 5-28, and includes the Brooks Arm of Kluane Lake (Figure 15). Closure for this unit is obtained by Talbot Arm to the east, the Donjek River to the west, and the Shakwak Trench and Kluane Lake to the south. To the north are lower elevation areas not typically suitable for sheep. The unit has some active mineral claims within it (Figure 15), but the majority of these are outside of areas where sheep have historically been observed.

Sheep were surveyed in this unit in 2015 (Table 8). Historical survey data for GMSs 5-18 and 5-20 are considerably sparser than for GMS 5-28 (Table 9). Non-lamb sheep numbers within GMS 5-28 have been highly variable over time, although for many previous surveys GMSs 5-18 and 5-20 were not concurrently surveyed (Table 9). The two most recent surveys (from 2015 and 2011) are identical in terms of non-lamb numbers in GMS 5-28 (Table 9). It is not known if numbers have truly declined in this unit since the late 1990s or if sheep were missed. However, the reduced numbers of sheep in this unit compared to the 1990s and earlier appears substantive (Table 9).

The current licensed harvest rate for this unit is 5.1%, above the recommended guideline of 4%. Harvest in GMS 5-28 has generally been consistent over the past several years, while in GMS 5-20 it has increased since the 2000s (Table 10; Figure 16). Licensed harvest in GMS 5-18 has generally declined since the 1980s (Figure 16).

Table 8. 2015 survey results for the Brooks Arm management unit.

	GMS 5-18	GMS 5-20	GMS 5-28	Combined
Non-lamb count	13	75	119	207
Lamb:nursery sheep ratio	N/A	36:100	38:100	37:100
Ram:nursery sheep ratio	N/A	60:100	42:100	58:100

Table 9. Historical summer survey results for the Brooks Arm management unit.

	Non-lamb count				Ram:nursery sheep ratio			
Year	GMS 5-18	GMS 5-20	GMS 5-28	Combined	GMS 5-18	GMS 5-20	GMS 5-28	Combined
2015	13	75	119	207	N/A	60:100	42:100	58:100
2011	-	-	119	-	-	-	87:100	-
1998	-	-	313	-	-	-	11:100	-
1997	-	-	272	-	-	-	52:100	-
1996	-	-	122	-	-	-	74:100	-
1993	22	68	190	280	267:100	152:100	77:100	100:100
1991	-	21	-	-	-	5:100	-	-

1989	-	-	363	-	-	-	38:100	-
1986	-	-	306	-	-	-	69:100	-
1985	-	-	338	-	-	-	63:100	-
1984	-	-	377	-	-	-	57:100	-
1983	-	-	284	-	-	-	63:100	-
1982	-	-	285	-	-	-	32:100	-
1980	-	-	261	-	-	-	35:100	-
1974	58	201	129	330	32:100	38:100	24:100	34:100

Table 10. Licensed sheep harvest in the Brooks Arm management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-18	0	1	4	0	0
GMS 5-20	3	6	4	4	5
GMS 5-28	5	6	4	8	3
Combined	8	13	12	12	8

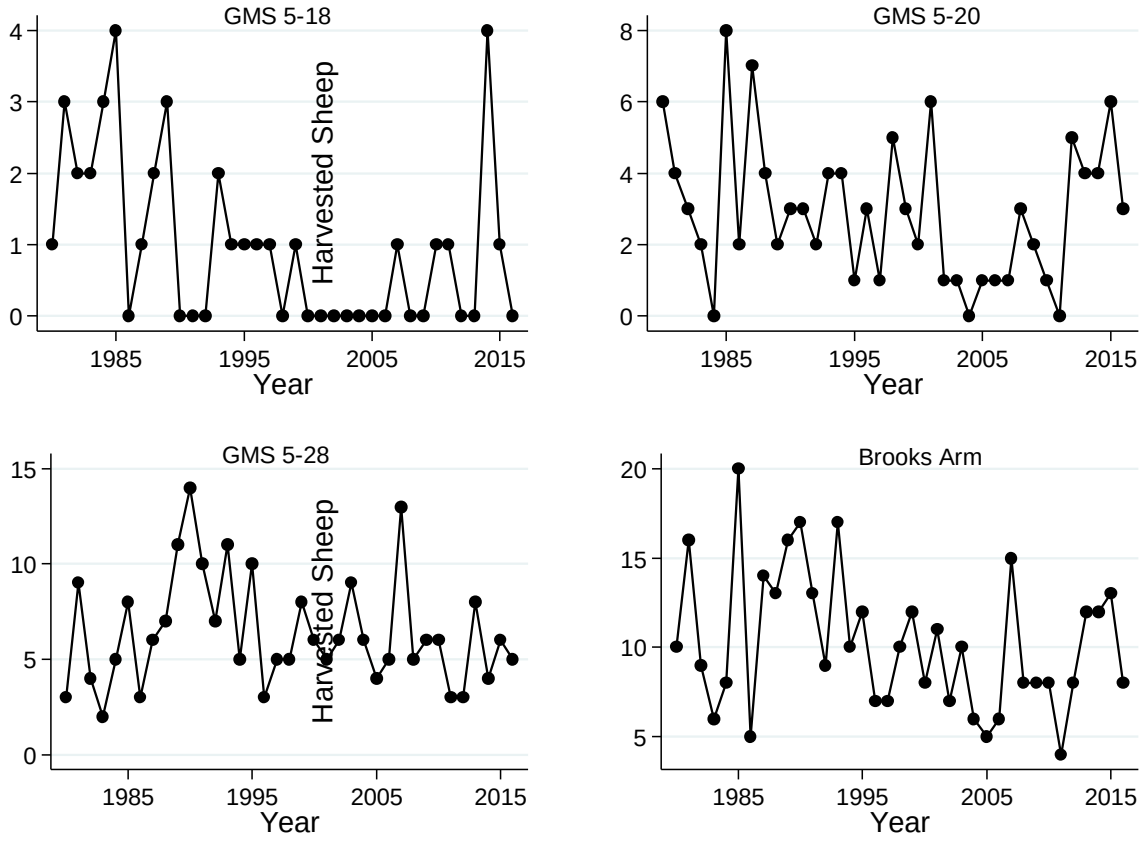

Figure 15. Long-term (1980 to 2016) licensed sheep harvest in the Brooks Arm management unit.

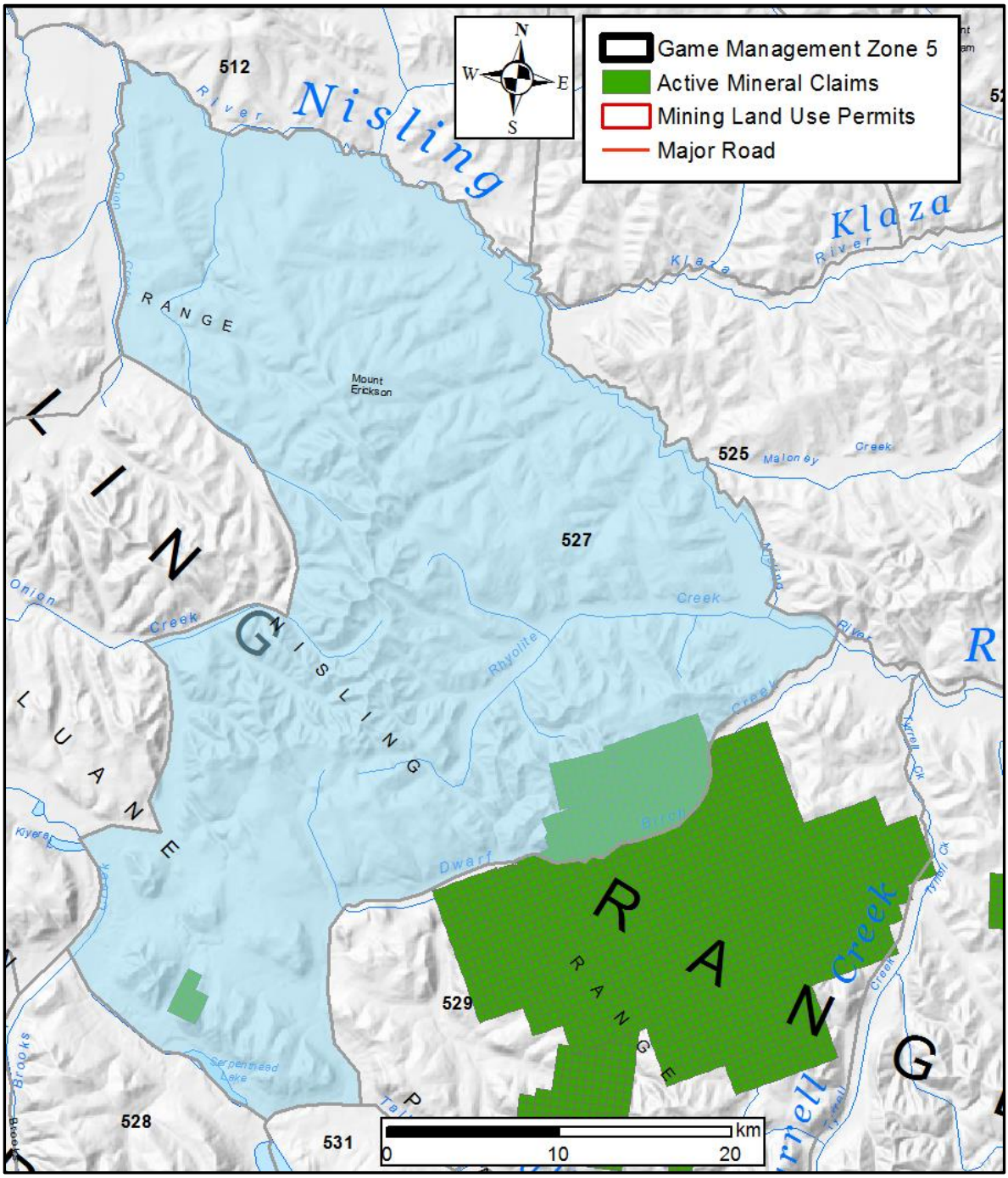

Figure 16. Location of the Rhyolite management unit.

Rhyolite (Game Management Subzone 5-27)

The Rhyolite management unit, named after the creek running through the unit, is a relatively isolated block from sheep found to the south in the Brooks Arm unit, and sheep to the east along the Nisling River (Figure 17). Sheep numbers in this unit are lower than surrounding units (Table 11), possibly due to lower amounts of suitable habitat. The only previous survey in this area was from 1974 (Hoefs 1975). During that survey, an area representing both GMSs 5-19 and 5-27 were surveyed together. This total survey block from 1974 yielded a count of 75 non-lambs (Table 12). Given the high ram:nursery sheep ratio observed in 2016 (Table 11), it is likely that some nursery sheep were missed during the survey, thus the current non-lamb count should be viewed cautiously. Sheep are generally

widely distributed across this unit and missing a single nursery group would not be unlikely. The unit is not as accessible as other units within GMZ 5. Mineral exploration is low, with active mineral claims primarily located along its eastern edge on Dwarf Birch Creek (Figure 17). Current licensed harvest in this unit is low (Table 13), with an average annual harvest rate of 0.4%.

Table 11. 2016 survey results for the Rhyolite management unit.

	GMS 5-27
Non-lamb count	48
Lamb:nursery sheep ratio	30:100
Ram:nursery sheep ratio	74:100

Table 12. Historical summer survey results for the Rhyolite management unit.

	Non-lamb count		Ram:nursery sheep ratio	
Area	2016	1974[a]	2016	1974[a]
GMS 5-27	48	75	74:100	36:100

Table 13. Licensed sheep harvest in the Rhyolite management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-27	0	0	0	0	1

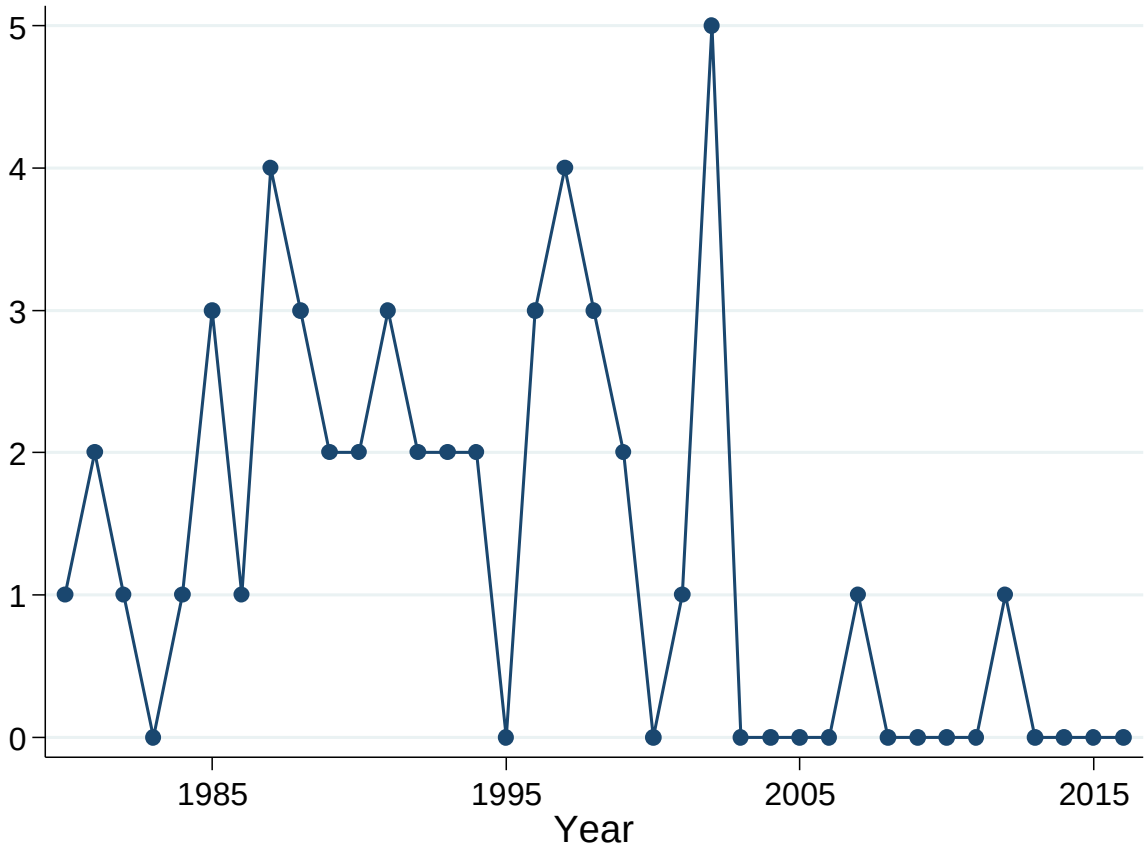

Figure 17. Long-term (1980 to 2016) licensed sheep harvest in the Rhyolite management unit.

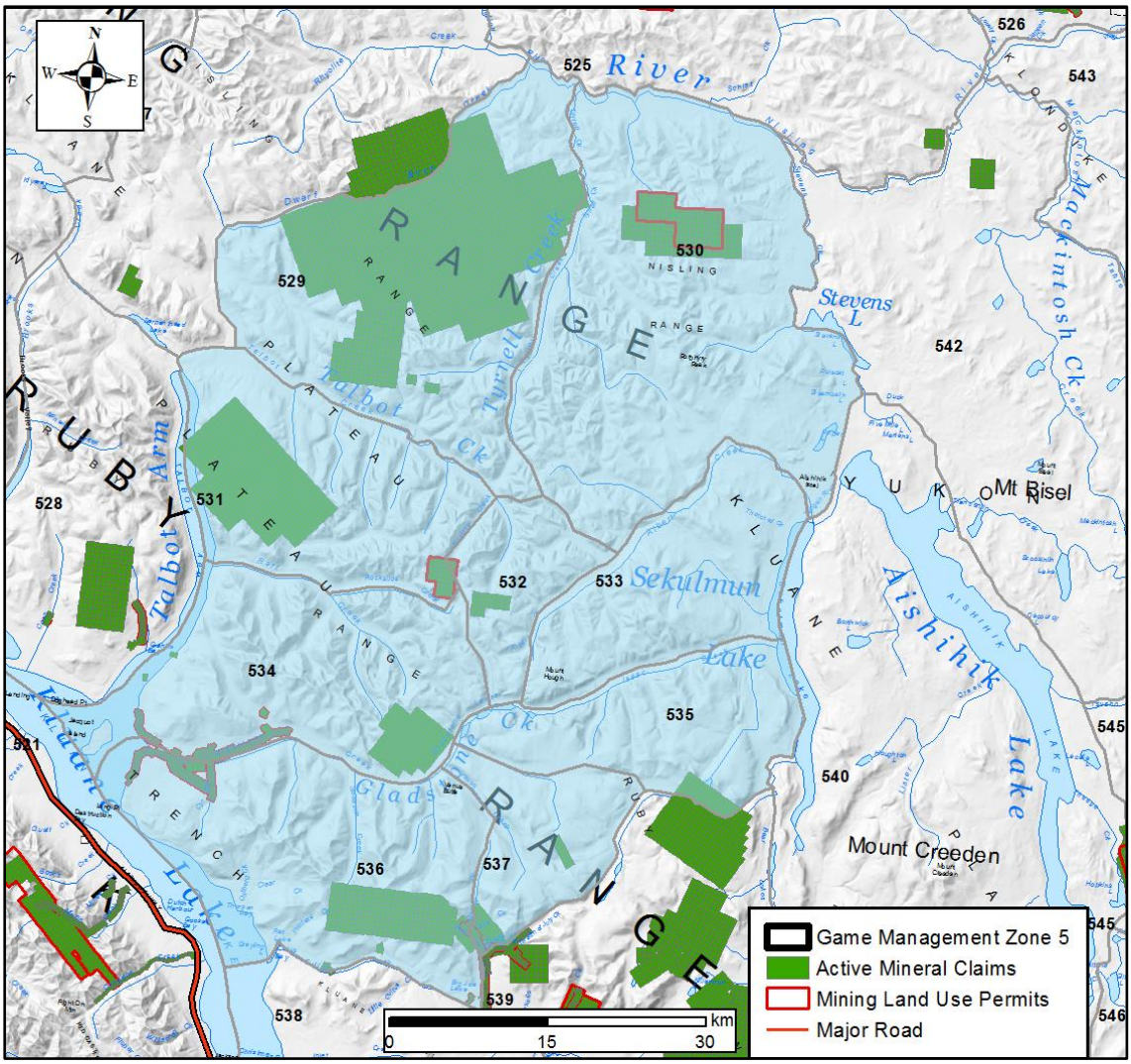

Figure 18. Location of the Ruby Range management unit.

Ruby Range (Game Management Subzones 5-29 to 5-37)

The Ruby Range management unit, located between Kluane Lake and Sekulmon Lake (Figure 19), has some of the highest numbers of sheep in Yukon (Table 14). Closure is weak across GMS boundaries, supporting creation of one large management unit. It is also one of the most frequently surveyed areas with many surveys having taken place since 1974 (Table 15). A unit-wide assessment of trend is unavailable due to the lack of comprehensive historical surveys (Table 15). However, sheep numbers in the GMSs surveyed most frequently appear to have declined since the 1980s. This spurred the creation of the Ruby Range Sheep Steering Committee in the mid-1990s to address local concerns. Current non-lamb numbers in the unit are roughly 10% higher than the only previous comprehensive survey of these GMSs conducted in 1993. There is considerable exploration activity (quartz and placer) throughout the unit (Figure 19).

Recent surveys in this unit occurred between 2014 and 2016 (Table 14; Figure 19). Not all areas of the management unit were surveyed each year. Given likely movements across GMS boundaries, identifying a reliable non-lamb count and population status is challenging. Monitoring efforts that endeavour to cover the entire management unit continuously would be helpful in avoiding issues of animal movements and double-counting. The

average annual licensed harvest rate of the Ruby Range unit is 2%, which is within recommended harvest guidelines. Since the late 1980s, licensed harvest in the Ruby Range unit has been demonstrating a declining trend (Table 16; Figure 20). In 1990, a regulation was enacted prohibiting the use of any vehicle for the purpose of hunting in GMSs 5-36 and 5-37, except on designated major routes. In 1999, this ban was extended to include GMS 5-34.

Table 14. 2014 thru 2016 survey results for the Ruby Range management unit.

	Non-lamb count	Lamb:nursery sheep ratio	Ram:nursery sheep ratio
GMS 5-29 [c]	16	N/A	N/A
GMS 5-30 [c]	5	20:100	0:100
GMS 5-31 [a]	198	22:100	57:100
GMS 5-32 [a]	113	21:100	35:100
GMS 5-33 [c]	122	38:100	45:100
GMS 5-34 [a]	76	24:100	81:100
GMS 5-35 [c]	42	20:100	110:100
GMS 5-36 [b]	203	24:100	39:100
GMS 5-37 [b]	28	46:100	0:100
Combined	803	26:100	50:100

a: 2014 results; b: 2015 results; c: 2016 results

Table 15. Historical summer survey results (a: non-lamb counts; b: ram:nursery sheep ratios) for the Ruby Range management unit.

A)

Year	GMS 5-29	GMS 5-30	GMS 5-31	GMS 5-32	GMS 5-33	GMS 5-34	GMS 5-35	GMS 5-36	GMS 5-37	Combined
2016	16	5	-	-	122	-	42	-	-	-
2015	-	-	-	-	-	-	-	203	28	-
2014	-	-	198	113	20	76	28	180	-	-
2011	-	-	216	62	122	201	107	137	17	-
2007	-	23	301	105	36	121	80	196	-	-
2004	-	-	273	120	-	-	-	124	-	-
2001	-	-	134	74	111	119	53	98	-	-
1999	10	17	-	117	148	-	47	-	53	-
1998	-	-	192	-	-	163	-	170	-	-
1997	-	-	236	-	-	189	23	106	-	-
1996	-	-	115	81	-	99	49	143	-	-

1995	-	-	205	-	-	117	-	168	-	-
1994	-	-	103	-	-	153	-	87	-	-
1993	16	4	196	52	139	125	46	78	9	665
1992	-	-	267	-	-	112	-	195	-	-
1989	-	-	185	-	-	129	-	121	-	-
1986	-	-	336	-	-	340	-	186	-	-
1985	-	-	334	-	-	292	-	250	-	-
1984	-	-	376	-	-	252	-	370	-	-

B)

Year	GMS 5-29	GMS 5-30	GMS 5-31	GMS 5-32	GMS 5-33	GMS 5-34	GMS 5-35	GMS 5-36	GMS 5-37	Combined
2016	N/A	0	-	-	45:100	-	110:100	-	-	-
2015	-	-	-	-	-	-	-	39:100	0	-
2014	-	-	60:100	35:100	17.64:100	81:100	3.7:100	36.54:100	-	-
2011	-	-	89:100	77:100	14:100	47:100	26:100	49:100	0	-
2007	-	0	31:100	289:100	24	46:100	11	39:100	-	-
2004	-	-	43:100	35:100	-	-	-	59.4:100	-	-
2001	-	-	179:100	57:100	39:100	63:100	29	56:100	-	-
1999	150:100	0	-	89:100	47:100	-	96:100	-	43:100	-
1998	-	-	64:100	-	-	70:100	-	52:100	-	-
1997	-	-	64:100	-	-	41:100	-	58:100	-	-
1996	-	-	61:100	23100	-	60:100	20:100	57:100	-	-
1995	-	-	33:100	-	-	35:100	-	42:100	-	-
1994	-	-	94:100	-	-	68:100	-	112:100	-	-
1993	N/A	N/A	47:100	79:100	36:100	140:100	48:100	39:100	N/A	65:100
1992	-	-	46:100	-	-	72:100	-	60:100	-	-

1989	-	-	109:100	-	-	82:100	-	90:100	-	-
1986	-	-	94:100	-	-	140:100	-	98:100	-	-
1985	-	-	83:100	-	-	80:100	-	52:100	-	-
1984	-	-	116:100	-	-	103:100	-	58:100	-	-

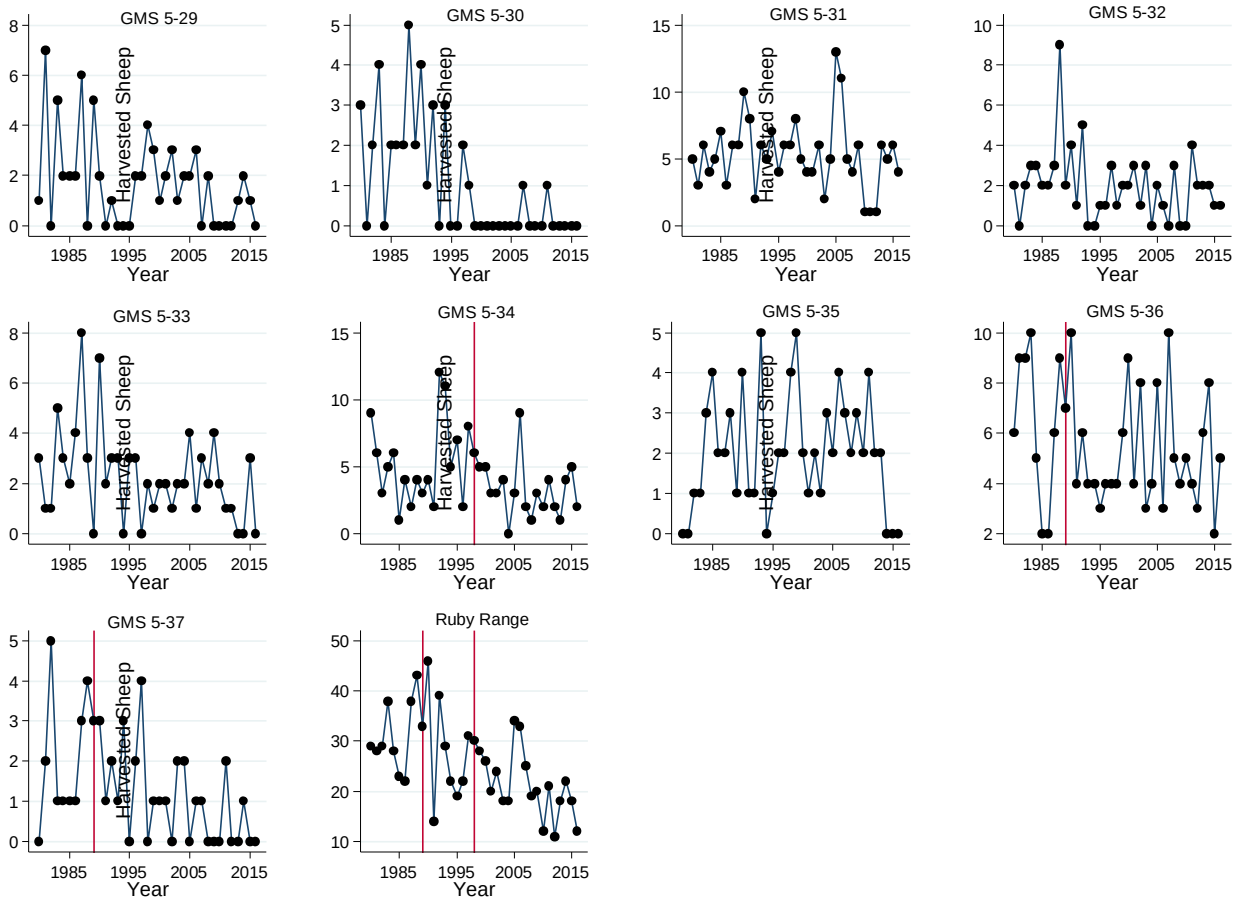

Figure 20. Long-term (1980-2016) licensed sheep harvest in the Ruby Range management unit. The red vertical lines indicate the years in which vehicle restrictions were implemented for harvesting activities in GMSs 5-34, 5-36, and 5-37.

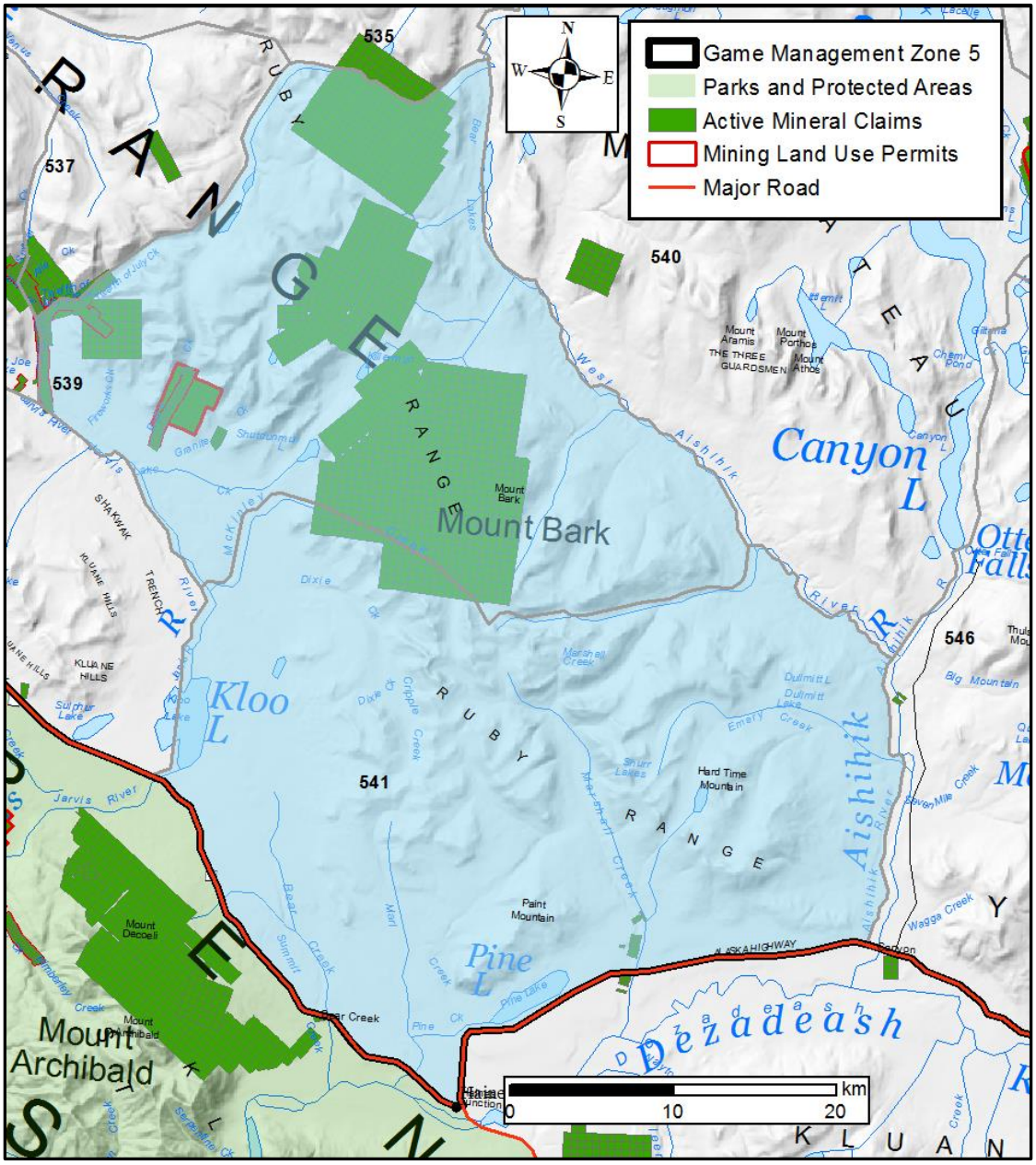

Figure 20. Location of the Killermun management unit.

Killermun (Game Management Subzones 5-39 and 5-41)

The Killermun management unit, named after Killermun Lake, consists of GMSs 5-39 and 5-41 (Figure 21). It is bordered by the West Aishihik River to the east, the Alaska Highway to the south, the Jarvis River to the west, and Twelfth of July Creek to the north. Geographic closure of this unit is weakest along its northern edge. The observed ram:nursery sheep ratio for the combined unit is lower than expected, while each GMS on their own had observed ratios not deemed biologically reasonable (Table 17). There is considerable mineral exploration activity in the unit, particularly in GMS 5-39 (Figure 21). Based on current and historical survey data, sheep presence is maintained in GMS 5-39 and GMS 5-41 (Tables 17, 18). The number of sheep occurring in in GMS 5-41 appears to have declined significantly (i.e., by more than

33%) since the 1980s and 1990s (Table 18).

The current annual average licensed harvest rate for this unit is 2.8%. Licensed harvest has declined since the late 1980s (Table 19; Figure 22). In 1990 the use of vehicles for the purpose of hunting was prohibited in GMS 5-39, except along major designated routes.

Table 16. 2015 survey results for the Killermun management unit.

	GMS 5-39	GMS 5-41	Combined
Non-lamb count	170	23	193
Lamb:nursery sheep ratio	46:100	55:100	47:100
Ram:nursery sheep ratio	23:100	109:100	30:100

Table 17. Historical summer survey results for the Killermun management unit (a: non-lamb counts; b: ram:nursery sheep ratios).

A)

	Non-lamb count					
Area	2015	2011	1999	1993	1989	1974
GMS 5-39	170	115	256	214	330	330
GMS 5-41	23	16	30	34	-	52
Combined	193	126	288	296	-	382

B)

	Ram:nursery sheep ratio					
Area	2015	2011	1999	1993	1989	1974
GMS 5-39	23:100	64:100	31:100	35:100	39:100	50:100
GMS 5-41	109:100	N/A	87.5:100	386:100	-	420:100
Combined	30:100	68:100	35:100	47:100	-	66:100

Table 18. Licensed sheep harvest in the Killermun management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-39	4	4	6	6	1
GMS 5-41	1	2	1	1	1
Combined	5	6	7	7	2

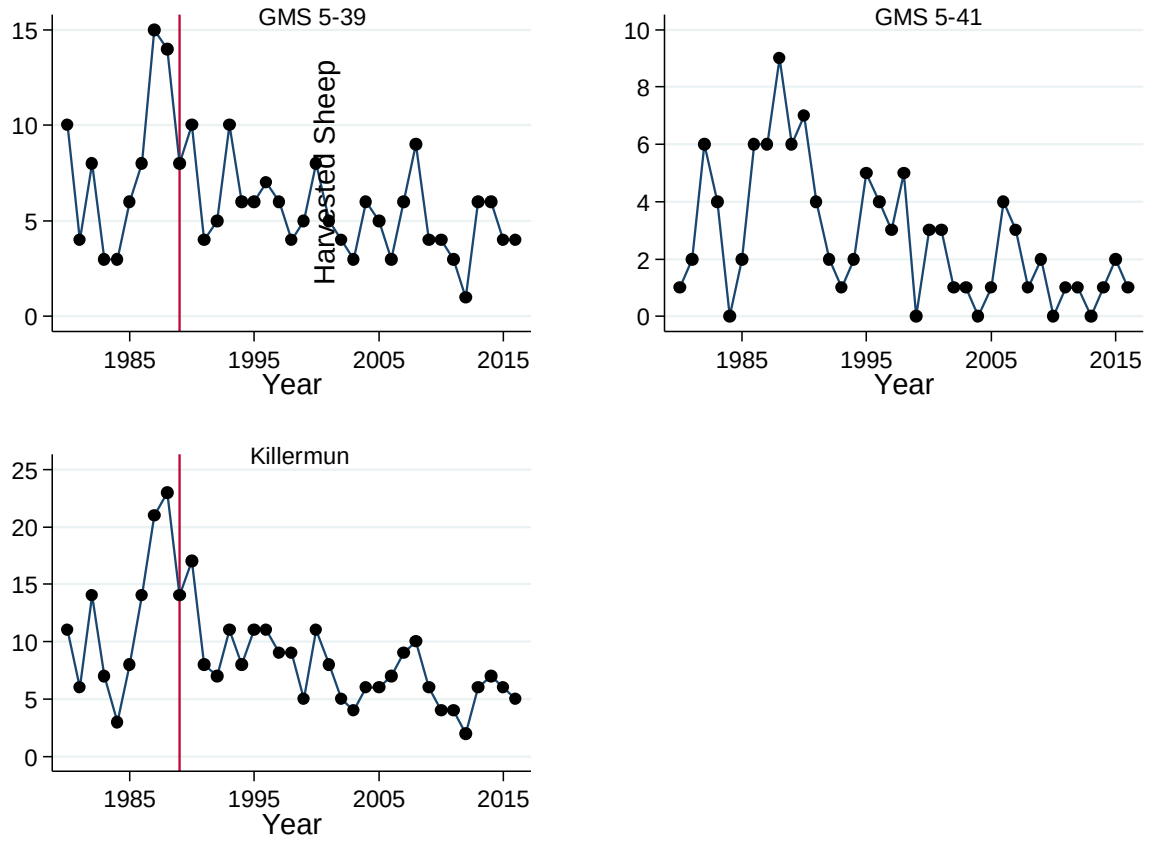

Figure 21. Long-term (1980 to 2016) licensed sheep harvest in the Killermun management unit. The red vertical lines indicate the year in which vehicle restrictions were implemented for harvesting.

activities in GMS 5-39.

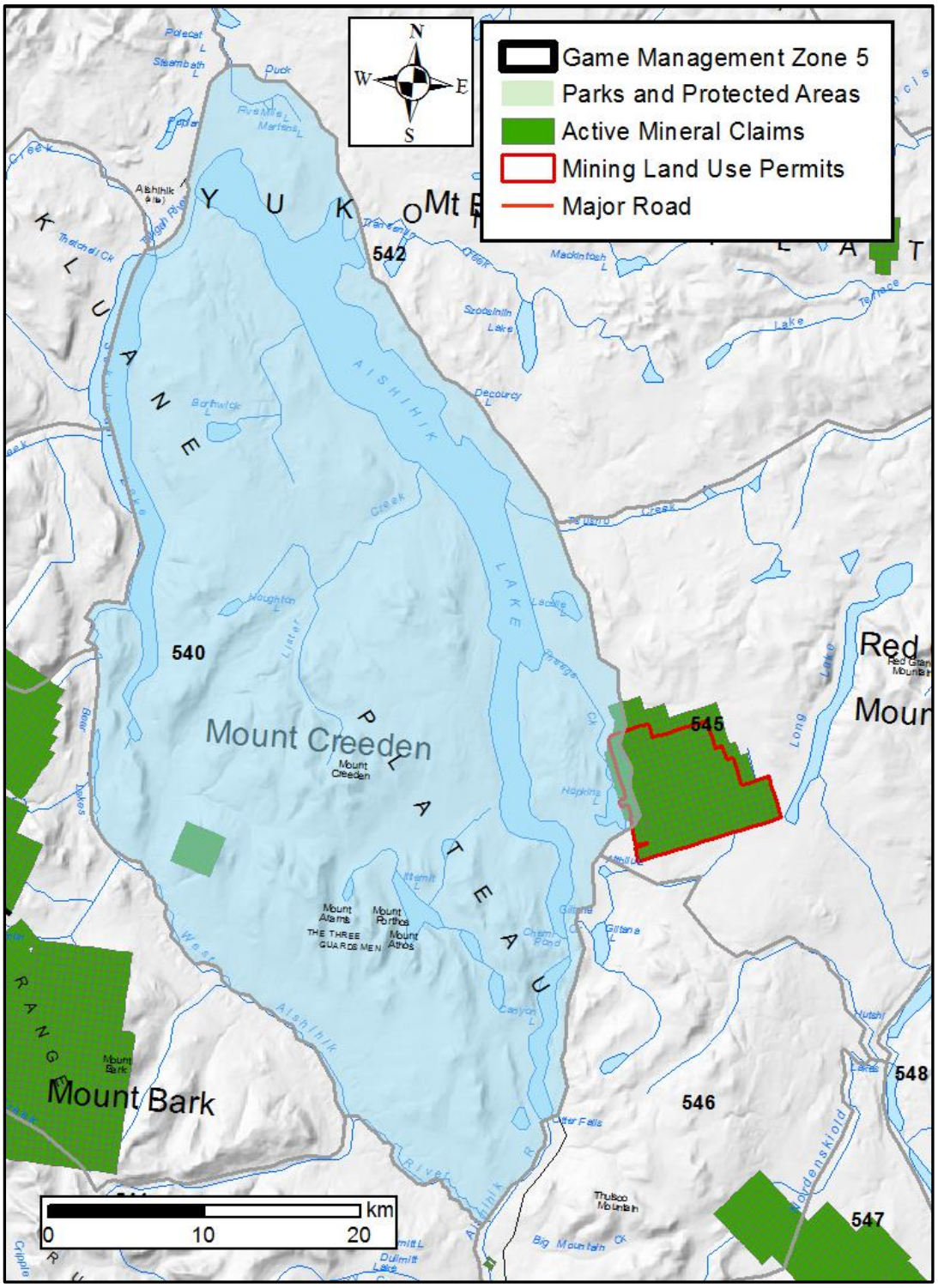

Figure 22. Location of the Three Guardsmen management unit.

Three Guardsmen (Game Management Subzone 5-40)

The Three Guardsmen management unit, consisting of GMS 5-40, is bounded on its west by Sekulmon Lake and the West Aishihik River, and on its east by Aishihik Lake and the Aishihik River (Figure 23). The unit is named after the three peaks

located in the southern portion of the subzone. The unit was surveyed in 2015 (Table 20). Mineral exploration is minimal in the unit (Figure 23). Observed sheep numbers in 2015 were lower than 2011, which was the highest recorded non-lamb count, but similar to those observed in 1993 (Table 21). However, given the lower than expected ram:nursery sheep ratio in 2015 compared to 2011, it appears likely that some rams were missed during the 2015 survey.

Based on 2015 survey numbers, the average annual licensed harvest rate in the Three Guardsmen unit is 2.1%. Licensed harvest in this unit has been relatively stable since the mid-1980s (Table 22; Figure 24).

Table 19. 2015 survey results for the Three Guardsmen management unit.

	GMS 5-40
Non-lamb count	143
Lamb:nursery sheep ratio	27:100
Ram:nursery sheep ratio	24:100

Table 20. Historical summer survey results for the Three Guardsmen management unit (a: non-lamb counts; b: ram:nursery sheep ratios).

A)

	Non-lamb count				
Area	2015	2011	1999	1993	1974
GMS 5-40	143	105	172	147	140

B)

	Ram:nursery sheep ratio				
Area	2015	2011	1999	1993	1974
GMS 5-40	24:100	50:100	52:100	37:100	40:100

Table 21. Licensed sheep harvest in the Three Guardsmen management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-17	4	0	4	3	4

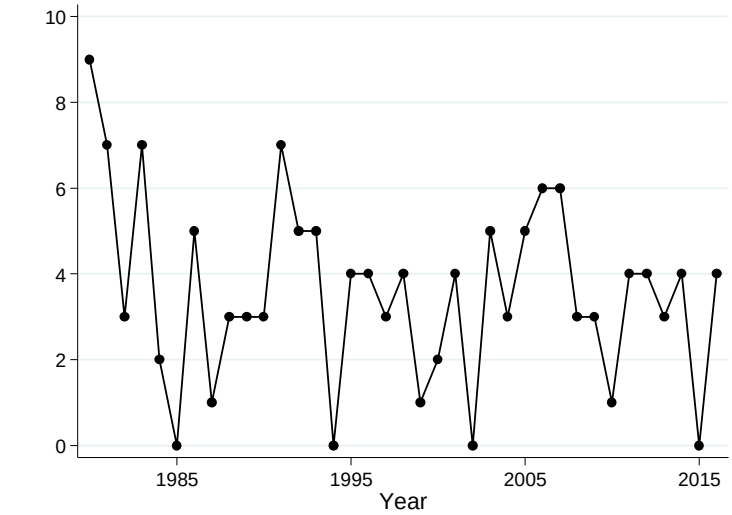

Figure 23. Long-term (1980 to 2016) licensed harvest in the Three Guardsmen management unit.

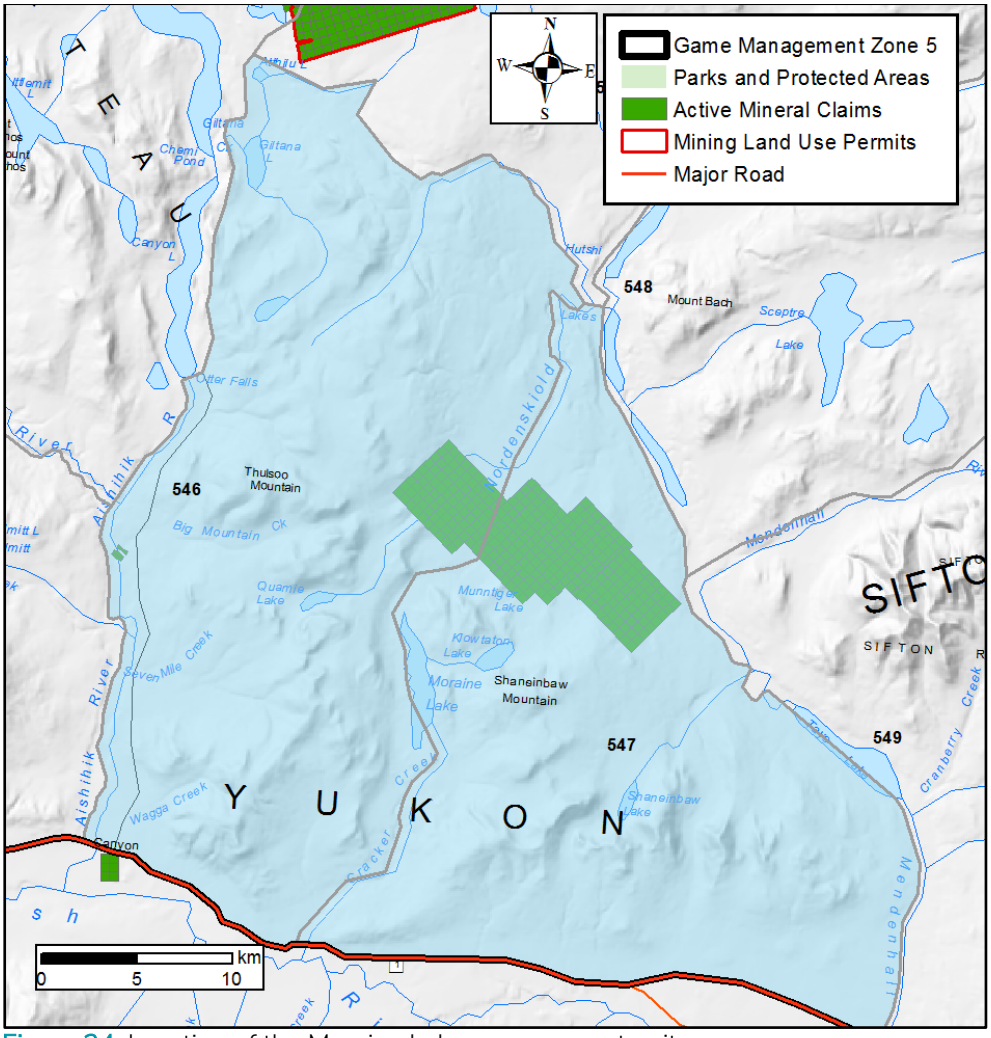

Figure 24. Location of the Moraine Lake management unit.

Moraine Lake (Game Management Subzones 5-46 and 5-47)

The Moraine Lake management unit (Figure 25), named after Moraine Lake located along the border of GMSs 5-46 and 5-47, is roughly bordered by the Alaska Highway to the south, the Aishihik River to the west, Taye Lake and the Mendenhall River to the east, and low-lying areas to the north. The weakest geographic closure in this unit is in the north of GMS 5-46. Given its proximity to both the Alaska Highway and the Aishihik Road, access to this unit is relatively high. There is one block of mineral exploration (Figure 25) located in the northern portion of the unit, generally outside of sheep habitat.

Sheep numbers are generally evenly distributed between the two GMSs (Table 23). Sheep in this unit have been surveyed relatively often (Table 24).

The current observed numbers are the highest recorded since the early-1980s, although ram:nursery sheep ratios are lower than what is expected for a moderately harvested population.

The current average annual licensed harvest rate of this unit is 2.4%, with licensed harvest being relatively stable since 1980 (Table 25; Figure 26).

Table 22. 2015 survey results for the Moraine Lake management unit.

	GMS 5-46	GMS 5-47	Combined
Non-lamb count	64	54	118
Lamb:nursery sheep ratio	32:100	50:100	40:100
Ram:nursery sheep ratio	28:100	29:100	28:100

Table 23. Historical summer survey results for the Moraine Lake management unit.

	Non-lamb counts			Ram:nursery sheep ratios		
Year	**GMS 5-46**	**GMS 5-47**	**Combined**	**GMS 5-46**	**GMS 5-47**	**Combined**
2015	64	54	118	28:100	29:100	28:100
2011	104	54	158	51:100	35:100	45:100
2009	54	24	78	54:100	118:100	70:100
1999	27	76	103	59:100	31:100	37:100
1994	42	42	84	68:100	17:100	38:100
1993	48	33	81	100:100	32:100	65:100
1984	-	62	-	-	22:100	-
1983	-	57	-	-	27:100	-
1982	114	41	155	61:100	24:100	49:100
1981	94	59	153	45:100	34:100	40:100
1980	43	51	94	26:100	28:100	27:100
1979	-	34	-	-	70:100	-
1978	-	49	-	-	36:100	-
1976	-	36	-	-	64:100	-
1974	91	38	129	98:100	41:100	77:100

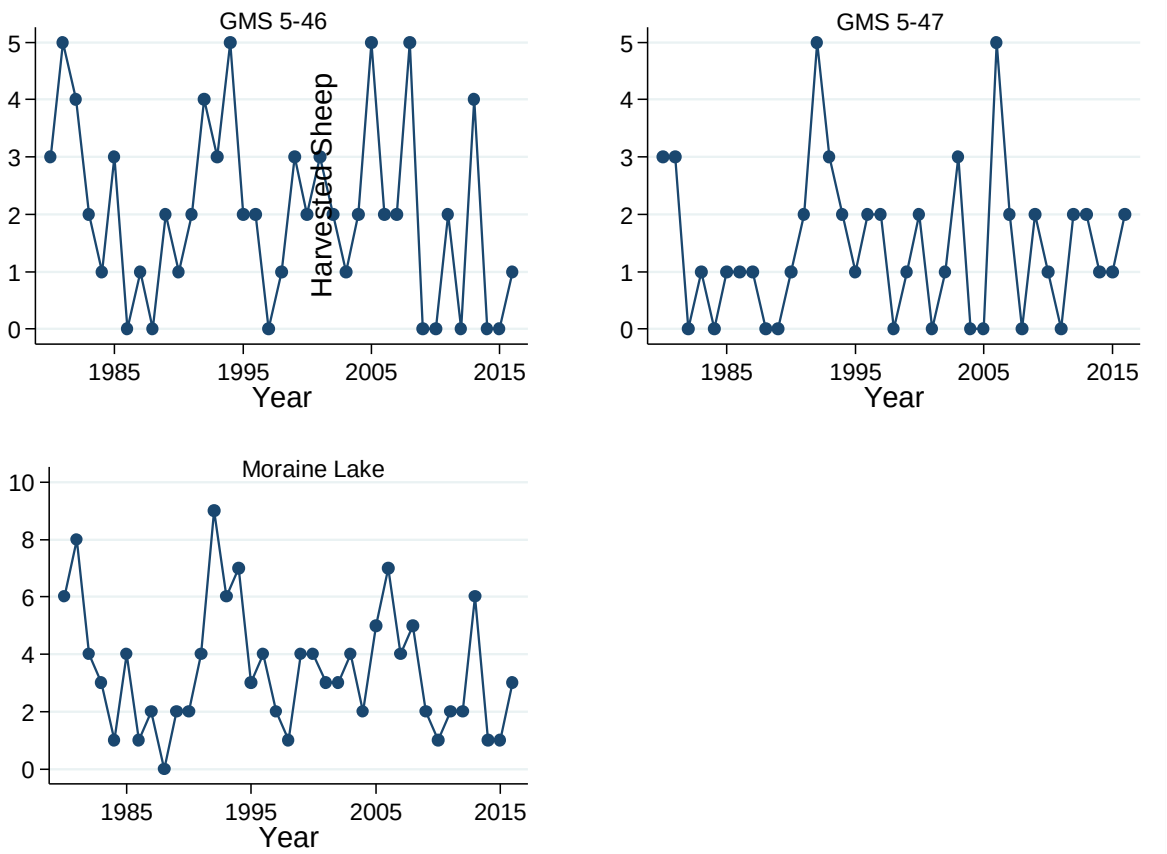

Figure 25. Long-term (1980 to 2016) licensed sheep harvest in the Moraine Lake management unit.

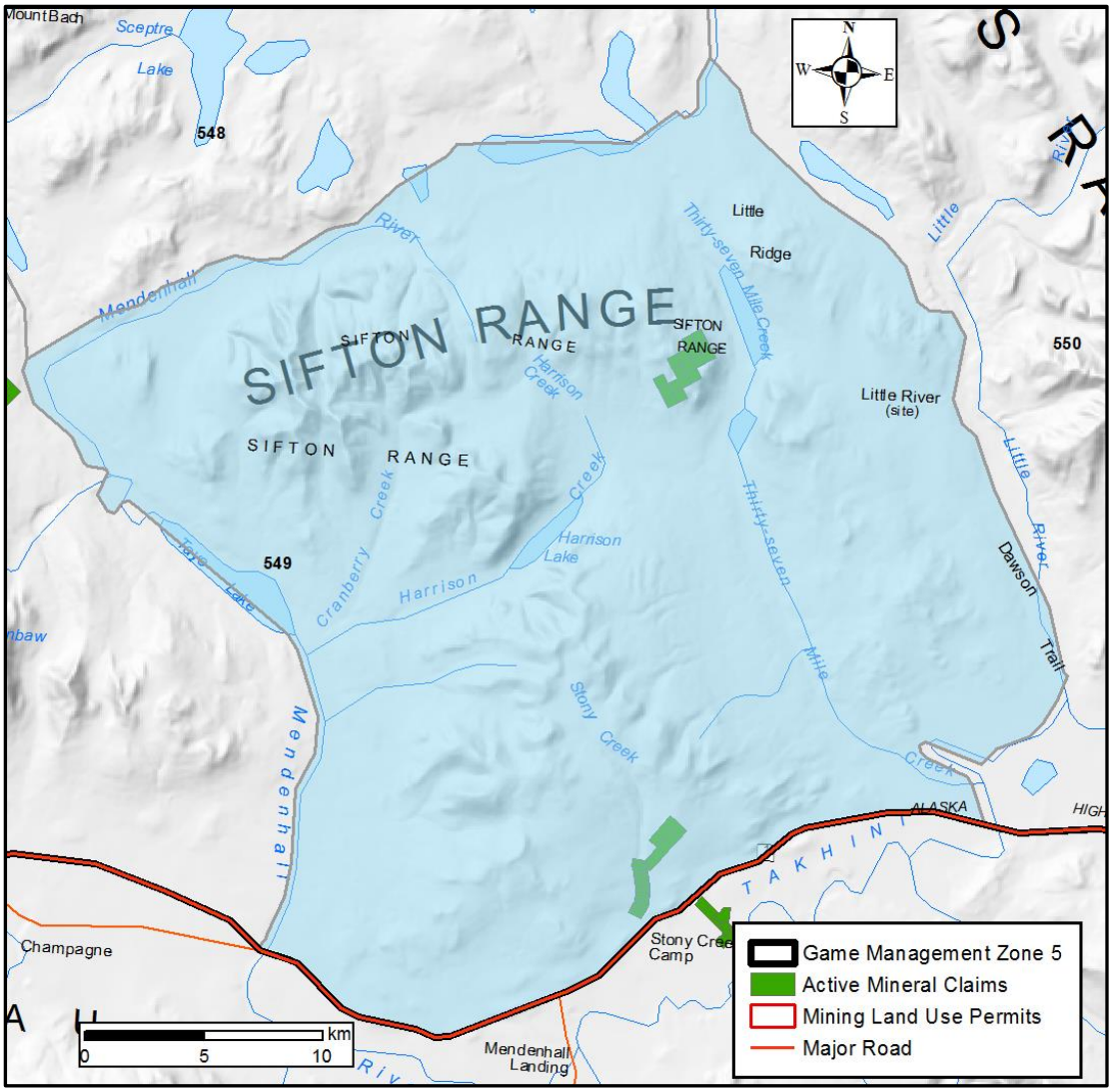

Figure 26. Location of the Sifton management unit.

Sifton (Game Management Subzone 5-49)

The Sifton management unit (Figure 27), named after the Sifton Range located in GMS 5-49, is a geographically isolated block bordered by the Alaska Highway to the south, Taye Lake and the Mendenhall River to the west, the Little River valley to the east, and the low-lying GMS 5-48 to the north. Sheep numbers observed in 2015 (Table 20) are one of the highest recorded (Table 21, Figure 27). Mineral exploration activity is low in this unit (Figure 27).

The current average annual licensed harvest rate in this unit is 2.7%, with no definitive change since 1980 (Table 22; Figure 28).

Table 24. 2015 survey results for the Sifton management unit.

Parameter	GMS 5-49
Non-lamb count	202
Lamb:nursery sheep ratio	44:100
Ram:nursery sheep ratio	33:100

Table 25. Historical summer survey results for the Sifton management unit.

	Non-lamb counts	Ram:nursery sheep ratios
Year	GMS 5-49	GMS 5-49
2015	202	33:100
2011	63	34:100
2009	155	45:100
1999	207	42:100
1994	185	53:100
1984	121	51:100
1983	152	31:100
1982	130	34:100
1981	193	42:100
1980	92	28:100
1979	97	29:100
1978	91	21:100
1976	79	68:100
1974	64	23:100

Table 26. Licensed sheep harvest in the Sifton management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-49	5	4	8	5	5

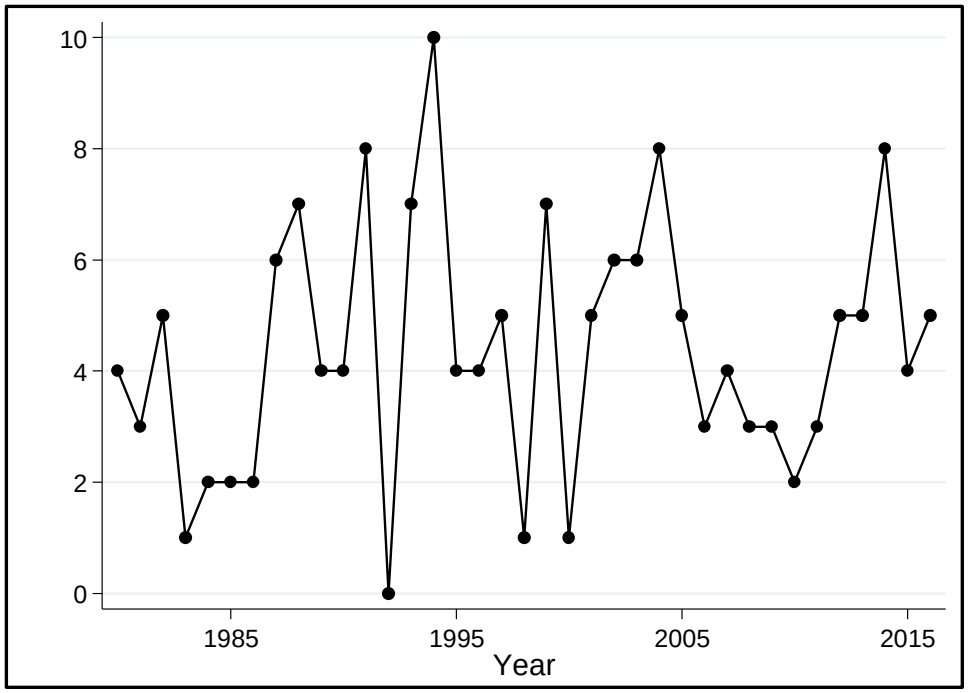

Figure 27. Long-term (1980 to 2016) licensed sheep harvest in the Sifton management unit.

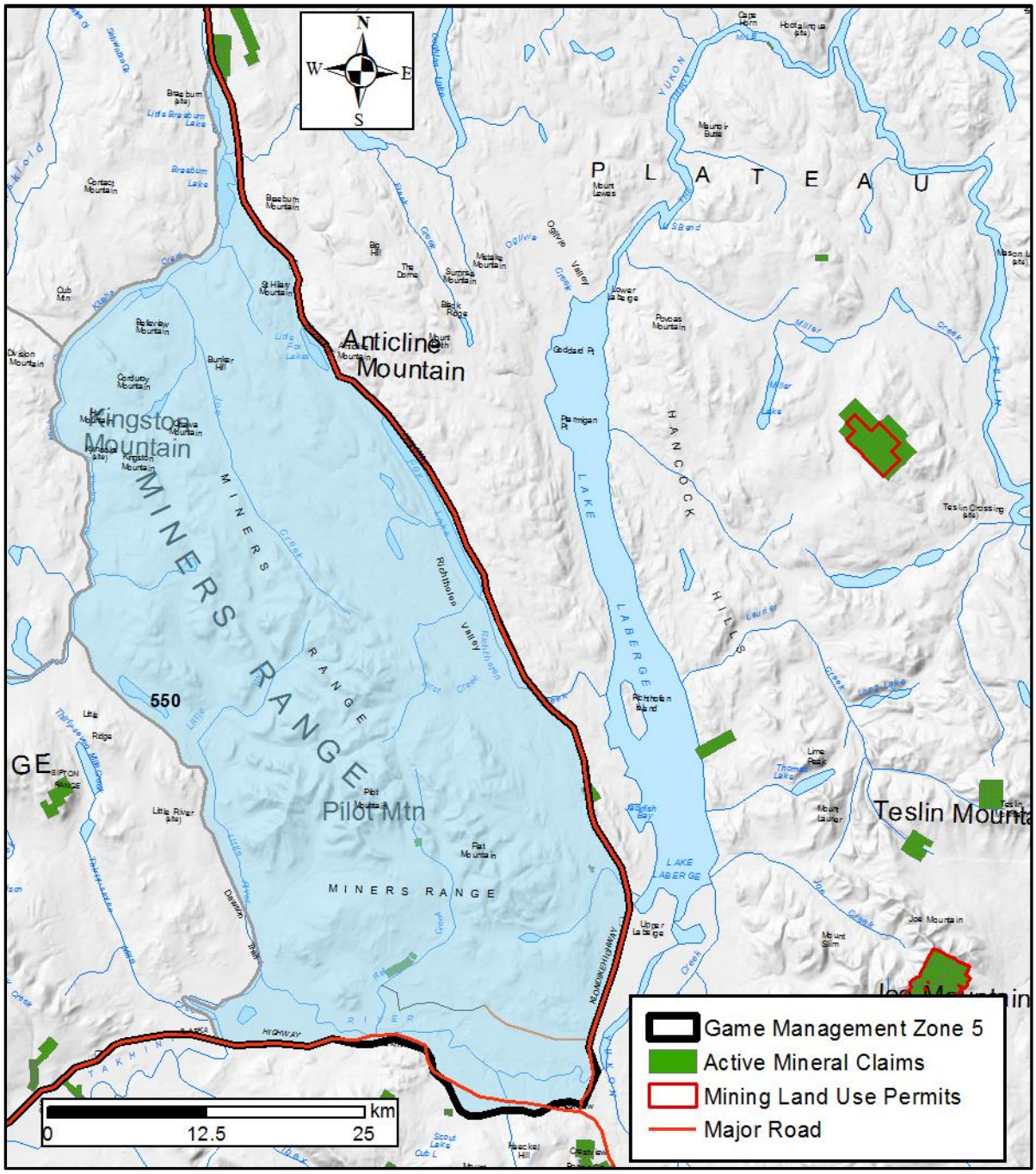

Figure 28. Location of the Pilot Mountain management unit.

Pilot Mountain (Game Management Subzone 5-50)

The Pilot Mountain management unit (Figure 29) consists entirely of GMS 5-50 and is named after Pilot Mountain. Geographic closure of this unit is considered high. Any sheep movement to other units would likely occur to the west into the Sifton unit. Sheep from this unit are also believed to move east towards the North Klondike Highway, where small numbers of sheep are occasionally observed near the southwest corner of Lake Laberge. Mineral exploration activities in this unit are limited (Figure 29). The 2015 survey of the unit (Tables 23 and 24) yielded one of the highest non-lamb counts on record. Given the low ram:nursery sheep ratio, some rams may have been missed during the 2015 survey. Due to concerns regarding overharvest in this unit, licensed sheep harvest in GMS 5-50 was placed under a

PHA in 2009 (Figure 30). Currently, 6 permits are issued annually. The current average annual licensed harvest rate in the unit is 1.8%. Current licensed harvest is roughly 50% lower than observed in the 1990s and 2000s (Table 31; Figure 30). Annual success rates for permit-holders has ranged from 0 – 67%, with the average success rate being 37.5%.

Table 27. 2015 survey results for the Pilot Mountain management unit.

	GMS 5-50
Non-lamb count	143
Lamb:nursery sheep ratio	42:100
Ram:nursery sheep ratio	27:100

Table 28. Historical summer survey results for the Pilot Mountain management unit.

	Non-lamb counts	Ram:nursery sheep ratios
Year	**GMS 5-50**	**GMS 5-50**
2015	143	27:100
2010	153	43:100
2009	129	63:100
2008	139	38:100
2007	149	27:100
2000	139	49:100
1995	118	46:100
1984	109	42:100
1982	127	44:100
1981	189	15:100
1980	116	36:100
1979	90	32:100
1978	97	25:100
1977	112	26:100
1976	94	31:100
1975	104	39:100
1974	94	29:100

Table 29. Licensed sheep harvest in the Pilot Mountain management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-50	3	4	2	2	2

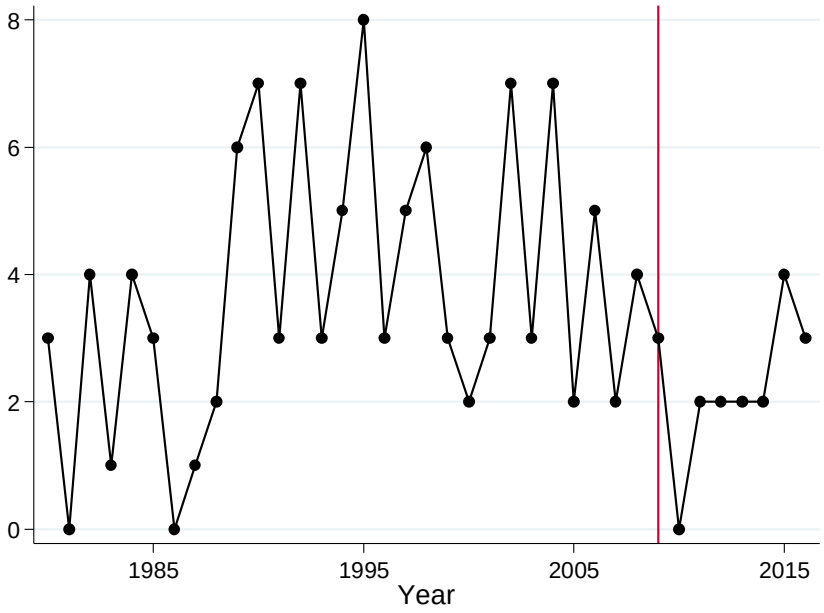

Figure 29. Long-term (1980 to 2016) licensed sheep harvest in the Pilot Mountain management unit. The red vertical line indicates 2009, when the PHA for licensed harvest was implemented.

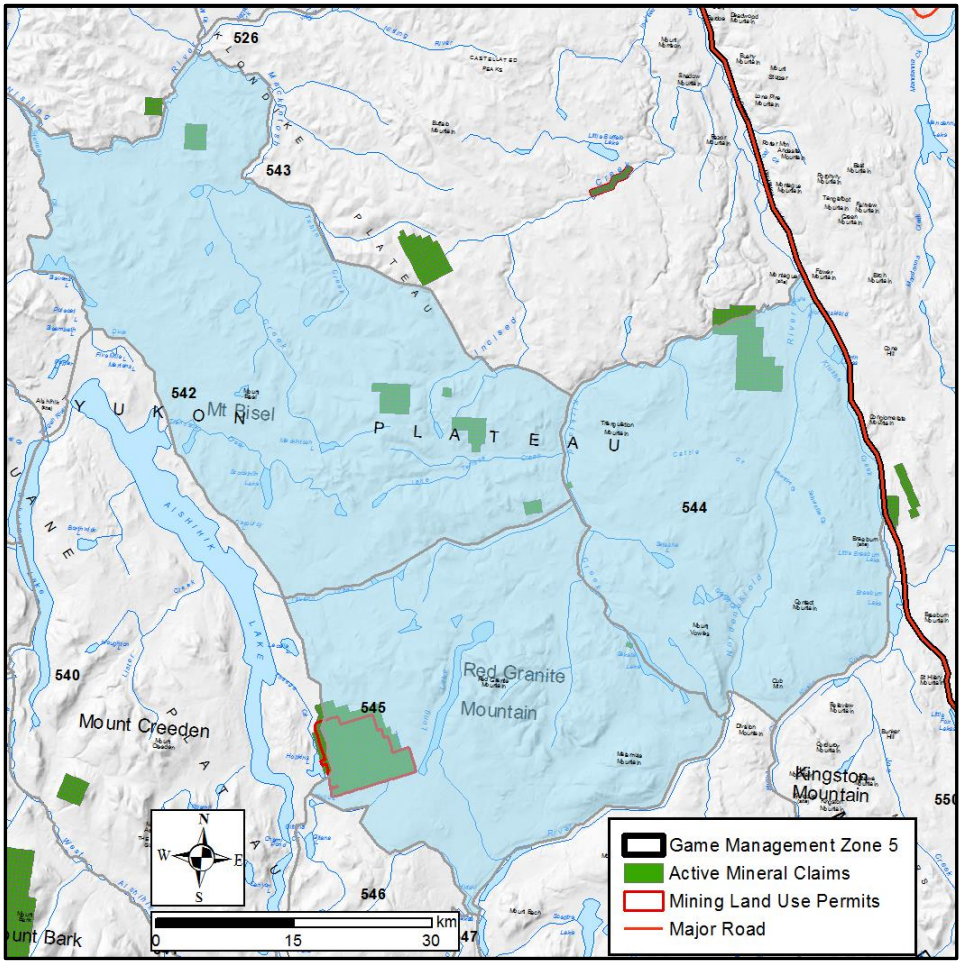

Figure 30. Location of the Long Lake management unit.

Long Lake (Game Management Subzones 5-42, 5-44 and 5-45)

The Long Lake management unit (Figure 31), consisting of GMSs 5-42, 5-44 and 5-45, is located east of Aishihik Lake, with Long Lake located in the southern portion of the unit. Sheep numbers vary between GMS 5-45 and GMS 5-42 (Figure 31, Table 33). The 2016 survey yielded the first sheep observed in GMS 5-44. This lone nursery group was found in a cave and thus accurate numbers were impossible to obtain and are not reported here (Table 32). While there appears to be geographic closure among the three GMSs, local information suggests movement among them. Additional evidence supporting the merging of GMS 5-42 with 5-45 is the biologically implausible ram:nursery sheep ratio observed in GMS 5-42, which could also be accounted for by missed nursery sheep. The current average annual licensed harvest rate for the Long Lake management unit is 3.4%. Licensed harvest in the unit has been steadily increasing since the mid-1990s (Table 34; Figure 32). In recent years, there has been considerable interest in the unit, particularly GMS 5-45, largely due to increased access via a trail to Long Lake from the Aishihik Road.

Table 30. 2015 and 2016 survey results for the Long Lake management unit.

	GMS 5-42[b]	GMS 5-44[b]	GMS 5-45[a]	Combined[c]
Non-lamb count	73	?	222	295
Lamb:nursery sheep ratio	74:100	?	38:100	44:100
Ram:nursery sheep ratio	109:100	0	44:100	56:100

a: 2015 survey; b: 2016 survey; c: excluding GMS 5-44

Table 31. Historical summer survey results for the Long Lake management unit.

	Non-lamb counts				Ram:nursery sheep ratios			
Year	**GMS 5-42**	**GMS 5-44**	**GMS 5-45**	**Combined**	**GMS 5-42**	**GMS 5-44**	**GMS 5-45**	**Combined**
2015/16	73	-	222	-	109:100	--	44:100	56:100
2011	72	-	183	-	80:100	--	62:100	--
1999	-	-	207	-	--	--	59:100	--
1993	50	-	121	-	37:100	--	68:100	--
1974	-	11	180	-	--	10:100	45:100	--

Table 32. Licensed sheep harvest in the Long Lake management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-42	3	5	3	2	1
GMS 5-44	0	0	0	0	0
GMS 5-45	8	5	5	8	10
Combined	11	10	8	10	11

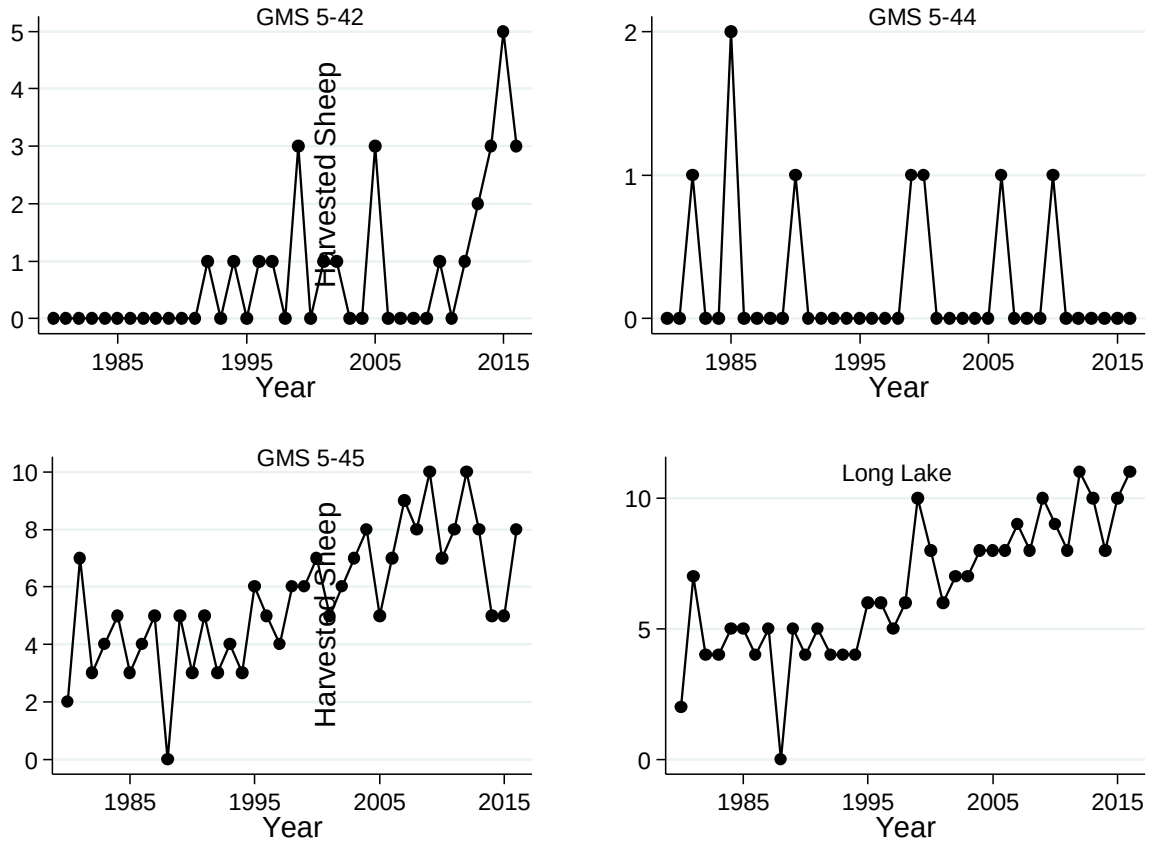

Figure 31. Long-term (1980 to 2016) licensed sheep harvest in the Long Lake management unit.

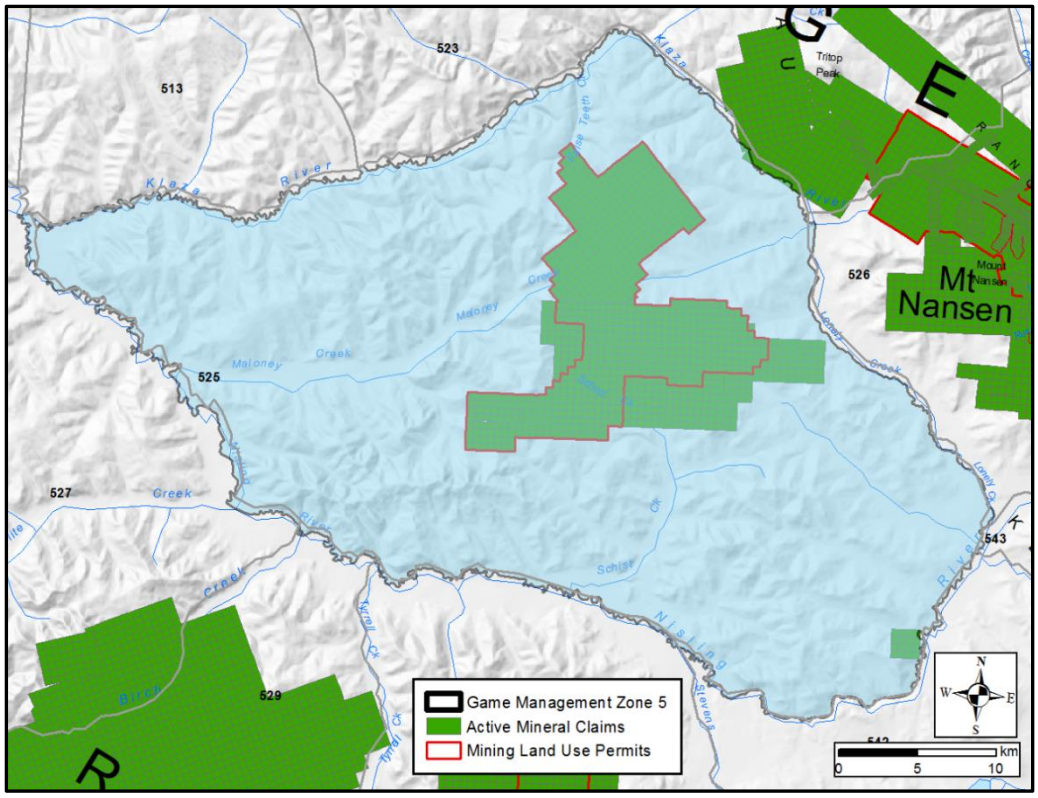

Figure 32. Location of the Nisling management unit.

Nisling (Game Management Subzone 5-25)

Sheep in the Nisling management unit are found primarily along the Nisling River (Figure 33). This small population is relatively inaccessible. Mineral exploration activity is extensive in the northern portion of the unit (Figure 33); however, this is generally outside known sheep habitat. It was last surveyed in 1974 (Table 35). Due to the extensive tree cover in the area, counts are likely low, as evidenced by the biologically implausible ram:nursery sheep ratio observed in 2013.

Based on the observed number of non-lambs in 2013, the current average annual licensed harvest rate of the unit is 0.42%, which is likely biased high given that sheep were likely missed during the survey. Overall, licensed harvest in this unit has been highly variable over time (Figure 34) and recent harvest (Table 36) reflects this pattern.

Table 33. 1974 and 2013 survey results for the Nisling management unit.

Parameter	2013	1974
Non-lamb count	130	143
Lamb:nursery sheep ratio	13:100	42:100
Ram:nursery sheep ratio	15:100	27:100

Table 34. Licensed sheep harvest in the Nisling management unit (2012 to 2016).

Area	2016	2015	2014	2013	2012
GMS 5-25	0	0	2	0	1

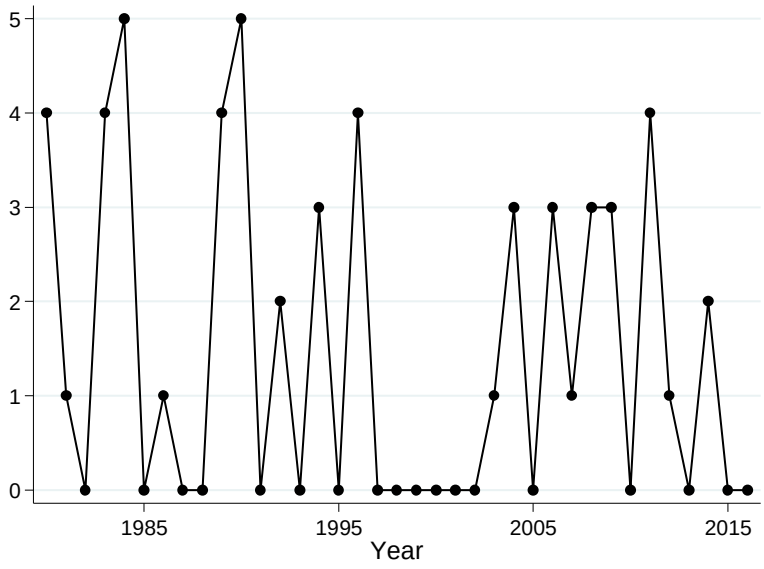

Figure 33. Long-term (1980 to 2016) licensed sheep harvest in the Nisling management unit.

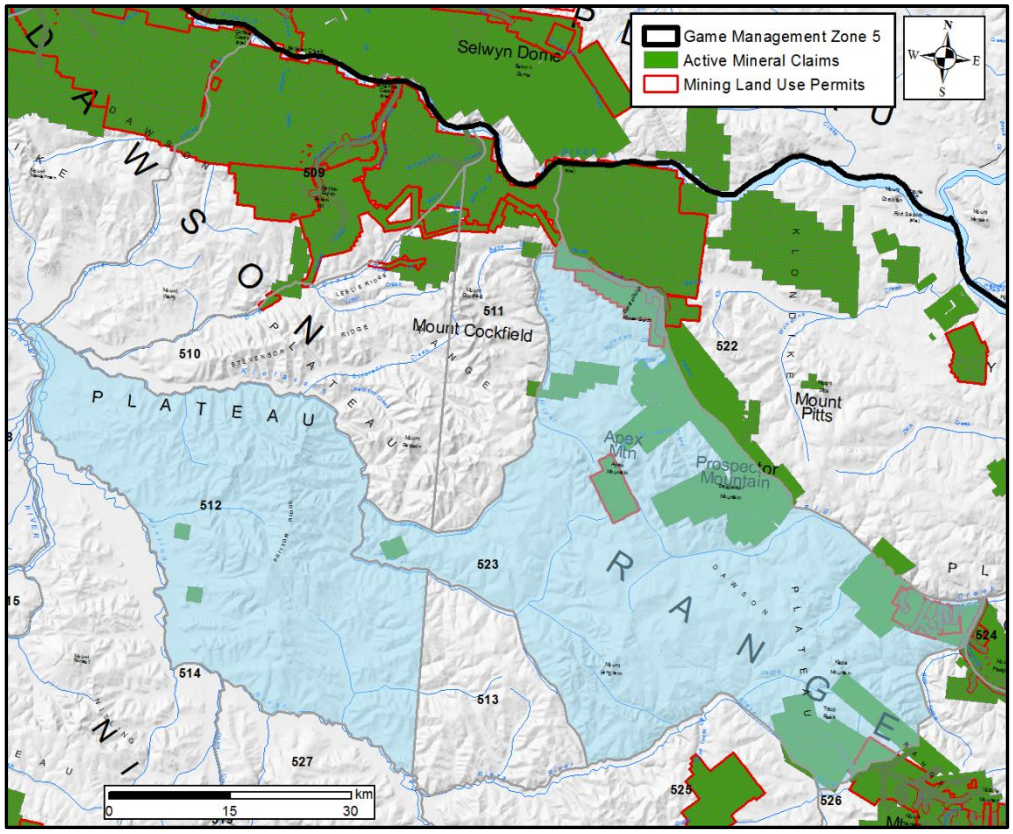

Figure 34. Location of the Dawson Range management unit.

Dawson Range (Game Management Subzones 5-12 and 5-23)

The Dawson Range management unit consists of GMSs 5-12 and 5-23 (Figure 35). Sheep in the unit were surveyed in July 2013 for an inventory survey and in June 2016 as part of a Wildlife Key Area survey (Table 37). The June 2016 survey yielded the highest number of sheep recorded during survey efforts for this unit (Table 38). The largest numbers of sheep in the area occur on Mount Langham, which may act as a source for the other mountains in the unit. However, overall, sheep numbers are low and scattered across this unit (Table 38).

Mineral exploration in this unit is high (Figure 35) and the area has been the focus of exploration for many decades. Current access into the unit is limited. If permanent roads are developed to service proposed mines (e.g., Casino). Sheep were historically observed on Stevenson Ridge (GMS 5-10) and north into GMS 5-09; however, sheep have either abandoned those areas or occur in extremely small numbers as none were observed during this work. It is not known if these sheep are part of the Dawson Range unit or sheep populations to the northeast. Regardless, sheep distribution in this area appears extremely limited. Sheep in this range have not been harvested by licensed hunters in the recent past (i.e., 0% harvest rate since 2008), although historically sheep have been harvested from this unit (Figure 36).

Table 35. 2016 and historical survey results for the Dawson Range management unit.

	GMS 5-12	GMS 5-23	Combined
Non-lamb count	21	66	87
Lamb:nursery sheep ratio	7:100	17:100	15:100
Ram:nursery sheep ratio	47:100	25:100	29:100

Table 36. Historical summer survey results for the Dawson Range management unit.

	Non-lamb counts			Ram:nursery sheep ratios		
Year	**GMS 5-12**	**GMS 5-23**	**Combined**	**GMS 5-12**	**GMS 5-23**	**Combined**
2016	21	66	87	47:100	25:100	29:100
2013	43	101	144	79:100	50:100	51:100
1986	-	28	-	-	33:100	-
1974	7	31	38	N/A	41:100	73:100

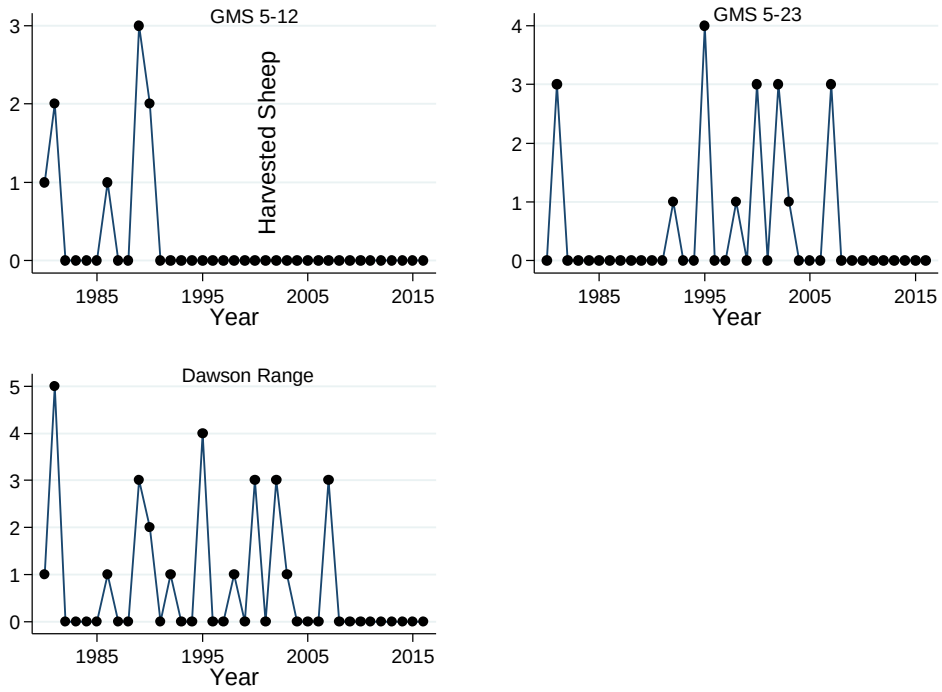

Figure 35. Long-term (1980 to 2016) licensed sheep harvest in the Dawson Range management unit.

Grayling (Game Management Subzone 5-14)

GMS 5-14 was not surveyed during this work as it was deemed a low priority GMS with no modern observations of sheep in this area. However, local knowledge suggests that sheep are sparsely distributed throughout this GMS and one sheep was harvested in the unit in 2007. Given this information and the relatively high geographic closure of GMS 5-14, it is tentatively assigned as a management unit even with the lack of survey information. Harvest pressure in this unit is deemed low.

Discussion

Population Status

Across GMZ 5, current overall sheep numbers (Table 1) are similar to those observed in 1974 (Hoefs 1975), with only a 3% difference in non-lamb numbers in roughly 40 years. The sheep counts presented here are unadjusted for missed animals and thus should be interpreted as minimum counts (Caughley 1974). Hoefs and Barichello (1985) suggested a sightability rate of 90% in southwest Yukon could reliably be assumed based on survey work on Sheep Mountain near Kluane Lake. Across the entire Territory, with differing terrain and habitat conditions, they recommended a sightability rate of 80-90%. This is similar to sightability trials conducted on Gray Ridge and Caribou Mountain which indicated sightability rates of ~85-95% (Government of Yukon, unpublished data). Thus, while we did not observe all sheep in GMZ 5 during this work, we likely observed a very high proportion of them and are confident in the results. For a number of identified management units, population trend is difficult to assess due to limited survey information. In some instances this current assessment and that from 1974 represent nearly all available data. While broadly the overall GMZ 5 sheep population appears to be stable since 1974, this does not account for population dynamics during this roughly 40 year time period. A number of GMSs have been surveyed more

frequently during this time period, and these data suggest that in some units, sheep numbers may have declined. These include the Brooks Arm unit (Table 9), in which GMS 5-28 had sheep numbers in the mid to high 300s during the 1980s, compared to roughly 200 presently. Likewise, the Killermun unit (Table 18) had more sheep prior to 2000 than presently. Conversely, the Sifton unit (Table 27) appears to have more sheep presently than historically.

Several units remain unsurveyed or possibly partially surveyed. These include the Grayling unit (Figure 10), which was not surveyed during this period and which is reported to maintain sheep. Geographic closure between GMSs 5-15 and 5-16 and the Brooks Arm and Donjek units (Figure 10) is also uncertain as both GMSs 5-15 and 5-16 were not surveyed during this time period but have had occasional sheep harvested in them and sheep may occur at their southern edges.

Harvest

Across GMZ 5, the overall annual average licensed harvest rate of 2.2% is below the Government of Yukon's recommended guideline of a 4% maximum for surveyed populations. Individually, nearly all management units are below this recommended rate with the exception of Brooks Arm (Figure 37). The Brooks Arm harvest rate of 5.1% may indicate an unsustainable harvest in this unit.

Licensed harvest in the Long Lake unit, while below the recommended guideline, has demonstrated an increasing trend (Figure 32) since the mid-1990s and if it follows this trajectory, harvest may be at the 4% level in the next 5 to 10 years. Access to GMS 5-45 is obtained via a well-defined trail to Long Lake and new trails are currently being developed into the western portion of GMS 5-42. Given this access, licensed harvest in this unit may continue to increase.

The Pilot Mountain management unit is the only unit within GMZ 5 in which licensed harvest is under a PHA. The current allocation of 6 permits has yielded an annual average licensed harvest rate of 2.1% with a hunter success rate of 37.5%, which is roughly equivalent to that observed in areas under a PHA in GMZ 7 (Hegel and Russell 2018).

Summary

Barichello *et al.* (1989) estimated a total of 22,000 thinhorn sheep in Yukon. Assuming this number from 1989 is similar to the present Yukon-wide situation, GMZ 5's sheep population represents roughly 17% of the total Yukon population. These results, paired with those of the recently assessed sheep population in GMZ 7 (Hegel and Russell 2018), suggest over one-quarter of Yukon's thinhorn sheep occur in GMZs 5 and 7, representing roughly 12.5% of the total area of Yukon. Overall, sheep numbers in GMZ 5 appear to have changed little since 1974.

The management units identified here provide a new framework by which management and monitoring of sheep in GMZ 5 can proceed. This approach moves away from a GMS-specific one, in which sheep in a single subzone were considered a "population". Results from this regional survey demonstrate that this is not the case in many areas across GMZ 5 and that populations should be considered to occur across wider areas. Results from this survey highlight the utility of broad-scale surveys of wide geographic scope. If, for example, we would have focussed on only a subset of GMSs in GMZ 5, we would have missed relevant demographic patterns (e.g., ram:nursery sheep ratios). These newly identified management units should be considered dynamic and open to change pending new biological information (e.g., sheep movement data).

With the exception of the Brooks Arm management unit, licensed harvest across GMZ 5 is currently below the Government of Yukon's recommended guideline of a less than 4% harvest rate for surveyed populations. A further consideration in interpreting unit specific harvest rates is that those presented here do not include First Nation subsistence harvest. The level of First Nation harvest across GMZ 5 is unknown, and all harvest rates reported here should be considered to be biased low. The degree of this bias is unknown and may vary based on the level of accessibility of different units. The Government of Yukon's recommended maximum harvest rate of 4% is for all harvest and human-caused mortality, not only licensed harvest. Thus, when determining if limitations are required or the number of permits requires adjustment, estimates of First Nation harvest, including ewe and ram numbers, in specific units may be required to ensure overall harvest is within sustainable limits. Knowing total harvest helps ensure it is sustainable.

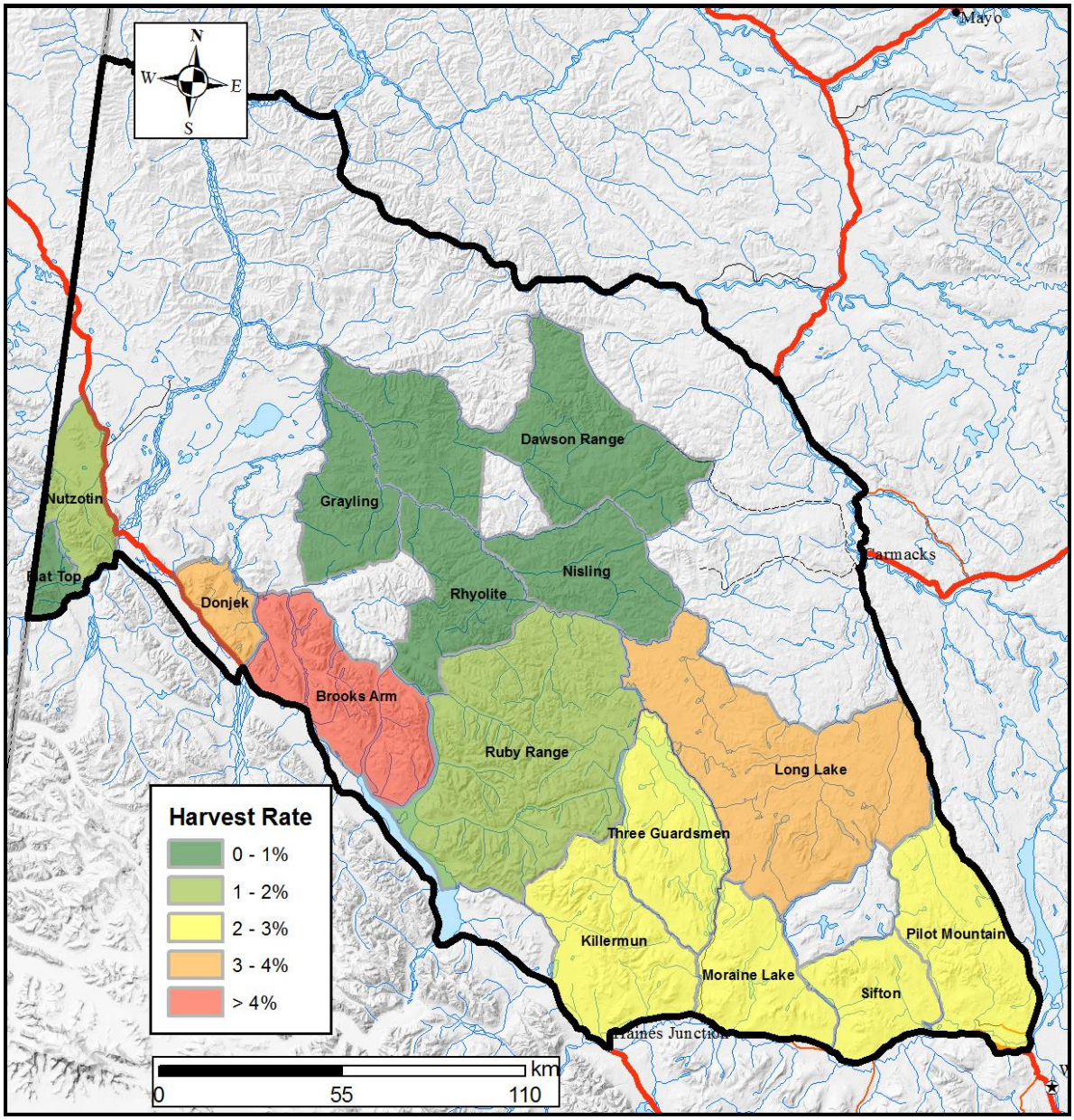

Figure 36. Current annual average licensed harvest rates for management units in GMZ 5.

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