



Mackenzie Mountain Non-resident and Non-resident Alien Hunter Harvest Summary 2017

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ABSTRACT

Each of the eight licenced outfitters and Renewable Resource Officers with the Sahtú and Dehcho Environment and Natural Resources (ENR) regional offices collected data on big game harvested in the Mackenzie Mountains during the 2017 hunting season. Harvest data and observations of wildlife from non-resident and non-resident alien hunters (collectively called 'non-resident' for this report) were recorded. This year, big game hunting licences were bought by 390 non-resident hunters, midrange of the 321-447 licenses purchased annually from 1991-2017. Of these license holders, 351 came to the NWT and most spent some time hunting. There was an increasing proportion of American hunters this year with the number of licenses purchased by other foreigners and non-resident Canadians at some of their lowest levels recorded: 281 from the USA, 36 from other foreign countries and 73 non-resident Canadians with 63 of from either Alberta or British Columbia. Hunts are marketed in American dollars; a strengthening American dollar likely reduced the number of non-resident Canadians and other foreigners hunting.

Hunter satisfaction remains high; 99% of respondents (n=231) rated their experience as either excellent (95%) or very good (4%). The high quality hunting experience, the abundance of wildlife in the Mackenzie Mountains (both game and predators), and the impressive management and stewardship of the land were specifically commented on. Repeat clients (23% of respondents) had returned for a 2nd to 8th hunt, and 91% of respondents indicated they would like to return in future years. We received 66% of the voluntary hunter observation forms, a welcome dramatic increase over 2016.

Only 222 tags were purchased for Dall's sheep this year, the lowest recorded in 23 years. With the expansion of Nahanni National Park Reserve (NNPR) in 2016, zone D/OT/02 had its hunting area reduced by almost 80%, subsequently their number of sheep clients has

been dramatically reduced. We anticipate the number of Dall's sheep tags purchased in future will remain at these reduced levels. This year's harvest of 186 rams (including four by resident hunters) was below the average annual harvest of 198 rams from 1991-2017. The mean ($\pm$ SD) age of rams harvested was 10.7 ± 1.9 years, the fourth oldest since records started in 1967, and the 30th consecutive year the average age has been >9.5 years for rams harvested in the Mackenzie Mountains. The 57.0 lambs:100 ewe ratio estimated from hunter observations in 2017 is similar to the average reported since 1995. However, the 71.3 rams:100 ewe ratio estimated is the lowest reported since 1995. Also, hunters observed the smallest percentage of legal, $>3/4$ curl, rams (40.2%) versus $<3/4$ curl rams than in any previous year. Sheep observations from a substantial part of their southern range have not occurred since 2015 with the expansion of NNPR. Loss of observations in these ranges could affect these data. The average right horn length was 88.5 cm, similar to the mean 89.0 cm from 1967 to present. This consistency is surprising given the increasing age of harvest; the percent broomed horns, 30% left and 37% right were similar and higher, respectively, than the 21 year averages.

In 2017, 308 tags were purchased for northern mountain caribou, more than the average 268 (range 181-347), but less than purchased in 2014-2016. At least 63% of tag holders hunted caribou, harvesting 195 males, the greatest harvest since records have been kept (1991). Hunters observed an estimated 36.8 caribou calves and 41.1 bulls per 100 adult female caribou, respectively. The calf:cow ratio was below the average 42:100 (range 33-59:100), but up from the lowest in 2016, while the bull:cow ratio was above the average 39:100 (range 21-61:100).

One hundred and two tags were purchased for moose this year, similar to previous years (2005-2016), but the harvest of 64 bull moose was lower than the average of 73 since 2005. Hunters observed an estimated 29.5 moose calves per 100 adult female moose similar to previous years (1995-2016). The estimated 96.4 bulls per 100 adult female moose was below the average of 104:100 from 1995-2016.

This year only 28 tags were purchased for mountain goats, noticeably fewer than pre-2016 as anticipated. The expansion of NNPR in 2016 included a substantial amount of mountain goat range where hunting is now prohibited. Six goats, all male, were harvested similar to the mean annual harvest prior to 2005. This year a 16 year-old billy was harvested. Only one other billy this old had been harvested since records started in 2005. Hunters observed an estimated 58.1 kids and 36.5 billies per 100 adult nannies, both ratios lower than the average from 2002-2017. Owing to the expansion of NNPR, these ratios are derived from fewer total animals located in a much smaller restricted area of goat range than ratios derived prior to 2016.

Wolf tags were purchased by 303 non-resident hunters in the 2017/2018 hunting season, down from a peak in tags purchased in 2015 but more than in any of the previous 20 years. Part of the recent increase could be related to the increasing popularity and success of winter season hunts; winter hunts were offered in two zones this season for the first time. Total wolf harvest in 2017/2018 was 17 similar to previous years. Hunters observed 248 wolves during 2017/2018, midrange of the 142-317 observed during 1995-2016.

This year 46% of hunters purchased a total of 179 wolverine tags, the third consecutive year of above average tag purchases; none were harvested. In total, 31 wolverines were observed in seven zones, including two groups of two and two family groups of three. Although wolverine numbers are believed to be declining in some parts of their range in the Northwest Territories, there is no support for a declining trend in the Mackenzie Mountains based upon voluntary observations of hunters from 1995-2017.

One black bear was harvested from the 18 tags purchased in 2017. This is only the eighth black bear harvested in the past 27 years. Black bears are relatively rare in the Mackenzie Mountains generally occurring south of 63°00'N. However this year, 11 of the 22 black bears observed were in S/OT/05, all north of 63°00'N, and one black bear was

photographed by a trail camera deployed as part of the pilot hair snagging project in the Sahtú.

There has been no grizzly bear hunting season for non-residents since 1982. This year more adult (n=655), and cub grizzly bears (n=140) were observed than in any other year. There continues to be a positive trend in the number of grizzly bears observed and the percent of hunters seeing grizzly bears from 1996-2017. Two nuisance grizzly bears were put down in 2017. A hair snagging pilot project was conducted by ENR in a 7,000 km² area of the Sahtú along the Canol trail to estimate grizzly bear numbers. Posts (n=86) were visited four times during summer to collect hair samples. DNA analysis of hair samples (n=1,533) was conducted at Wildlife Genetics International and identified 91 individual grizzly bears. Further modeling and statistical analyses are being completed in order to obtain density estimates. ENR hopes to conduct hair snagging in two more areas in future.

We continue to use summary meat recording forms in addition to Association of Mackenzie Mountain Outfitters meat forms and for the seventh year we have information about meat distribution for all eight outfitters. An estimated minimum of 18,940 kg (41,667 lbs.) of wild game meat, mostly moose and mountain caribou, was distributed locally this year. Replacement cost of meat from local northern retailers is conservatively estimated at \$473,500 using a \$25/kg average replacement cost.

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INTRODUCTION

General Background

The 140,000 km² (54,000 mi²) area of the Mackenzie Mountains in the western Northwest Territories (NWT) was first opened to non-subsistence hunters in 1965 (Simmons 1968). Since then, the Mackenzie Mountains have become world-renowned for providing a high quality wilderness hunting experience (Veitch and Simmons 1999, www.spectacularnwt.com/whattodo/hunting/themackenziemountains, www.huntingreport.com), particularly for Dall's sheep and more recently moose. In return, non-resident hunters and outfitters in the Mackenzie Mountains provide about \$2.5 million annually to individuals, businesses, and governments in the NWT (Harold Grinde personal communication). The outfitted hunting industry in the Mackenzie Mountains also provides employment for 150-170 outfitters, guides, pilots, camp cooks, camp helpers, and horse wranglers (Werner Aschbacher personal communication). In addition, fresh meat from many harvested animals is provided to a number of local communities including Tulít'a, Fort Good Hope and Norman Wells in the Sahtú and Wrigley, Nahanni Butte, Fort Liard and Fort Simpson in the Dehcho. This meat is distributed among local elders and residents and to health/long-term care facilities. The estimated annual replacement value of this meat has ranged from *ca.* \$60,000-625,000.

Eight outfitters are currently licenced by the Government of the NWT (GNWT) to provide big game outfitting services within the Mackenzie Mountains (Figure 1, Appendix A). Under the NWT *Wildlife Act*, each licenced outfitter has the exclusive privilege of providing services within their zone, which enhances the outfitters' ability to practice sustainable harvest through annual allocation of the harvest effort. Harvesting in the area including the Nahanni National Park Reserve and the Nááts'ihch'oh National Park Reserve, collectively NNPR for this report (Figure 1), is restricted to subsistence harvest by Aboriginals under section 17 of the *Wildlife Act* or NWT general hunting licence (GHL) holders.

The hunting licence year in the NWT runs from 1 July - 30 June and those who desire to hunt big game within the NWT must annually obtain a big game hunting licence and must be at least 12 years old (Environment and Natural Resources 2017). Any youth under the age of 18 must have the consent of a parent or guardian to obtain a licence. There are four classes of licenced big game hunters in the NWT:

- 1) *General*: only available to Aboriginal people eligible or belonging to an organization listed in the regulations.
- 2) *NWT Resident*: Canadian citizens or landed immigrants who have been living in the NWT for at least 12 continuous months prior to application for the licence.
- 3) *Non-resident*: Canadian citizens or landed immigrants who live outside the NWT, or have not resided in the NWT for 12 months prior to application for the licence.
- 4) *Non-resident Alien*: an individual who is neither a NWT resident nor a non-resident.

Both non-resident and non-resident alien hunters must use the services of an outfitter and must be accompanied by a licenced guide at all times while hunting big game. For simplification in this report, we call both non-resident and non-resident alien hunting licence holders 'non-residents' and combine their harvest statistics. The data from four resident hunters, who harvested Dall's sheep in the Mackenzie Mountains without a guide, have been included in the number of sheep harvested and the age and horn length measurements in this report as indicated.

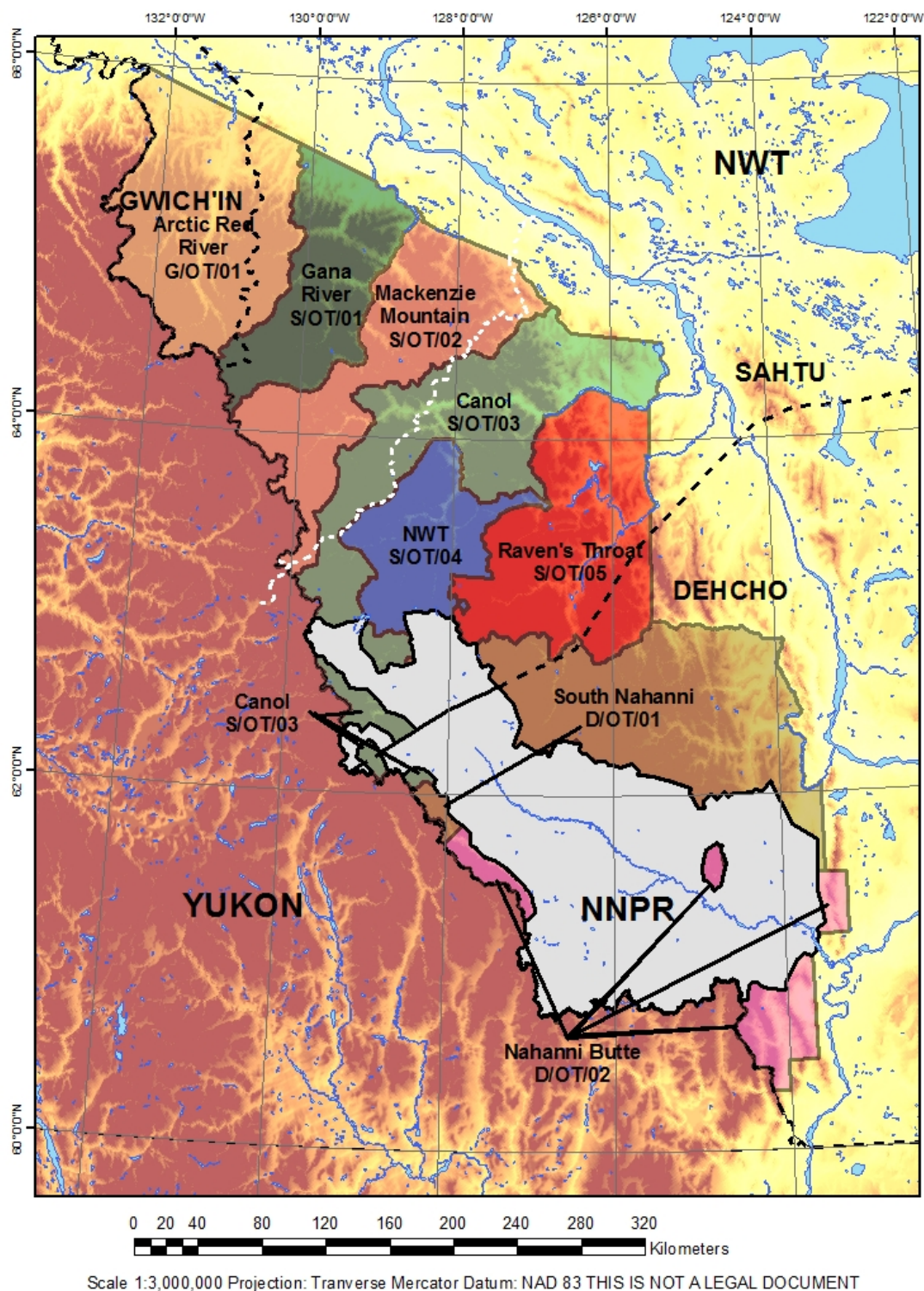


Figure 1: NWT Mackenzie Mountain Outfitting zones and names, NNPR, and land claim areas (black dotted lines). The white hatched line is the Canol road.

Individual non-resident hunters are annually restricted to one each of the following big game species (Appendix B): Dall's sheep (male with at least one $\frac{3}{4}$ curl horn), northern mountain woodland caribou (either sex), moose (either sex), mountain goat (either sex), wolf (either sex)¹, wolverine (either sex), and black bear [adult not accompanied by cub(s)]. Although non-resident hunters are allowed to hunt female moose and caribou they prefer to hunt males for their trophy antlers and the harvest is exclusively males. Non-resident hunting for grizzly bears was closed in 1982 as a result of concerns about over-harvest (Miller et al. 1982, Latour and MacLean 1994). There are currently no restrictions on the total number of each big game species that an outfitter can take within the zone for which they are licenced.

Wildlife management within the Mackenzie Mountains is the responsibility of a variety of government agencies and boards set up as a result of comprehensive land claim agreements. The post-2009 boundaries of Nahanni NPR plus the newly established Nááts'ihch'oh NPR comprise an area of 33,917 km² in the south Mackenzie Mountains that is managed by Parks Canada – an agency of the Canadian federal government. Under the terms of the *Sahtú Dene and Métis Comprehensive Land Claim Agreement* (signed in 1993) and the *Gwich'in Comprehensive Land Claim Agreement* (signed in 1992), the main instrument of wildlife management within the two settlement areas lies with the Sahtú Renewable Resources Board (SRRB) and the Gwich'in Renewable Resources Board (GRRB), respectively. Approximately 68,000 km² of the central and northern Mackenzie Mountains are within the Sahtú Settlement Area and 8,300 km² are within the Gwich'in Settlement Area, which encompass the extreme north end of the outfitter zones (Figure 1). However, the GNWT maintains ultimate jurisdiction for management of wildlife and wildlife habitat within each of the claim areas. The Department of Environment and Natural Resources (ENR) is responsible for licencing outfitters, guides, and hunters and for annually monitoring non-resident big game harvest in the Mackenzie Mountains.

¹In the Sahtú region, non-resident hunters and non-resident alien hunters are allowed to hunt two wolves from 1 August - 15 April in S/MX/01. Only one wolf can be hunted in the Dehcho and Gwich'in areas.

Annually, ENR under the *Wildlife Act* related provisions in the *Wildlife Business Regulations* requires outfitters to submit an outfitter return on a client hunter success form for each person that purchased a NWT non-resident big game hunting licence (Figure 2). These are known as outfitter return forms and they must be submitted whether or not a client actually hunted, and whether or not any game was harvested. The outfitter return forms allow us to quantify harvest by non-resident hunters to help biologists with the GRRB, SRRB, and ENR to ensure that the harvest of each species is within sustainable limits.

Starting in 1995, the then Department of Resources, Wildlife and Economic Development, requested all non-resident hunters fill out an additional voluntary questionnaire. The questionnaire has evolved through the years based upon suggestions from outfitters, their clients, and government staff. Different questions pertaining to wildlife observations, the quality of the hunting experience, the quality of services related to hunter travel, and specific topics for hunter comment have come and gone. However, a key component of the questionnaire that has remained constant through the years is reporting the different types and numbers of wildlife species seen during their hunts. These data have been recorded and the questionnaire forms have been referred to as hunter observation forms in this report (Figure 2). These data provide valuable time series of observations and are used in assessing mountain caribou herd status (Larter 2012a, 2018). There have been no changes in the questions or format of the forms since 2013.

This is the 23rd consecutive year that a summary of the data collected by ENR on non-resident hunters in the Mackenzie Mountains has been made. In the text of this document, data for 1995 are found in Veitch and Popko (1996), for 1996 in Veitch and Popko (1997), for 1997 in Veitch and Simmons (1998), for 1998 in Veitch et al. 2000b, for 1999 and 2000 in Veitch and Simmons (2000, 2002, respectively), for 2001 by A. Veitch and N. Simmons (unpublished data), for 2002-2016 in Larter and Allaire (2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017 respectively). Additionally, Latour and MacLean (1994) summarized data for 1979-1990. This report compiles the harvest data collected during the 2017 hunting season and compares it with available data collected since 1995, and earlier when available.

MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES
HUNTER WILDLIFE OBSERVATION REPORT - 201

Dear Hunter: The Department of Environment and Natural Resources (ENR), Government of the Northwest Territories is undertaking a survey and invites you to participate in completing this questionnaire about your NWT hunting experience. The survey will be used to assist us with the management of Mackenzie Mountain big game populations. Your participation is voluntary. The information is intended to be used internally by the GNWT for government programs and services. Under the *Access to Information and Protection of Privacy Act*, if a request is submitted, the GNWT may have to disclose some information included in this survey.

HUNTER INFORMATION

First Name	Last Name		
Address – number and street, box number		Town, City	Province, State, Country

Hunting License # _____ Outfitter Zone: 30/T/04 Outfitter: NWT Outfitters
 Start Date of Hunt: Aug 11 2017 End Date of Hunt: Aug 20 2017 Observations Made Over 2 Days

ESTIMATED NUMBER OF DALL'S SHEEP SEEN			
¾ and Full Curl Rams	Less than ¾ Curl Rams	Ewes	Lambs
3	0	6	5

ESTIMATED NUMBER OF MOUNTAIN CARIBOU SEEN		
Bulls	Cows	Calves
5	8	6

ESTIMATED NUMBER OF MOOSE SEEN		
Bulls	Cows	Calves
0	0	0

ESTIMATED NUMBER OF MOUNTAIN GOAT SEEN			
Billys	Nannys	Kids	Unknown Age
0	0	0	0

Other Species						
	Wolf	Wolverine	Black Bear		Grizzly Bear	
			Adult	Cub	Adult	Cub
Number(s) Seen	0	0	0	0	1	0

How would you rate your overall hunting experience with your Outfitter? Could you please check the appropriate box.

☒ Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor

How many times have you hunted in the Mackenzie Mountains, including this year's hunt? 2

Do you plan to return to hunt in the Mackenzie Mountains again? Yes ☒ No ☐

The balance of my meat was provided to my outfitter. Yes ☒ N/A ☐ Did you hunt with a bow? No

COMMENTS: Very good hunt 39" Ram

Thank you! Please give this form to the Officer or Clerk when you are exporting your trophies, or to the guide/outfitter with whom you hunted. We would appreciate receiving this form whether or not you harvested an animal(s).

Figure 3: Example of a fully completed hunter observation report form.

Ownership Change

Prior to the 2017 hunting season Ramhead Outfitters (zone S/OT/03) and Redstone Trophy Hunts (zone S/OT/05) sold their concessions. Zone S/OT/03 is now owned by Canol Outfitters and zone S/OT/05 is now owned by Raven's Throat Outfitters (Figure 1; Appendix A).

Health and Condition of Ungulates

Although ungulates have historically been harvested from the Mackenzie Mountains, there is a paucity of information on the general health and condition of Dall's sheep, northern mountain caribou, moose, and mountain goat inhabiting the area. In the late 1990s, with the discovery that Dall's sheep were a new host of the lungworm *Parelaphostrongylus odocoilei*, there was research dedicated to studying that infection in Dall's sheep (Kutz et al. 2001, Jenkins 2005, Jenkins et al. 2007). However, since then the few other studies have investigated the levels of a range of naturally occurring elements (most notably cadmium, lead and mercury) and radionuclides in various tissues of the different wildlife species (Larter and Kandola 2010, Larter et al. 2016, 2018). Findings from these latter studies have resulted in human consumption notices by the GNWT Department of Health and Social Services (GNWT-HSS 2017). The direct assistance of Association of Mackenzie Mountain Outfitters (AMMO) personnel, who provided samples from harvested animals, was critical to these latter studies.

In 2017, ENR once again solicited the assistance of AMMO members, to initiate a pilot project to improve the knowledge on the health and condition of Dall's sheep, northern mountain caribou, moose, and mountain goats in the Mackenzie Mountains. ENR requested that outfitters provide biological samples from a subset of their clients' harvest: a small piece of hide, some poop (fecal) material, blood samples on dried filter paper, and the lower jaw from each individual sampled. They also requested photographs of anything that looked peculiar and if ticks were found an actual tick so the species could be verified. The request was for samples from 10-15 Dall's sheep, northern mountain caribou, and moose and as many mountain goat as possible. The response by AMMO members was excellent with samples from over 100 animals (Table 1).

Table 1: The total number of individual animals, Dall's sheep, northern mountain caribou, moose, and mountain goat, sampled during the 2017 hunting season for the ENR animal health and condition pilot project.

Sheep	Caribou	Moose	Goat	Total
54	32	12	3	101

Samples of hide represent DNA samples. Fecal samples can be used to test for parasites, stress hormone and can be used to extract DNA. Blood dried on filter paper can be used to test for the presence of or exposure to diseases. The intact lower jaw provides teeth which can be used for aging and a measure of mandibular fat. ENR is currently analyzing the 2017 samples.

ENR plans to continue this pilot project for the 2018 hunting season. In addition they will be requesting the collection of throat swabs from Dall's sheep to screen for disease. Because of the logistical challenges in keeping entire lower mandibles intact and frozen it is likely ENR will only request lower incisor bars from northern mountain caribou and moose so age can be determined. Aging by counting horn annuli is collected from all Dall's sheep and mountain goats when exported.

METHODS

General Background

Prior to the start of the 2017 hunting season, each outfitter in the Mackenzie Mountains received sufficient copies of the outfitter return and hunter observation forms for all their clients for the year. The *Wildlife Business Regulations* require outfitter return forms to be returned by the tenth day of the month following the month of the hunt – e.g. for a hunter that was in the field in July, a form must be submitted by the tenth of August. Forms were submitted to the senior biologist in the Dehcho or Sahtú region, whether or not a client actually hunted and whether or not harvest occurred. In co-operation with ENR Renewable Resource Officers and the outfitters, persistent attempts were made to obtain outfitter return forms for every non-resident that held a big game hunting licence through a Mackenzie Mountain outfitter in 2017. Hunter observation forms were submitted voluntarily.

Information from both the outfitter return forms and hunter observation forms were entered into Microsoft Excel (Microsoft Corporation 2010) spreadsheets. Harvest data for all species is cross-referenced with data in the Licence Information System-IntraNet (LISIN) data management system maintained by ENR offices across the NWT. This includes GNWT wildlife export permit data. Additionally, because each set of legally harvested Dall's sheep horns must have a uniquely numbered identifier plug inserted prior to export, the plug numbers are cross-references with sheep harvest data.

In some instances observation data were reported on outfitter return forms, but not on a hunter observation form; we included these observations in our analyses. If observation information differed between the hunter observation form and the outfitter return form for the same client, we used only the data from the hunter observation form. Occasionally we received identical observation data from forms of different hunters. These hunters had the same guides and lengths of hunts, and obviously had hunted together. We recorded forms with data that had been provided, but for the wildlife observation analyses only one set of

observations was used. All descriptive statistical analyses were performed using Microsoft Excel. We present means $\pm$ standard deviation (SD).

RESULTS AND DISCUSSION

Hunters

In 2017, big game hunting licences for the Mackenzie Mountains were bought by 390 non-resident hunters from fourteen countries (Table 2), midrange of the 321-447 licenses purchased annually from 1991-2017 (average 373; Figure 4, Appendix F). Of those 390 hunters, 351 came to the NWT and spent some time hunting. The remaining 39 cancelled their hunts, decided not to hunt for themselves but participated with other hunters they knew, or decided not to hunt due to unforeseen complications after arriving in the NWT. Thirty-four of these 39 were guides. Guides often purchase licences annually but rarely have the opportunity to hunt themselves.

Hunters from the United States (US) purchased 72% (n=281) of licenses, the greatest proportion since 2005 and continued the increasing trend from 2013. Contrastingly, license sales to non-resident Canadians (n=73; 19%) and foreign residents, other than Americans, (n=36; 9%) were at some of their lowest levels and continued the declining trend from 2013 (Table 2, Figure 5).

Hunts are marketed in American dollars. In years when the Canadian and American dollars are close to par (2010-2013) *ca.* 40% of hunters were from other than the US. With the continued decline in the Canadian dollar to about \$0.75 in 2017 the proportion of US hunters has continued to increase and was at levels similar to pre-2006 when the Canadian dollar ranged from \$0.64-\$0.83 (www.canadianforex.ca).

In general guided hunting in the Mackenzie Mountains occurs from July to October however guided hunting for wolves also occurs during winter in zones S/OT/01 and S/OT/05. For the ninth consecutive year winter wolf hunting occurred in zone S/OT/01; one wolf was harvested in April 2018. No wolves were harvested in zone S/OT/05, the first year for guided winter wolf hunting in this zone.

Table 2: Province, state and/or country of origin of the 390 non-residents who purchased licences for hunting in the Mackenzie Mountains, 2017.

Canada		United States		W. Europe		Other	
Yukon	4	Eastern States ¹	105	Germany	11	Mexico	3
British Columbia	33			Austria	4	Poland	2
Alberta	30	Western States ²	176	Belgium	3	Australia	2
Saskatchewan	3			Switzerland	2	New Zealand	2
Manitoba	3			Spain	3	South Africa	1
				France	2	Norway	1
Total	73		281		25		11

¹AL, AR, CT, DE, FL, GA, IL, IN, IA, KY, LA, ME, MD, MA, MI, MN, MS, MO, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV, WI

²AK, AZ, CA, CO, HI, ID, KS, MT, NE, NV, NM, ND, OK, OR, SD, TX, UT, WA, WY

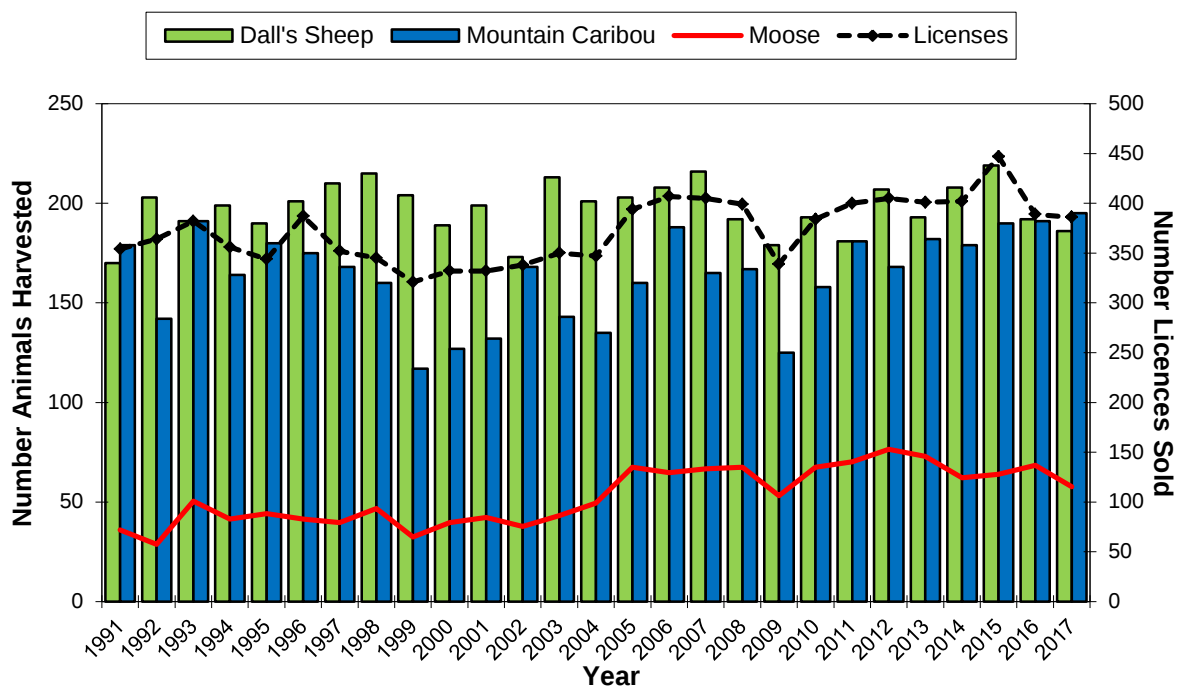


Figure 4: The number of Dall's sheep, mountain caribou, and moose harvested in the Mackenzie Mountains by non-resident hunters, and the number of non-resident licences sold during 1991-2017.

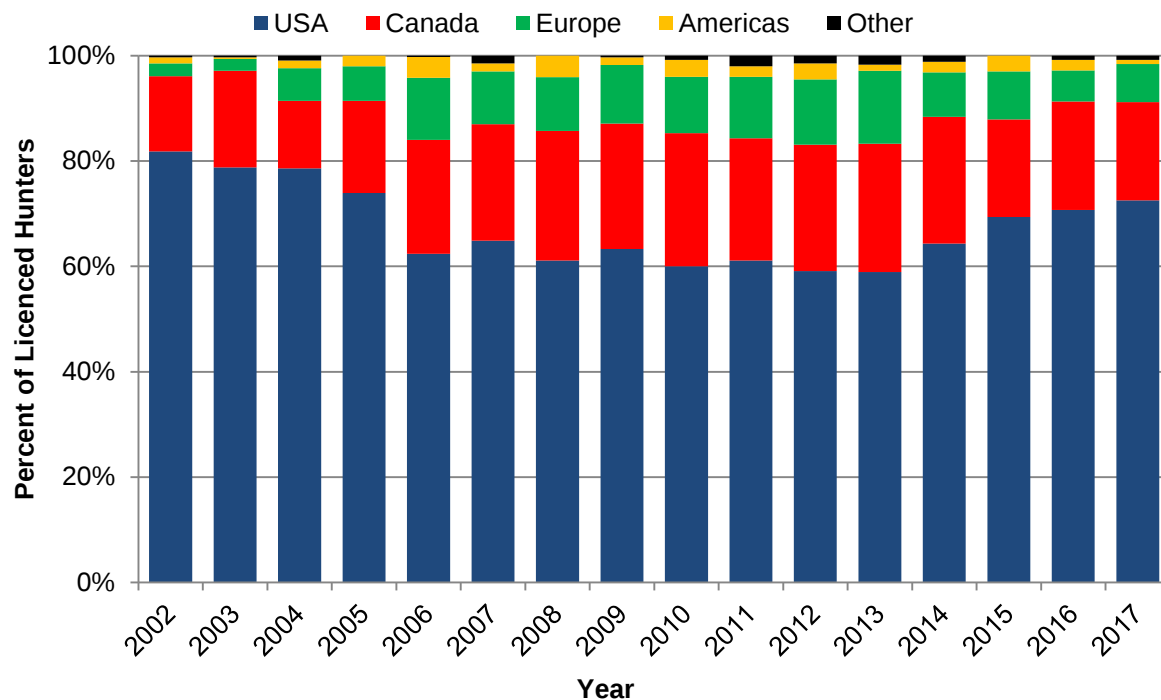


Figure 5: The geographical areas of origin of hunters purchasing licences (in %) to hunt in the Mackenzie Mountains from 2002-2017.

This year we received all of mandatory outfitter return forms for the 390 people that purchased non-resident licences and received 233 (66%) of the possible 351 voluntary hunter observation forms (Table 3). The dramatic increase in the number of voluntary hunter observation forms submitted in 2017 compared to 2016 is encouraging, especially since the number of clients in zone D/OT/02, a zone with consistently high form returns, has substantially decreased due to park expansion. Also, Canol Outfitters (zone S/OT/03) were unaware of the voluntary hunter observation forms so none of their 29 clients provided forms. The need for returning voluntary observation forms has been emphasized at AMMO general meetings and most outfitters endeavour to have clients complete and submit these forms, but we received only 28% of 71 forms from G/OT/01; limited returns from zones with large clientele is a concern because it precludes the ability to generalize observations over the entire Mackenzie Mountains. See Figure 3 as an example of a fully completed hunter observation form.

Table 3: Percent of Mackenzie Mountain outfitter and non-resident hunter forms submitted, 1995-2017.

Form Type	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Outfitter Return (mandatory)	100	99	99	99	98	99	99	98	99	99	98
Hunter Observation (voluntary)	66	55	72	75	56 ¹	60	62	60	62	71	65

Form Type	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Outfitter Return (mandatory)	99	100	99	98	95	92	96	96	97	98	100	98
Hunter Observation (voluntary)	64	65	74	60	59	57	53	51	60	50	71	80

¹5% of forms were lost after being completed but prior to submission.

It is obvious that non-resident hunters immensely enjoyed their hunting experience in the Mackenzie Mountains (Table 4). In 2017, 99% of respondents rated their experience as either excellent (95%) or very good (4%). Not only do voluntary client comments make specific mention of the high quality of hunts (65%; n=95), and the abundance/quality of animals (19%, n=28; Appendices C and D), many comments make reference to (1) the professional and world class experience with their chosen guides, (2) the abundance of a wide variety of game species and predators, (3) the apparent health and condition of the game animals, (4) the pristine and scenic environment of the Mackenzie Mountains, and (5) compliments on the management and stewardship of the land.

Comments about grizzly bears have been common since the start of the voluntary hunter observation forms in 1995; their abundance, problems created around camps and kills, and the lack of, and need for, a grizzly hunting season being consistent themes. This year was no different (Appendices C and D). In 2000 we started getting a limited number of comments about high wolf numbers. This year was no exception. We continue to get comments about the expansion of Nahanni NPR, mostly about lost hunting opportunities.

Table 4: Satisfaction ratings for non-resident hunters (including non-hunting guides) in the Mackenzie Mountains, 1996-2017.

Rating	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
Number of Hunters Reporting	220	195	290	262	207	212	210	193	191	239
Excellent (%)	95	86	86	88	86	93	90	88	86	85
Very Good (%)	4	12	12	10	11	5	6	10	12	10
Good (%)	1	2	2	2	2	2	4	1	2	4
Fair (%)	0	0	0	0	1	0	0	1	0	1
Poor (%)	0	0	0	0	0	0	0	0	0	0

Rating	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
Number of Hunters Reporting	239	230	256	229	191	193	191	158	157	202	144	224
Excellent (%)	81	80	90	84	82	82	75	76	73	80	78	77
Very Good (%)	12	16	7	10	15	15	16	17	20	17	17	17
Good (%)	5	3	2	5	3	3	6	6	5	2	3	2
Fair (%)	2	1	1	0	0	0	1	0	1	1	1	3
Poor (%)	0	0	0	1	0	0	1	1	2	0	1	1

It was the first time hunting in the Mackenzie Mountains for 179 of 231 (77%) respondents (including non-hunting guides). The 52 repeat hunters had hunted from two to eight times previously. Of 231 respondents (including non-hunting guides) 91% indicated they would like to return to the Mackenzie Mountains to hunt in the future.

ENR continues to provide outfitters with summary meat record forms which can be used in conjunction with AMMO meat forms to provide better reporting of harvested meat. Both forms record the amount of meat (Dall's sheep, northern mountain caribou, moose, and mountain goat) taken from harvested animals and how the meat was used and/or distributed. For the seventh consecutive year we received summary forms from all eight outfitters. Additionally, 53 AMMO meat forms were also submitted.

The distribution of wild game meat by outfitters is an important and greatly appreciated local benefit but can often be a topic of heated local debate. Meat is used in outfitter camps by guides and clients, is taken out with clients, and is provided to local communities. We believe that the information from summary meat record forms provides a better overall picture of the amount of wild game meat being distributed by the outfitters. Generally the majority of meat from harvested Dall's sheep and mountain goats is used in outfitter camps. Nevertheless, at least 1,344 kg (2,956 lbs.) from 186 harvested Dall's sheep was distributed locally. Northern mountain caribou and moose meat is also used in outfitter camps, but harvested mountain caribou and moose make up a large portion of the wild game meat that is distributed locally: at least 7,223 kg (15,891 lbs.) from 195 northern mountain caribou and at least 10,372 kg (22,820 lbs.) from 64 moose. If we use an extremely conservative \$25/kg as the replacement cost for meat from local northern retailers, then some \$473,500 of meat was distributed locally in 2017.

Dall's Sheep (*Ovis dalli*)

Although Dall's sheep is one of the most desired species sought by non-resident hunters in the Mackenzie Mountains the proportion of Dall's sheep tags purchased this year (57%) was the lowest recorded in 23 years with only 222 tags purchased (Table 5). The reduced number of sheep hunters this year appears to be directly related to a dramatic drop in sheep clients for D/OT/02 over the past two seasons. With the expansion of NNPR in 2016, this zone had its hunting area reduced by almost 80%.

At least 84% of sheep tag holders (including four resident hunters) pursued Dall's sheep, harvesting 186 rams, one of the fewest annual harvests since 1991 (Figure 4, Appendix F). The mean ($\pm$ SD) length of a sheep hunt was 4.3 ± 3.0 days, similar to hunt lengths from 1997-2017 (Table 6), but less than the 5.3 day average from 1979-1990 (Latour and MacLean 1994). Outfitted hunts in the Mackenzie Mountains are generally booked for ten days; when hunters fill their sheep tag, any remaining time is typically spent in pursuit of other big game species for which tags are held, or in hunting small game. The number of hunters taking multispecies hunts has increased in recent years (Jim Lancaster personal communication and Werner Aschbacher personal communication).

Harvest by non-residents comprises at least 90% of the total annual harvest of Dall's sheep in the Mackenzie Mountains and takes only 0.9-1.6% of the estimated 14,000-26,000 Dall's sheep in the Mackenzie Mountains (Veitch et al. 2000a). The 2017 harvest of 186 rams is 1.3% of 14,000. Therefore, the current non-resident harvest level appears well within sustainable limits, provided that hunting pressure is geographically distributed across each of the zones. In the Yukon (YT), where harvest is managed by a full curl rule, the sustainable harvest is set at 4% of the non-lamb population; if the management objective is to increase population size, harvest is limited to 2% of the total population. (YT Renewable Resources 1996).

There has been remarkable consistency in the mean outside contour length of the right horns from rams harvested by non-residents for the past 46 years (1972-2017), mean 89.0 ± 1.6 cm (SD) (Appendix E, Table 7), which is surprising given the increase in average age of harvested sheep during that same period. We expected to see more broomed or broken horn tips on older animals, since horn breakage generally occurs as a result of fights between rival males (Geist 1993).

The maximum left and right horn lengths reported in 2017 were 108.5 and 110.0 cm respectively (Table 7). The maximum horn length recorded by Boone and Crockett for Dall's sheep in North America is 115.6 cm (45.5 in.) for a sheep taken from the Mackenzie Mountains in 1973. One of the top 50 Dall's sheep recorded in the 13th edition of the Boone and Crockett Club record book are from the Mackenzie Mountains; the highest scoring horns hold 32nd place (Boone and Crockett Club on-line trophy database accessed 2018).

The Safari Club International (SCI) offers another measuring system for antlered animals. They have a unique all-inclusive record keeping system, the most used system in the world. Unlike Boone and Crockett scoring, this system has no deductions or penalizing for antler asymmetry, and provides points for all tines, which is important for caribou antlers (Jim Lancaster personal communication). Eleven of the top 50 Dall's sheep in the SCI on-line record book are from the Mackenzie Mountains. One sheep harvested in 1983 holds 12th place in scoring (SCI on-line trophy database accessed 2018).

Table 5: Tags for big game species purchased by non-resident hunters with outfitters in the Mackenzie Mountains, 1995-2017.

Species	2017 390 Hunters		2016 389 Hunters		2015 447 Hunters		2014 402 Hunters		2013 401 Hunters		2012 396 Hunters		2011 400 Hunters		2010 384 Hunters		2009 339 Hunters		2008 391 Hunters	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Dall's Sheep	222	57	252	65	291	65	264	66	264	66	270	68	251	63	253	66	215	63	261	67
Mountain Caribou	308	79	319	82	347	78	327	81	296	74	300	76	314	79	295	77	252	74	275	70
Moose	102	26	121	31	117	26	123	31	131	33	115	29	121	30	116	30	96	28	109	28
Mountain Goat	28	7	25	6	71	16	57	14	58	14	42	11	55	14	45	12	45	13	45	12
Wolf	303	78	310	80	358	80	298	74	299	75	292	74	285	71	294	77	252	74	228	58
Wolverine	179	46	190	49	179	40	154	38	155	39	153	39	163	41	171	45	133	39	111	28
Black Bear	18	5	18	5	20	4	19	6	34	8	16	4	32	8	28	7	22	6	2	1

Species	2007 399 Hunters		2006 407 Hunters		2005 394 Hunters		2004 337 Hunters		2003 347 Hunters		2002 329 Hunters		2001 339 Hunters		2000 332 Hunters		1999 321 Hunters		1998 345 Hunters	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Dall's Sheep	266	67	276	68	246	62	229	68	257	74	218	66	220	65	231	70	227	71	246	71
Mountain Caribou	272	68	274	67	285	72	243	72	247	71	229	69	201	59	206	62	181	56	223	65
Moose	108	27	112	28	101	26	84	25	85	24	68	21	65	19	69	21	63	20	69	20
Mountain Goat	50	13	21	5	40	10	24	7	18	5	18	5	12	4	12	4	6	2	23	7
Wolf	227	57	201	49	214	51	166	49	207	60	159	48	137	40	155	47	89	28	165	48
Wolverine	150	38	108	27	154	39	89	26	141	40	97	29	83	25	85	26	65	20	99	29
Black Bear	7	2	3	1	40	10	8	2	9	3	3	1	0	0	6	2	2	<1	2	<1

Species	1997 352 Hunters		1996 387 Hunters		1995 343 Hunters	
	N	%	N	%	N	%
Dall's Sheep	252	72	252	65	218	64
Mountain Caribou	260	74	274	71	233	68
Moose	73	21	74	18	70	20
Mountain Goat	30	8	14	4	16	5
Wolf	209	59	193	50	72	21
Wolverine	135	38	114	30	35	10
Black Bear	8	2	0	0	0	0

Table 6: Mean length, SD and range (in days) of Dall's sheep hunts where at least one day was spent hunting from 1997-2017.

		2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
Number of Reports		186	185	213	206	193	207	173	179	179	192
Mean Hunt Length		4.2	4.0	4.0	3.8	4.0	4.0	4.0	4.0	3.9	3.7
SD		3.0	3.0	3.0	2.9	3.0	3.0	3.0	3.0	2.6	2.6
Range		1-18	1-14	1-15	1-14	1-13	1-14	1-11	1-13	1-10	1-14
	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
Number of Reports	216	214	190	167	189	174	176	198	201	224	216
Mean Hunt Length	4.1	4.1	4.1	4.0	3.8	4.7	4.8	4.6	4.7	4.4	4.3
SD	2.6	2.7	2.6	2.9	2.9	2.7	3.0	2.7	3.1	2.8	2.6
Range	1-13	1-12	1-14	1-17	1-12	1-15	1-15	1-15	1-16	1-15	1-12

Table 7: Measurements of Dall's sheep ram horns from sheep harvested by non-resident hunters in the Mackenzie Mountains, 2017.

	Left Horn Contour Length		Right Horn Contour Length		Left Horn Base Circumference		Right Horn Base Circumference		Tip To Tip Spread	
	cm	in	cm	in	cm	in	cm	in	cm	in
Mean	89.7	35.3	88.5	34.8	32.2	12.7	32.1	12.6	59.6	23.5
SD	7.7	3.0	8.7	3.4	1.6	0.6	1.5	0.6	10.6	4.2
Maximum	108.5	42.7	110.0	43.3	38.0	15.0	37.0	14.6	97.5	38.4
Minimum	59.0	23.2	34.0	13.4	28.0	11.0	28.0	11.0	33.0	13.0

This year we aged 183 of 186 harvested rams; 133 (73%) were ≥ 10 -years-old. The mean age ($\pm$ SD) of harvested rams was 10.7 ± 1.9 years (range 6.5-14.5 years, Figure 6). This is the fourth highest average age of harvested rams recorded in the Mackenzie Mountains since records have been kept (1967), and the 30th consecutive year where the reported mean age of harvested rams was 9.5 years or older (Appendix E). The 30% broomed left horns this year is similar to the 21 year average of 30%, however we report 37% brooming on the right horn versus the 21 year average of 31%.

The continued high age of harvested trophy sheep may be a result of harvest being spread out in time and space within hunting zones. Exclusivity of non-resident big game harvesting within each zone provides the opportunity for outfitters to harvest in different parts of their zone on a rotational basis and forgo hunting in some areas for two or three seasons. In recent years some outfitters have used helicopters to gain access into areas not accessible by horseback (e.g. S/OT/04). These areas have not been exposed to hunting previously, and spread out the harvest in space, likely contributing to the continued high average age of harvested rams.

Horns are not shed and provide detailed records of growth history in the form of discernable annual growth segments, or annuli. Annuli are evident in the keratin sheath of the horn, and form as the result of a stop-start pattern of growth in the winter and spring seasons, respectively. Horn growth can be limited by resource availability which is regulated by regional climatic conditions (Hik and Carey 2000). Examining horn growth

patterns over time can reveal years of high and low environmental productivity. Since 2002 ENR has tried to measure the annuli from as many harvested Dall's sheep rams as possible using a flexible tape to measure the length and basal circumference of each segment; from 2002-2017, 837 Dall's sheep horns were measured.

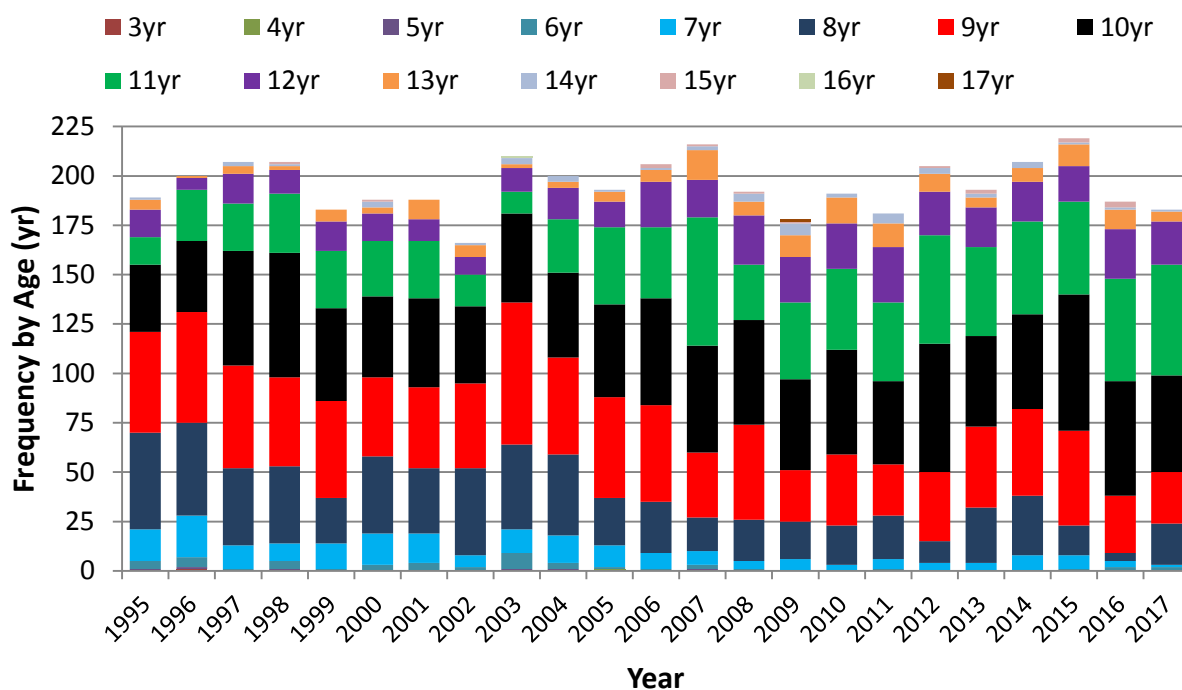


Figure 6: Age-structure of Dall's sheep ram harvest by non-resident and resident hunters in the Mackenzie Mountains, 1995-2017, based upon counting horn annuli.

Preliminary results on measurements collected until 2015 showed that horn growth patterns were influenced by year of birth and demonstrated both statistically and biologically significant variation in volume acquisition as a function of age. This reveals the presence of a cohort effect, which suggests that birth year conditions impact the growth rates of Dall's sheep in the southern Mackenzie Mountains (K. Eykelboom unpublished data). Although the underlying cause of this variation is not clear, similar trends were seen in neighbouring populations of Dall's sheep in the YT. It is likely that climate plays a role in horn growth variation, and correlations in the YT have been found between horn growth periodicity and inter-decadal climate variability (Hik and Carey 2000). A more detailed analysis of these growth patterns using the 2002-2017 dataset of measurements is

currently underway using a general linear mixed modeling approach (Sofia Karabatsos personal communication).

Although Festa-Bianchet et al. (2014) implicated trophy hunting of bighorn sheep in a limited range in Alberta as a factor in their reduced horn size and increased age of harvest over time, Kennedy (2017), using horn measurements from the Mackenzie Mountains collected 2002-2016 found no evidence of such. A low level of harvest in the Mackenzie Mountains relative to other ranges also reduces selection pressures (Heffelfinger 2018).

We calculated an estimated 57 lambs per 100 ewes based upon hunter classifications of sheep observed during their hunts in 2017 (Table 8); this is similar to the 55 lambs:100 ewes average reported since 1995 (Appendix G). Average ratios of 62.8 (range 36.7-83.0) and 55.1 (range 17.3-94.1) lambs:100 ewes were reported from ground-based surveys in the northern Sahtú region of the Mackenzie Mountains during 1997-2014 (A. Veitch unpublished data, Heather Sayine-Crawford personal communication).

The sheep population in the Richardson Mountains of the northern YT and NWT has been undergoing a continued decline since reaching peak numbers in 2003 (Lambert Koizumi et al. 2011) with the 2014 estimate at <500 (Davison and Callaghan 2018). The estimated number of lambs per 100 'nursery sheep' has ranged from 13-46 with 36 lambs:100 'nursery sheep' in 2014 (Davison and Callaghan 2018). Surveys in the southwestern YT conducted during late June-mid-July 2015 classified 5,460 sheep, reporting a similar ratio of 37 lambs per 100 nursery sheep; the actual recruitment in lambs:100 ewes would be higher (Troy Hegel personal communication).

Differences in adult sex ratios among populations may result from differences in hunting pressure, differences in survival of males and females from birth to adulthood, or both (Nichols and Bunnell 1999). However, since the ratio of rams to ewes is almost never equal in wild populations of mountain sheep, even where they are unhunted, it is clear that there is a different natural mortality rate for the two sexes. This difference was believed to be a result of injuries and stress accumulated by males during the breeding season (Geist 1971).

Table 8: Observations of Dall’s sheep reported by non-resident hunters in the Mackenzie Mountains, 2017.

	Number of Hunters Reporting	Number Observed	Mean Number Observed/Hunter	% of Sheep Classified
Rams	194	3,387	17.0	31.2
Ewes ¹	188	4,750	25.0	43.8
Lambs	181	2,707	15.0	25.0

¹ includes females >1-yr-old, yearlings, and younger rams; also called nursery sheep.

The 71 rams:100 ewe ratio estimated from hunter observations in 2017 is the lowest reported from 1995-2017 (Appendix G), but is higher than reported elsewhere. Sheep observations from a substantial part of their southern range have not occurred since 2015 with the expansion of NNPR. Loss of observations in these ranges could affect these ratios which have been below the average 86 rams:100 ewes from 2015-2017. Ground-based surveys conducted in July in two areas of the northern Sahtú region of the Mackenzie Mountains on an annual or semi-annual basis from 1997-2011 reported average ratios of 63.4 and 58.1 rams:100 ewes (A. Veitch unpublished data).

In the YT, mid- to late June annual aerial surveys to count and classify sheep from 1973-1998 reported a mean of 48 rams (range 28-74) per 100 ‘nursery sheep’ (J. Carey unpublished data). More recently, a similar survey of 5,460 sheep, in late June-mid-July 2015, reported 43 rams per 100 ‘nursery sheep’ (Troy Hegel personal communication). For the Richardson Mountains population (YT-NWT), the estimated ratios from 1984-2014 have ranged from 21-55 rams per 100 ‘nursery sheep’ (1984-2014) with 43 rams:100 ‘nursery sheep’ in 2014 (Davison and Callaghan 2018). In Alaska, ram:ewe ratio for two unhunted herds in Denali and Gates of the Arctic National Parks typically averaged 60-67:100 (Nichols and Bunnell 1999). In more heavily hunted Alaskan herds, ram:ewe ratio ranged from 33:100 (heavily hunted) to 87:100 (lightly hunted). The ram:ewe ratios reported for the Mackenzie Mountains since 1995 (Appendix G) suggest that the harvest of rams in the Mackenzie Mountains is sustainable at current levels.

This year hunters observed the greatest percentage of rams with $<\frac{3}{4}$ curl (59.8%; n=1,755), versus legal ($>\frac{3}{4}$ curl) rams (n=1,181) than in any previous year. However, the mean number of legal rams observed per hunt was 7.0, similar to most years (Table 9).

Table 9: Classification of Dall's sheep rams observed by non-resident hunters in the Mackenzie Mountains, 1995-2017.

	2017		2016		2015		2014		2013		2012		2011		2010		2009	
Ram Class	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl
Number of hunters reporting	169	169	142	130	215	202	208	186	156	149	140	124	149	133	158	142	139	132
Number of rams classified	1,181	1,755	968	1,186	1,406	1,693	1,372	1,484	1,006	1,230	1,117	987	1,234	1,168	1,314	1,620	1,040	1,093
% of rams classified	40.2	59.8	44.9	55.1	45.4	54.6	48.0	52.0	45.0	55.0	53.0	47.0	51.4	48.6	48.8	55.2	48.8	51.2
Mean number of rams observed/hunt	7.0	10.0	7.0	9.0	7.0	8.0	7.0	8.0	6.0	8.0	8.0	8.0	8.0	9.0	8.3	11.4	7.5	8.3
	2008		2007		2006		2005		2004		2003		2002		2001		2000	
Ram Class	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl	Horn > ³ / ₄ Curl	Horn < ³ / ₄ Curl
Number of hunters reporting	184	174	150	168	108	171	186	182	188	183	127	121	148	133	186	174	151	147
Number of rams classified	1,520	1,698	1,902	2,266	1,769	2,019	1,787	1,899	2,185	2,324	1,662	1,654	1,720	1,720	1,812	1,765	1,351	1,717
% of rams classified	47.2	52.8	45.6	54.4	46.7	53.3	48.5	51.5	48.5	51.5	50.1	49.9	50.0	50.0	50.7	49.3	44.0	56.0
Mean number of rams observed/hunt	8.3	9.8	11.0	13.5	9.9	12.0	9.6	10.4	11.6	12.7	11.9	11.9	11.6	12.9	9.7	10.1	8.9	11.7

	1999		1998		1997		1996		1995	
Ram Class	Horn >³/₄ Curl	Horn <³/₄ Curl	Horn >³/₄ Curl	Horn <³/₄ Curl	Horn >³/₄ Curl	Horn <³/₄ Curl	Horn >³/₄ Curl	Horn <³/₄ Curl	Horn >³/₄ Curl	Horn <³/₄ Curl
Number of hunters reporting	144	138	177	177	205	205	172	174	181	180
Number of rams classified	1,579	1,756	1,848	1,924	1,538	1,586	1,713	1,699	2,070	1,645
% of rams classified	47.3	52.7	49.0	51.0	49.2	50.8	50.2	49.8	55.7	44.3
Mean number of rams observed/hunt	11.0	12.7	10.4	11.3	7.5	7.7	10.0	9.8	11.4	9.1

Northern Mountain Caribou (*Rangifer tarandus caribou*)

In their 2002 assessment, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the boreal population of woodland caribou as Threatened, and the northern mountain population of woodland caribou as Special Concern. These two populations of woodland caribou were subsequently listed under the federal *Species at Risk Act* (SARA) in 2004 and 2007 respectively. Caribou of the Mackenzie Mountains are part of the northern mountain population of woodland caribou. In order to be more specific and to avoid confusion this report will use “northern mountain caribou” when referring to caribou from the Mackenzie Mountains.

Northern mountain caribou are another of the more desired species sought by non-resident hunters. Tags were purchased by 308 (79%) of non-resident hunters (Table 5), more than the average 268 (range 181-347) since reporting started in 1995, but less than purchased in 2014-2016. At least 63% of tag holders hunted caribou, harvesting 195 males, the greatest harvest since records have been kept (Figure 4; Appendix F). The mean ($\pm$ SD) length of a caribou hunt, determined from the 209 reports where hunters spent at least one day hunting, was 3.9 ± 3.0 days (range 1-21 days), comparable to that of previous years (Table 10).

We calculated ratios of 36.8 calves and 41.1 bulls (males) per 100 adult females (cows) based upon hunter classifications of northern mountain caribou observed during hunts. Bulls comprised 23.1% of all caribou classified (Table 11). The calf:cow ratio estimated from hunter observations was below the average 42:100 (range 33-59:100), but up from the lowest ratio reported last year. The bull:cow ratio estimated from hunter observations was above the average 39:100 (range 21-61:100; Appendix G).

Based upon a limited number of incisor teeth ($n=84$) turned in voluntarily since 1975, the range in age of harvested male caribou is two to 13 years (mean 6.3 years, median 6.0 years); the majority being aged from five to eight years. Tooth ages are determined by

counting the cementum annuli much like the growth rings of a tree: June 1 is used as the birthdate for caribou (Matson 1981, www.matsonslab.com).

Table 10: Mean length, SD and range (in days) of northern mountain caribou hunts where at least one day was spent hunting from 2000-2017.

	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Number Reports	209	190	206	190	196	180	187	175	155	190	172
Mean Hunt Length	3.9	4.0	4.0	4.0	3.0	4.0	3.0	4.0	4.0	3.0	4.0
SD	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	3.0	3.2
Range	1-21	1-20	1-18	1-14	1-13	1-17	1-16	1-14	1-14	1-15	1-16

	2006	2005	2004	2003	2002	2001	2000
Number Reports	171	191	120	172	181	178	141
Mean Hunt Length	4.3	3.7	4.9	3.8	3.6	4.3	4.0
SD	3.1	3.8	3.9	2.8	2.7	3.2	2.7
Range	1-14	1-32	1-34	1-14	1-12	1-15	1-12

Table 11: Observations of northern mountain caribou reported by non-resident hunters in the Mackenzie Mountains, 2017.

Sex/Age Class	Number of Hunters Reporting	Number Observed	Mean Number Observed/hunter	% of Total Classified
Bulls	203	4,854	23.9	23.1
Cows	183	11,823	64.6	56.2
Calves	162	4,350	26.9	20.7

Although antler measurement information sometimes goes unreported on outfitter forms, we received antler lengths from 114 (58%) successful hunters. This year, as in other years, there was substantial variation in antler lengths, range 85.0-152.0 cm (33.5-59.8 in.). The maximum left and right antler lengths reported were 152.0 and 150.2 cm respectively (Table 12). The maximum antler length recorded by Boone and Crockett for northern mountain woodland caribou in North America is 158.5 cm (62.4 in.) for a caribou taken from the Mackenzie Mountains in 1978. Thirteen of the top 50 mountain woodland caribou recorded are from the Mackenzie Mountains; the highest scoring antlers hold 9th place (Boone and Crockett Club on-line trophy database accessed 2018). Twenty-two of the top 50 mountain woodland caribou recorded in the SCI on-line record book are from the Mackenzie Mountains, with a caribou harvested in 2006 holding second place in scoring (SCI on-line trophy database accessed 2018).

Since 1991 the percentage of bulls observed by clients in the Mackenzie Mountains has never been greater than 28%. This is lower than the cumulative 39% average adult bull component reported by Bergerud (1978) in his summary of eight North American caribou populations that were either non-hunted or hunted non-selectively (i.e., both males and females included in the harvest). Veitch et al. (2000c) classified 2,659 of an estimated 5,000 caribou in the central Mackenzie Mountains in August 1999 and reported only 25% of those animals as males. Surveys done on the presumed rutting grounds of the South Nahanni caribou population in 1995, 1996, and 1997 reported 24, 28, and 20% of animals classified as males ≥ 1 -year-old (Gullickson and Manseau 2000) and in 2001 reported 27%

bulls (Gunn et al. 2002). A 2007 survey during the rut estimated 33.7 bulls:100 adult cows (R. Farnell and K. Egli unpublished data). A 2008 composition count during the rut in the same general area estimated a slightly higher ratio of 35.5 bulls:100 adult cows (Troy Hegel personal communication).

Table 12: Antler measurements of northern mountain caribou bulls harvested by non-resident hunters in the Mackenzie Mountains, 2017. All measurements are in cm (in.).

	Contour Length	
	Left Antler (cm)	Right Antler (cm)
Number Measured	114	114
Mean	118.8 (46.8 in.)	117.8 (46.4 in.)
SD	59.3 (23.4 in.)	58.9 (23.2 in.)
Maximum	152.0 (59.8 in.)	150.2 (59.1 in.)
Minimum	92.0 (36.2 in.)	85.0 (33.5 in.)

Since 1991 the percentage of bulls observed by clients in the Mackenzie Mountains has never been greater than 28%. This is lower than the cumulative 39% average adult bull component reported by Bergerud (1978) in his summary of eight North American caribou populations that were either non-hunted or hunted non-selectively (i.e., both males and females included in the harvest). Veitch et al. (2000c) classified 2,659 of an estimated 5,000 caribou in the central Mackenzie Mountains in August 1999 and reported only 25% of those animals as males. Surveys done on the presumed rutting grounds of the South Nahanni caribou population in 1995, 1996, and 1997 reported 24, 28, and 20% of animals classified as males ≥ 1 -year-old (Gullickson and Manseau 2000) and in 2001 reported 27% bulls (Gunn et al. 2002). A 2007 survey during the rut estimated 33.7 bulls:100 adult cows (R. Farnell and K. Egli unpublished data). A 2008 composition count during the rut in the same general area estimated a slightly higher ratio of 35.5 bulls:100 adult cows (Troy Hegel personal communication).

Nagy (2011) determined ten activity periods for northern mountain caribou in the Sahtú using movement data from satellite collared caribou (Olsen 2000, 2001). The breeding period, or rut, was defined as October 9-25. This period was also the activity period with the greatest daily movement rate (Nagy 2011). Hunter observation data are collected and the 1999 survey was carried out prior to the breeding period (Veitch et al. 2000c). Surveys conducted well before the rut or breeding period may underestimate the male component of the population. The surveys in 2007 and 2008 were conducted in late September and early October, just prior to the defined breeding period, and findings were more comparable to what Bergerud (1978) reported. Based upon hunter observations there is some evidence that the proportion of males differs between populations, with male:female ratio lower in Redstone than in Bonnet Plume; this difference has been consistent over the past 20-25 years (Larter 2012a; Larter 2018). Further investigation is required to explore demographic attributes of northern mountain caribou in the Mackenzie Mountains.

Northern mountain caribou in the Mackenzie Mountains are estimated to number between 15,000 and 20,000 from at least three separate populations shared between the YT and NWT (Figure 7). Currently, estimated population sizes (excluding calves) are *ca.* 4,200 for the Bonnet Plume, a minimum of 7,300 for the Redstone, and *ca.* 2,700 for the greater Nahanni (South Nahanni, Coal River and Labiche pooled) population (COSEWIC 2014). These caribou are subjected to an annual bull-selective non-resident harvest averaging 165 males per year (1991-2017). The resident harvest of northern mountain caribou in the Mackenzie Mountains also tends to be bull-selective (but not restricted to bulls). Based upon an analysis of resident hunter questionnaires *ca.* 20-25 animals were harvested annually from 2001-2010. Harvest from 2011-2015 increased to *ca.* 45 animals but remains generally light (S. Carrière unpublished data). Subsistence harvest includes both males and females, with the proportion of each dependent on the time of year that animals are harvested (J. Snortland unpublished data, ENR unpublished data). Subsistence harvesters in the Mackenzie Mountains include residents of both the NWT and YT; harvest is generally not reported.

A study on the Redstone population of northern mountain caribou was initiated by the SRRB in March 2002 when ten female caribou in the central and north-central Mackenzie Mountains were equipped with satellite radio collars (Creighton 2006, Olsen 2000, 2001, Olsen et al. 2001). Analysis of these location data indicated that some of the collared animals in the range of the Redstone population are relatively sedentary year round, while others show the more typical seasonal migratory movements (J. Nagy personal communication).

Satellite collars were deployed on nine adult female caribou during March 2000 and October 2001 by the YT Department of the Environment (Jan Adamczewski personal communication). These animals were believed to be part of the greater Nahanni population. As part of a co-operative study between YT Territorial Government, Parks Canada (PC) and the Wildlife Conservation Society, 18 female caribou were equipped with satellite collars in October 2004 along the YT-NWT border. These caribou were also believed to be from the greater Nahanni population, but three animals were determined to be from the Finlayson population (Weaver 2006). In October 2008, 30 female caribou were equipped with satellite collars along the YT-NWT border in order to assess spatial distribution, habitat use, and population characteristics of the South Nahanni and Coal River herds of the greater Nahanni population. Collared animals permitted herd estimates based upon mark-recapture methodology and indicated stability to a slightly increasing trend for the South Nahanni herd (Hegel et al. 2016).

Tulít'a regularly conducts community hunts in the Caribou Flats. Biological samples were collected from 43 northern mountain caribou harvested during hunts in 2013 and 2014. Blood and fecal samples were screened for pathogens, parasites and exposure to diseases. Body condition scoring was made using depth of back fat, the kidney fat index, percent bone marrow fat, and a pre-defined four score qualitative index. Preliminary results documented pathogens, diseases, and parasites that have been reported in caribou elsewhere (e.g. Johnson et al. 2010), but some were the first reported for mountain

woodland caribou. No animals tested positive for *Brucella* (Carlsson et al. 2015). With the recently established study on the health and condition of ungulates in the Mackenzie Mountains, ENR hopes to build on this baseline information.

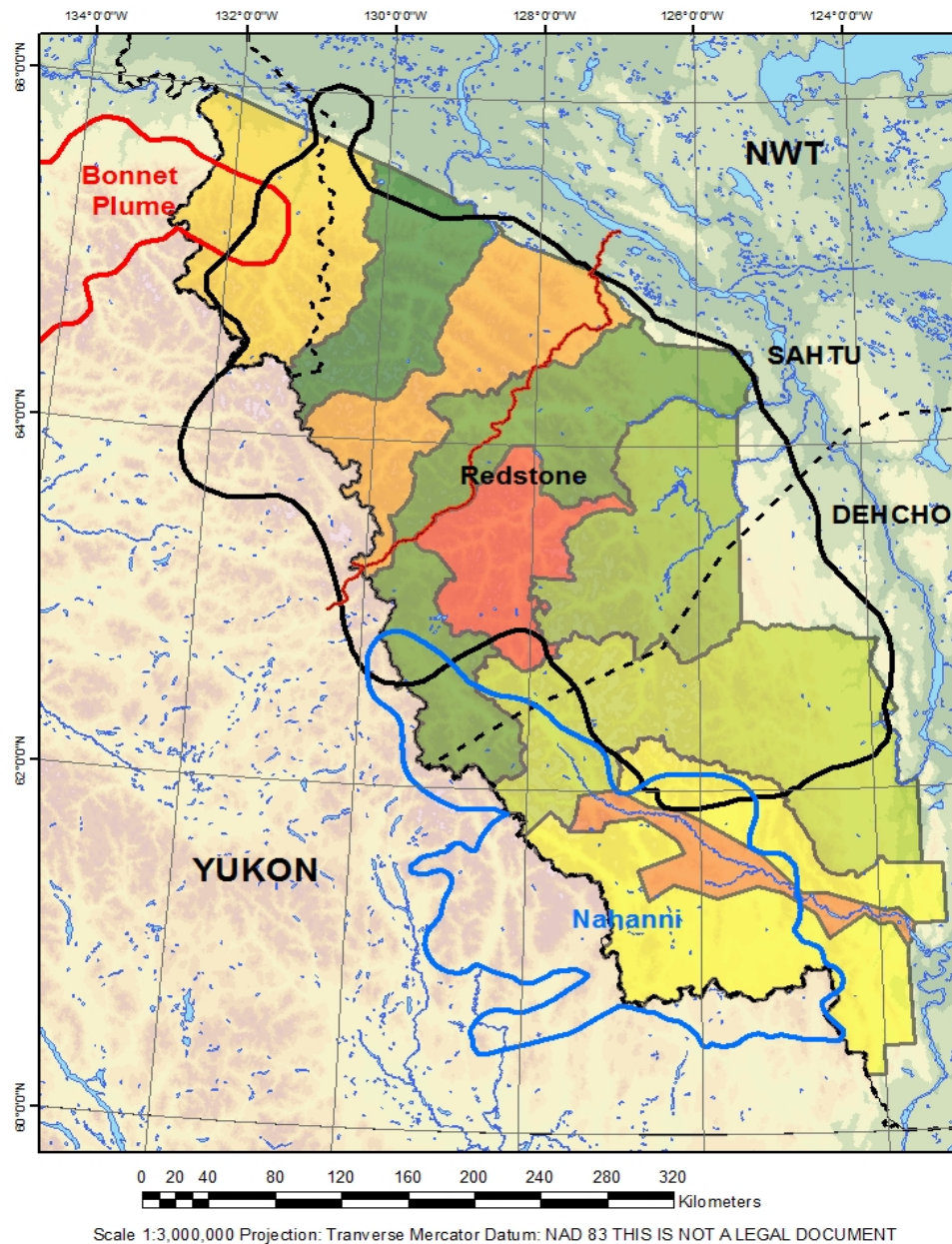


Figure 7: Distribution of Bonnet Plume (in red), Redstone (in black), and greater Nahanni (in blue) caribou populations following COSEWIC (2014) population polygons. Map: GNWT/B. Fournier, ENR (2013).

Moose (*Alces americanus*)

Tags to hunt moose were purchased by 26% (n=102) of non-resident hunters in 2017, slightly above the 25% average purchased from 2005-2017 (Table 5). At least 63% of tag holders hunted moose and harvested 64 bulls. The 2017 harvest was higher than the average 59 moose (range 32-85) harvested annually since 1991, but lower than the average annual harvest of 75 during 2005-2016 (Figure 8). The number of moose tags purchased increased in 2005 (Table 5, Appendix F). Success rates for moose hunts have remained relatively stable, but the increased number of tag sales in recent years has resulted in an increased overall harvest (Figure 8). The mean ($\pm$ SD) length of a moose hunt, determined from the 67 reports where hunters spent at least one day hunting, was 3.8 ± 3.4 days (range 1-21 days), similar to reports from previous years (Table 13).

In 2005 there was a noticeable increase in moose harvest relative to pre-2005 levels. The consistently higher post-2004 harvest levels were likely in part related to the change in ownership of outfitting zone D/OT/01 (Figure 8). This zone is one of the largest, with an abundance of good moose habitat. From 1991-2004 the average harvest was <4 moose/year because most clients wanted to hunt Dall's sheep. The new owner has many European clients who are specifically looking for trophy moose for European mounts. He also began accessing previously unhunted areas of the zone. From 2005-2017 the average annual harvest has been *ca.* 20 moose from this zone. Moose in the Mackenzie Mountains are considered to be of the Alaska-YT subspecies, physically the largest subspecies of moose with large males attaining *ca.* 725 kg. (www.adfg.alaska.gov/index.cfm?adfg=moose.main). Recently, the Mackenzie Mountains have emerged as one of the top destinations to have success in taking these large moose (Jim Lancaster personal communication).

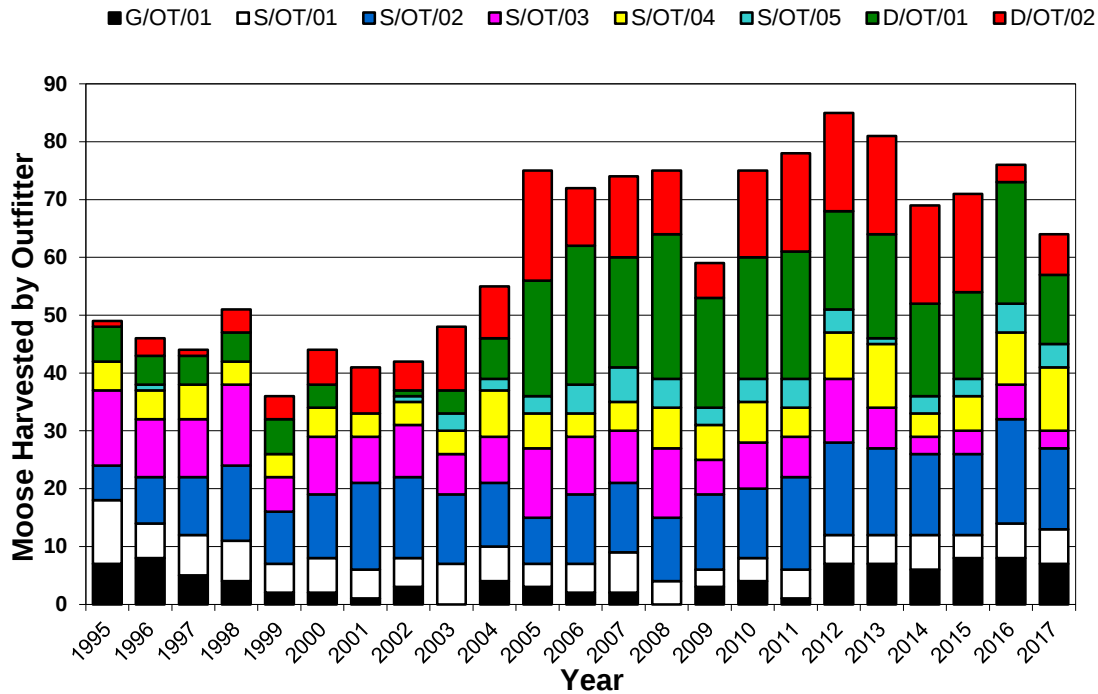


Figure 8: Moose harvested by individual Mackenzie Mountain outfitters from 1995-2017.

Table 13: Mean length, SD and range (in days) of moose hunts where at least one day was spent hunting from 2000-2017.

	2017	2016	2015	2014	2013	2012	2011	2010	2009
Number Reports	67	73	73	71	91	85	86	86	68
Mean Hunt Length	3.8	4.0	3.0	4.0	4.1	4.2	4.1	4.5	4.2
SD	3.4	3.0	3.0	3.0	3.1	3.1	2.8	4.0	3.4
Range	1-21	1-16	1-13	1-14	1-15	1-15	1-14	1-18	1-14
	2008	2007	2006	2005	2004	2003	2002	2001	2000
Number Reports	82	80	72	85	49	60	46	42	48
Mean Hunt Length	3.6	4.0	3.6	4.4	4.8	3.9	3.6	3.7	4.4
SD	2.9	2.5	2.7	3.1	3.3	2.8	2.6	2.9	2.7
Range	1-16	1-9	1-11	1-14	1-12	1-14	1-12	1-12	1-12

Based upon a limited number of incisor teeth (n=139) turned in voluntarily since 2003, the range in age of harvested male moose is three to 15 years (mean 7.7 years, median 7.0 years); the majority being aged from five to nine years. Tooth ages are determined by counting the cementum annuli much like the growth rings of a tree; June 1 is used as the birth date for moose (Matson 1981, www.matsonslab.com).

The mean ($\pm$ SD) tip-to-tip spread of measured antlers (n=49) from bull moose harvested in 2017 was 146.0 ± 63.8 cm (57.5 ± 25.1 in) similar to other years (Table 14). The maximum recorded antler spread of 172.0 cm (67.7 in.) this year was less than the record spread of 196.9 cm (77.5 in.) for a moose harvested 1982. One moose taken from the Mackenzie Mountains currently holds 21st place in the record book of the 13th edition of the Boone and Crockett Club; another holds 27th place (Boone and Crockett Club on-line trophy database accessed 2018). Three of the top 50 Alaska-YT moose recorded in the SCI on-line record book are from the Mackenzie Mountains, with a moose harvested in 1996 holding the highest placement (44th; SCI on-line trophy database accessed 2018). A moose harvested during the 2010 season ranks second as a Pope and Young World Record moose with a score of 241 5/8.

We calculated a ratio of 29.5 calves:100 adult females (cows) based upon hunter observations of moose during hunts (Table 15, Appendix G). The calves:100 cows in 2017 is similar to the average 30:100 calf:cow ratio (range 20-36:100) recorded since 1995. The calf:cow ratios reported for the fall in the Mackenzie Mountains remain lower than the 40-60:100 that is generally documented during early to mid-winter aerial surveys for moose along the Mackenzie River in the vicinity of the communities of Fort Good Hope (MacLean 1994a), Norman Wells (Veitch et al. 1996) and Tulít'a (MacLean 1994b) (Appendix G). However, these surveys were conducted after the major fall subsistence harvest and variable female harvest can certainly impact the interpretation of calf:cow ratios. As no research has been done on moose in the Mackenzie Mountains, we have no explanation for the apparent discrepancy in calf production, survival, or both between the mountains and

the river valley. A survey of moose in the Norman Wells study area in January 2001 estimated a calf:cow ratio of 18:100 (ENR Norman Wells unpublished data). Aerial surveys of the Mackenzie River Valley and vicinity in the Dehcho region south from the Blackwater River to Jean Marie River conducted in Novembers 2003, 2011, and 2017 estimated calf:cow ratios of 32.5:100, 54.4:100, and 34.4:100 (Larter 2009; N. Larter and D. Allaire unpublished data). These studies indicate that low calf:cow ratios may not be restricted to the Mackenzie Mountains and that further studies are required to determine the cause(s).

Table 14: The yearly mean and range of measured bull moose tip-to-tip antler spread in cm (in.).

	2017	2016	2015	2014	2013	2012	2011	2010
Measured (n)	49	61	59	61	69	67	69	65
Mean Spread	146.0 (57.5)	145.9 (57.4)	145.0 (57.1)	144.1 (56.7)	144.9 (57.0)	142.0 (55.9)	144.0 (56.7)	143.5 (56.5)
Range	100.0-172.0 (39.4-67.7)	86-169 (34.0-66.5)	94-185 (37.0-72.8)	89-185 (35.0-72.6)	97-170 (38.3-67.0)	98-161 (38.6-63.4)	113-168 (44.5-66.1)	106-174 (41.7-68.5)

	2009	2008	2007	2006	2005	2004	2003	2002
Measured (n)	53	63	62	56	53	38	34	32
Mean Spread	143.5 (56.5)	145.5 (57.3)	141.1 (55.6)	141.3 (55.6)	144.9 (57.0)	150.3 (59.2)	150.0 (59.1)	149.3 (58.8)
Range	92-175 (36.2-68.9)	101-174 (39.8-68.5)	102-179 (40.2-70.5)	107-170 (42.1-66.9)	122-165 (48.0-65.0)	127-174 (50.0-68.5)	107-165 (42.1-65.0)	103-178 (40.6-65.0)

	2001	2000	1999
Measured (n)	32	34	26
Mean Spread	144.3 (56.8)	147.0 (57.9)	144.2 (56.8)
Range	113-165 (44.5-65.0)	127-179 (50.0-70.5)	109-166 (42.9-65.4)

Table 15: Observations of moose reported by non-resident hunters in the Mackenzie Mountains, 2017.

Age/Sex Class	Number of Hunters Reporting	Number Observed	Mean Number Observed/Hunter	% of Total Classified
Bulls	103	432	4.2	42.7
Cows	95	448	4.7	44.3
Calves	52	132	2.5	13.0

We calculated a bull:cow ratio of 96:100 from the 2017 observations, below the 104:100 average from 1995-2017 (Table 15; Appendix G). Bull:cow ratios from the Mackenzie Mountains continue to be generally higher than the range of 27-105:100 reported in the YT (R. Ward cited *in* Schwartz 1997), 26-69:100 reported in Norway (Solberg et al. 2002), and the 16:100 from heavily harvested populations in Alaska (Schwartz et al. 1992).

There has been concern that low bull:cow ratios could influence conception dates, pregnancy rates and newborn sex ratios (Bishop and Rausch 1974, Crête et al. 1981, Solberg et al. 2002) and that management strategies should maintain a high bull:cow ratio (Bubenik 1972). Studies on tundra moose in Alaska have not found evidence that moose populations with low bull:cow ratios have reduced reproductive rates (Schwartz et al. 1992); populations with a more skewed sex ratio had a relative rate of population increase greater than populations without a skewed sex ratio (Van Ballenberghe 1983). However, a study of eight heavily harvested moose populations in Norway indicated a relationship between declining recruitment rate and skewed adult sex ratio (Solberg et al. 2002). Based upon hunter observations since 1995, there is no indication of any decreasing trend in the bull:cow ratio of moose in the Mackenzie Mountains, hence the adult sex ratios are an unlikely factor in the low calf:cow ratios reported. The reported sex ratios may have an inherent bias towards a greater number of bulls if harvesters consistently spend more time searching for moose in areas frequented more by large males than females.

Mountain Goat (*Oreamnos americanus*)

There has been a wide range in the number of mountain goat tags sold annually since 1995 (six to 71). Tag sales were consistently higher from 2005-2015 than during 1995-2004, but since 2016 have dropped dramatically. This year mountain goat tags were purchased by only 28 (7%) of non-resident hunters (Table 5).

The use of rotary aircraft in the 2000s increased access to more remote and rugged areas of their zones where goats were resident. During 2005-2015 more hunting packages included a mountain goat hunt, with 10-16% of hunters purchasing licences also purchasing a mountain goat tag. Increased accessibility to areas of untouched goat range has had some effect on the increased number of goat hunters and success in goat harvest during this period. The dramatic decrease in goat tags purchased since 2015 was anticipated because a large proportion of mountain goat range falls within the expanded boundaries of NNPR and as of 2016 hunting was prohibited in these areas. We anticipate the reduction in number of goat hunters and number of goat tags purchased will continue in future years likely remaining at recent low levels. Concomitantly, voluntary hunter observations of mountain goat will be reduced, restricted to limited parts of mountain goat range, and are less representative of mountain goat demography of the Mackenzie Mountains as a whole.

Six goats, all males, were harvested this year, similar to the mean annual harvest prior to 2005 (Appendix F). The mean ($\pm$ SD) length of a goat hunt, determined from the seven reports where hunters spent at least one day hunting, was 2.6 ± 1.7 days (range one to six days), similar to that reported in previous years (Table 16).

Mountain goats are known to inhabit five of the eight outfitting zones in the Mackenzie Mountains, occurring almost exclusively below 63°00'N (Veitch et al. 2002). They are most numerous in high relief terrain along the YT-NWT border between 61°00' and 62°00'N. However, since 1995 we have received hunter observations or harvest reports of goats from only four of those outfitter zones - D/OT/01, D/OT/02, S/OT/03 and S/OT/04 (Figure

1). In 2017, observations came from just two zones, D/OT/01 (n=77), and D/OT/02 (n=72); harvest occurred in both zones. We estimated 58.1 goat kids and 36.5 billies per 100 nannies based upon hunter observations. Both ratios were lower than the average 63.6 kids and 66.5 billies per 100 nannies estimated from 2002-2017 (Appendix H). One must note that these ratios are derived from fewer total animals located in a much smaller restricted area of goat range than ratios derived prior to 2016.

Table 16: Mean length, SD and range (in days) of goat hunts where at least one day was spent hunting from 2000-2017.

	2017	2016	2015	2014	2013	2012	2011	2010	2009
Number Reports	7	8	19	15	13	17	20	13	22
Mean Hunt Length	2.6	3.0	3.0	2.0	2.3	2.8	2.3	3.2	2.5
SD	1.7	2.0	2.0	2.0	1.3	1.7	1.2	1.9	2.0
Range	1-6	1-6	1-8	1-8	1-5	1-7	1-5	1-7	1-8
	2008	2007	2006	2005	2004	2003	2002	2001	2000
Number Reports	21	27	12	18	8	6	4	2	1
Mean Hunt Length	3.0	2.7	2.8	3.8	3.9	3.0	2.8	1.5	3.0
SD	1.8	1.7	1.5	2.8	1.6	2.6	1.9	0.7	n/a
Range	1-8	1-6	2-6	1-14	2-6	1-8	1-5	1-2	3

In 2005, we began estimating the age of harvested goats by counting horn annuli; we try to age as many harvested goats as possible. The average age of 170 harvested goats (153 billies and 17 nannies) is 8.0 years (range 2.5-16.5; median 7.5). Although most harvested goats are 4-10 years old, 25% (n=43) are >10 years old. This year a 16 year-old billie was harvested. Only one other billie this old has been harvested since records started in 2005.

The average age of 4.5 years (range 1-10; median 4.0; N=17) determined from archived incisor teeth (1972 n=10 and 1975 n=7) shows a somewhat younger distribution than that based upon counting horn annuli annually from 2005-2017. Tooth ages are determined by counting the cementum annuli much like the growth rings of a tree; June 1 is used as the birth date for mountain goat (Matson 1981, www.matsonslab.com).

The longest horns from a mountain goat taken in 2017 were 23.5 cm (left) and 24.4 cm (right). No mountain goats from the NWT are listed in the top 50 in the 13th edition of the Boone and Crockett Club record book (Boone and Crockett Club on-line trophy database accessed 2018). Based upon age and horn length data over the past twelve years there may be a somewhat linear relationship between age and horn length from 4.5-13.5 years, but for ages outside of that range there is almost no relationship. Large horned animals are found over a wide range of animal ages (Figure 9).

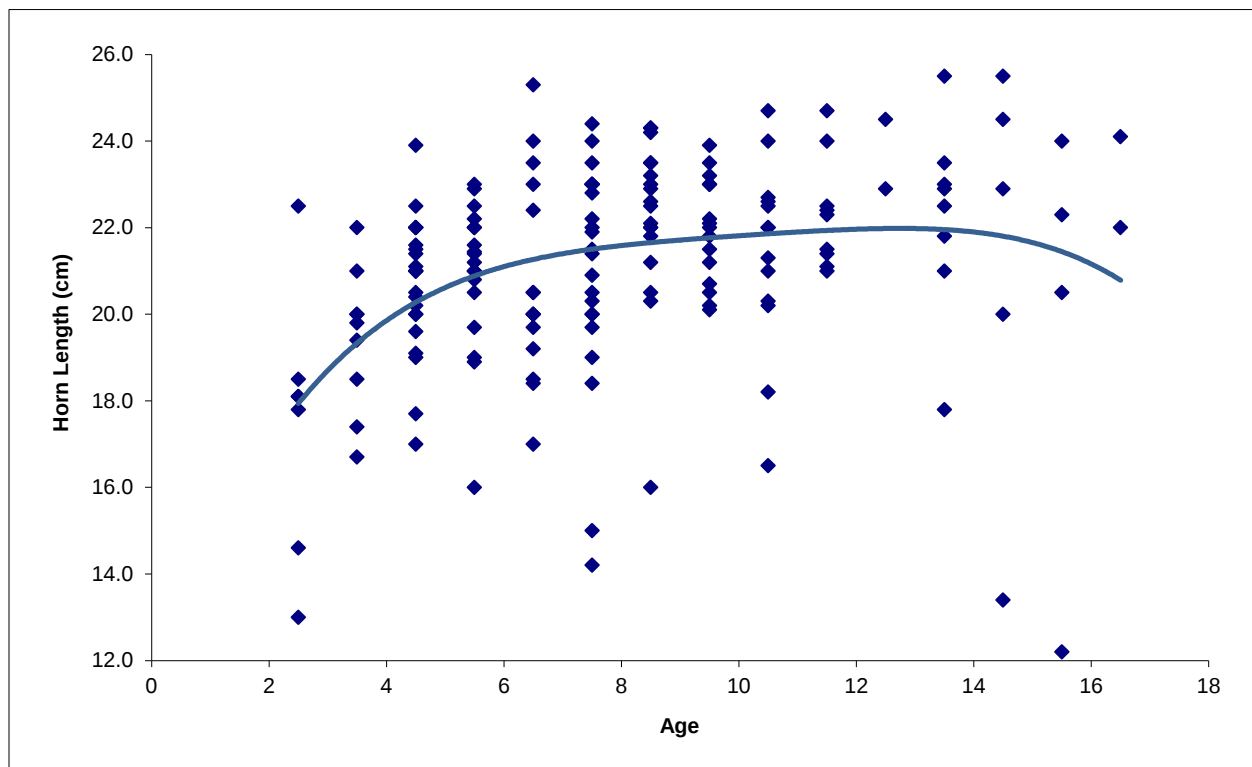


Figure 9: The relationship between the horn length (cm) and age (based upon horn annuli) from 170 mountain goats harvested in the Mackenzie Mountains 2005-2017. Line of best fit is a 4th order polynomial.

There is some evidence that goat numbers and distribution have been increasing in both zones D/OT/01 and D/OT/02 in the southern Mackenzie Mountains (Larter 2004, 2012b, Jim and Clay Lancaster and Werner Aschbacher personal communication). The total number of goats observed has been increasing in recent years and billies have been observed in places they had not been seen previously in these zones (Clay Lancaster and Werner Aschbacher personal communication, Appendix H).

In a 2.5 hr. rotary-winged survey of zone D/OT/02 on 11 September 2006, 88 goats were observed (38 billies, 27 nannies, 19 goat kids, and four yearlings), producing estimates of 140.8 billies and 70.4 goat kids per 100 nannies (N. Larter unpublished data). This survey was conducted in an area that could not be surveyed during a 2004 aerial survey and provided similar numbers of goats and ratio estimates as the 110.7 billies and 71.4 kids per 100 nannies from that 2004 survey (Larter 2004). A rotary-wing survey was conducted 22-24 August 2011 in the Ragged Range area of zone D/OT/01; 278 goats were observed (124 billies, 80 nannies, 50 goat kids, six yearlings; 18 goats were unclassified), producing estimates of 155.0 billies and 62.5 goat kids per 100 nannies (Larter 2012b). These survey results generally support the contention of increasing goat numbers and distribution but we acknowledge there was seven years between surveys. A large portion of the areas surveyed for goats in 2004, 2006, and 2011, and indeed a substantial proportion of mountain goat range in the Mackenzie Mountains now falls within the boundaries of Nahanni NPR precluding future surveys conducted by ENR.

Wolf (*Canis lupus*)

Wolf tags were purchased by 78% (n=303) of non-resident hunters in 2017 (Table 5), down from a peak in tags purchased in 2015 but more than in any of the previous 20 years (Table 17). Part of the recent increase could be related to the increasing popularity and success of winter season hunts. At least 10% (n=30) of tag holders actively hunted wolves, harvesting 17 wolves (two males, three females and 12 with undocumented gender) (Appendix F), similar to previous annual harvests. Hunters reported spending 1-13 days

actively hunting wolves (mean $\pm$ SD 4.7 $\pm$ 3.5 days). For the ninth year winter season hunting for wolves occurred in zone S/OT/01. One male wolf was harvested in April 2018; the lowest winter season harvest. With the change in ownership winter guided hunts were offered for the first time in zone S/OT/05 during spring 2018. No wolves were harvested.

Hunters observed 248 wolves during 2017/2018, midrange of the 142-317 observed during 1995-2016. There is no relationship between the number of wolves observed/year and annual harvest nor does the number of tags purchased/year explain annual differences in wolf observations (Table 17). The number of hunters reporting since 2001 has been consistently higher than in previous years, which is attributed to a change in how we defined hunter reporting. For data collected after 2001, we assumed that all returned observation forms where there was a blank, a zero, or a dash in the box indicating the number of wolves observed was a report of no wolves being observed. When looking at the forms this seemed like a reasonable assumption. This assumption may well be invalid for previous years' data and would bias the post 2001 values to be higher than the previous years.

Beginning in 1999, we received hunter comments on voluntary observation forms that wolf numbers were high. In subsequent years the number of hunters commenting about high wolf numbers increased. Interestingly, for 2017, only one respondent commented on high wolf numbers.

Table 17: Observations of wolves reported by non-resident hunters in the Mackenzie Mountains, the number of wolves harvested and the number of wolf tags purchased, 1995-2017.

	2017 ¹	2016 ¹	2015 ¹	2014 ¹	2013 ¹	2012 ¹	2011 ¹	2010 ¹	2009 ¹	2008 ¹	2007 ¹
# Hunters Reporting	233	251	294	216	242	215	218	203	194	244	244
# Wolves Observed	248	221	152	275	155	253	184	203	167	260	262
# Hunters Seeing ≥1	69	63	26	42	36	45	74	61	65	76	88
Number Harvested	17	29	20	23	16	24	21	19	20	17	12
Number Wolf Tags	303	310	358	298	299	292	285	294	252	228	227

	2006 ¹	2005 ¹	2004 ¹	2003 ¹	2002 ¹	2001	2000	1999	1998	1997	1996	1995
# Hunters Reporting	239	254	244	203	197	142	116	103	148	141	76	119
# Wolves Observed	202	245	317	200	249	215	228	142	148	200	186	269
# Hunters Seeing ≥1	84	76	81	74	69	65	61	40	57	76	26	26
Number Harvested	23	19	18	12	11	15	14	11	9	17	11	14
Number Wolf Tags	201	204	166	207	159	137	145	89	165	209	194	72

¹Change in reporting since 2002 may have resulted in the number of hunters reporting for 1995-2001 being artificially low, see text.

Wolverine (*Gulo gulo*)

This year 46% of hunters purchased a total of 179 wolverine tags. This is the third consecutive year of above average tag purchases (Tables 5, 18). At least three tag holders (2%) actively hunted wolverine; none were harvested. Hunters spent from one to 13 days actively hunting wolverine (mean $\pm$ SD of 6.7 ± 6.0 days). Wolverines were observed in seven zones, with most observations in zones S/OT/01, S/OT/02 and D/OT/01. In only 1996 and 2014 have wolverines been observed in all eight zones (Figure 10). Historically, wolverine observations are mostly of solitary animals; few family groups have been observed. This

year 21 of 25 observations were of solitary individuals, however two groups of two and two family groups of three were also seen.

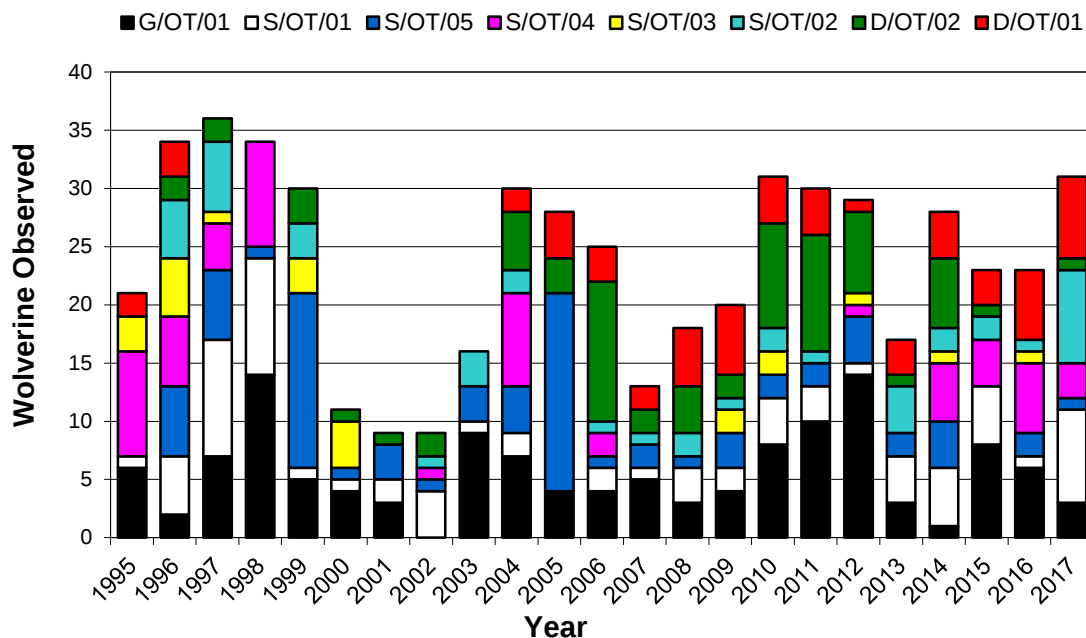


Figure 10: The number of wolverine observed by hunters from 1995-2017 and the outfitter zones where the observations occurred. Data are based upon voluntary hunter observation forms.

Although wolverine is considered a species not at risk, wolverine numbers are believed to be declining in some parts of their range in the NWT (SARC 2014). Based upon the voluntary observations of hunters from 1995-2017 there is no support for a declining trend in the Mackenzie Mountains (Table 18, Figure 10). There is no relationship between the number of wolverines observed/year and annual harvest nor do the number of tags purchased/year explain annual differences in wolverine observations (Table 18). Wolverines occur throughout the Mackenzie Mountains, but sightings are considered rare. Most wolverine observations are made in hunting zones G/OT/01, S/OT/01, S/OT/05 and D/OT/02.

Table 18: The number of reported observations of wolverine, the number of wolverine harvested, the number of hunters with wolverine tags, the percentage of total hunters with wolverine tags and the total number of hunting licences purchased for 1995-2017.

Year	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Reported Observations	25	23	23	28	17	29	30	31	20	18	13
Number Harvested	0	2	2	1	2	0	2	3	3	1	0
No. Wolverine Tags	179	190	179	154	155	153	163	171	133	111	150
% Wolverine Tags	46	49	40	38	39	39	41	45	39	28	37
Total Hunting Licences	390	389	447	402	401	396	400	384	339	399	405

Year	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995
Reported Observations	25	28	30	12	9	9	11	30	34	36	34	21
Number Harvested	1	1	0	0	1	2	0	3	0	1	4	1
No. Wolverine Tags	108	154	89	141	97	83	78	65	99	135	114	35
% Wolverine Tags	27	39	26	40	29	26	23	20	29	38	29	11
Total Hunting Licences	407	394	337	347	338	332	332	321	345	352	387	344

Black Bear (*Ursus americanus*)

This year 18 tags were purchased by non-resident hunters for black bears (Table 5); one bear was harvested. This is only the eighth black bear to be harvested in the past 27 years. Black bears are relatively rare in the Mackenzie Mountains generally occurring south of 63°00'N. In 2017, 22 black bears (18 adults and four cubs) were observed (Table 19), observations came from four outfitter zones D/OT/01, D/OT/02, S/OT/01 and S/OT/05. Nine adults and two cubs, half of all reported observations, occurred in S/OT/05, all north of 63°00'N.

As with the other post-2001 carnivore data, we assumed that all returned observation forms where blanks, zeroes, or dashes occurred in the boxes indicating the number of

carnivores observed was a report of no carnivores being observed. This assumption is likely invalid for previous years' data and likely somewhat inflates the post 2001 values relative to 1996-2001 values.

Table 19: Observations of black bears reported by non-resident hunters (including non-hunting guides) in the Mackenzie Mountains, 1995-2017.

	2017 ¹		2016 ¹		2015 ¹		2014 ¹		2013 ¹		2012 ¹		2011 ¹		2010 ¹		2009 ¹	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad
Total # Observed	4	18	5	16	2	14	5	27	12	18	3	34	2	27	0	29	3	14
% of Total Observed	18	82	29	71	13	87	16	84	40	60	8	92	7	93	0	100	18	82
No. Hunters Reporting	233	233	196	196	298	298	262	262	212	212	216	216	218	218	203	203	194	194
No. Hunters Saw at Least 1	2	14	2	12	1	11	4	22	4	13	1	7	2	19	0	8	3	10
Maximum # Observed	2	3	3	3	2	3	2	2	4	3	2	3	1	8	0	2	1	3

	2008 ¹		2007 ¹		2006 ¹		2005 ¹		2004 ¹		2003 ¹		2002 ¹		2001		2000	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad
Total # Observed	8	48	4	34	2	27	4	21	1	23	3	34	3	17	0	7	2	15
% of Total Observed	14	86	11	89	7	93	16	84	4	96	8	92	15	85	0	100	12	88
No. Hunters Reporting	244	244	244	244	239	239	256	256	229	229	191	191	199	199	127	130	88	93
No. Hunters Saw at Least 1	3	10	2	17	1	14	3	18	1	19	2	21	2	14	1	7	1	10
Maximum # Observed	3	4	2	8	2	11	2	2	1	3	2	7	2	3	0	1	2	3

	1999		1998		1997		1996		1995 ²
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	All Bears
Total # Observed	4	7	0	15	2	3	1	10	11
% of Total Observed	36	64	0	100	40	60	9	99	nil
No. Hunters Reporting	87	89	121	124	96	96	6	14	44
No. Hunters Saw at Least 1	2	6	0	8	2	3	1	9	9
Maximum # Observed	2	2	0	3	1	1	1	2	2

¹ Change in reporting for 2002 may have resulted in artificially lower numbers of hunters reporting for 1995-2001.

² All bears not separated out by cubs and adults.

Grizzly Bear (*Ursus arctos*)

The Mackenzie Mountains have been closed to non-residents for hunting grizzly bears since 1982 and resident hunters have been restricted to one bear per lifetime since the same year (Veitch 1999). It is clear from hunter comments on voluntary observation forms that, despite the lack of hunting opportunities, grizzly bears in the Mackenzie Mountains remain a subject of considerable interest for non-resident hunters and their guides (Appendices C and D). For the past 19 years there have been a variety of comments about grizzly bears and 2017 was no exception. This year hunters reported the loss of meat, capes and food to grizzly bears, and commented that there were too many grizzly bears and a hunt should be considered. Outfitters also continue to mention camp and equipment damage by grizzly bears both during and after the season. To minimize human-grizzly bear interactions electric fences have been used at main camps, temporary camp use has been reduced, clean camp policy has become standard for most camps, and some known high-use grizzly bear areas have been avoided.

Even though moose calf numbers, based upon hunter observations, are generally lower in the Mackenzie Mountains than those reported in the Mackenzie Valley, and predation by grizzly bears could be a potential cause (Ballard 1992), there were few hunter comments indicating low moose or caribou calf numbers.

From 1996-2013, the number of adult grizzly bears observed annually fluctuated around a mean of 305 (range 218-402) with no discernable trend over time. Similarly the number of cubs observed annually fluctuated around a mean of 76 (range 40-115) with no trend over time. This year observations of adult (n=655), and cub grizzly bears (n=140) was the highest reported in the 22 years that records have been kept. The 2017 observations coupled with those from the past three years result in a positive trend in grizzly observations over the entire 22 years and a substantial increase since 2013 (Figure 11, Table 20). Even though the number of hunters and the number of voluntary observation forms received shows yearly variation, the percent of hunters seeing bears clearly shows a positive trend over time (Figure 12).

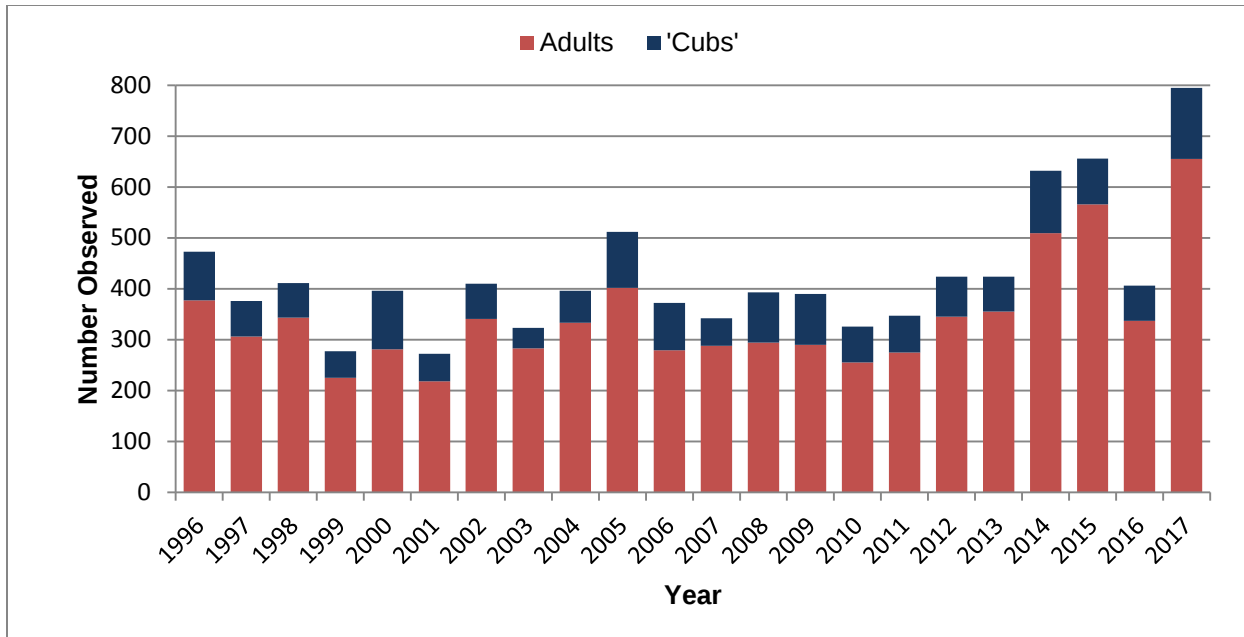


Figure 11: The number of adult and 'cub' grizzly bears observed by hunters from 1996-2017. Data are based upon returned voluntary hunter observation forms. 'Cubs' likely refer to cubs-of-the-year, yearlings, and possibly two-year olds.

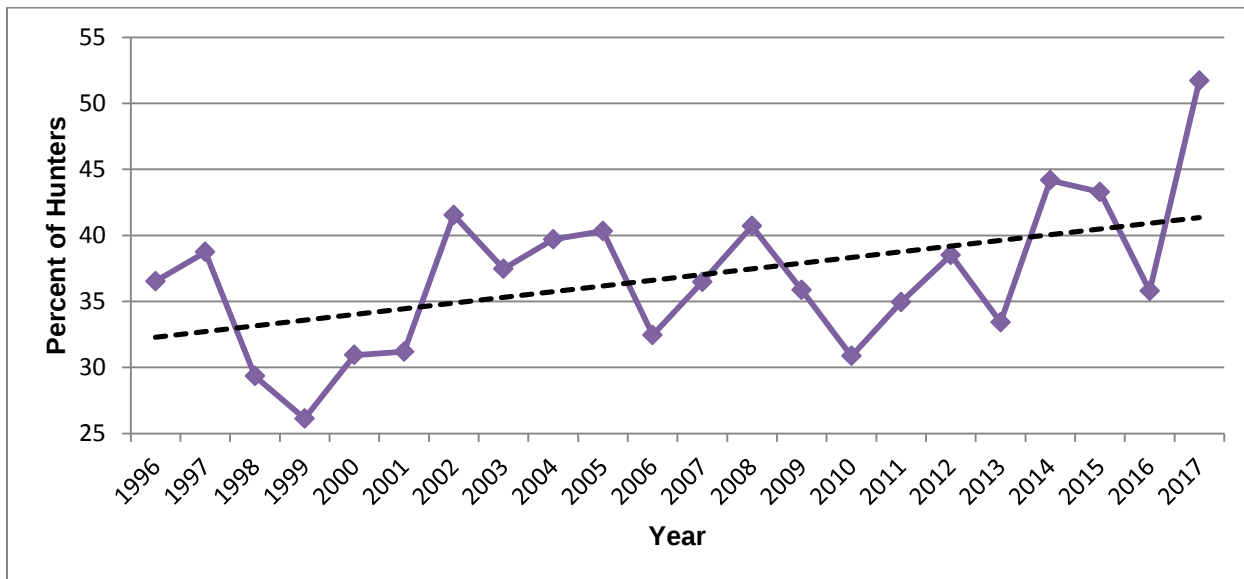


Figure 12: The percent of hunters observing grizzly bears annually from 1996-2017. Data are based upon returned voluntary hunter observation forms.

Because cub grizzlies in the Mackenzie Mountains tend to stay with their mothers for three years (Miller et al. 1982), reported observations of 'cubs' likely refers to cubs-of-the-year, yearlings, and possibly two-year-old bears. This may account for some of the variability in our cub observations (Figure 11). The percent 'cubs' reported from 1996-2017 ranges from 12.4-29.0 (mean 19.5). Miller et al. (1982) estimated that cubs and yearlings made up 14.3 and 10.4%, respectively of the grizzly population during 1973-1977. If yearlings were reported as cubs this could explain the high range we report for observed 'cubs'.

Since 1993, 81 nuisance grizzly bears have been killed, the majority in the Sahtú (n=48), with 21 and 12 for the Gwich'in and Dehcho regions, respectively (ENR unpublished data). The Sahtú covers the largest area of the Mackenzie Mountains at *ca.* 68,000 km². In 2017 only two nuisance grizzly bears were killed, both in the Gwich'in region fewer than in most years.

Most instances of grizzly-human conflict used to come at night when grizzlies took the meat, and left without incident. However, more recently there have been increasing reports of grizzlies claiming either meat or hides from kills while guides were in the vicinity or while they were at camp (Carl Lafferty personal communication). A frequent comment of guided hunters is that bears have lost their fear of humans because of a lack of hunting and they are concerned that this has become a human safety issue. Prior to 2014 there were no documented incidences of injuries to humans caused by grizzly bear attacks (Veitch 1999). Unfortunately, in 2014 a hunter was fatally injured in a grizzly bear attack while butchering a moose with his guide (the first documented hunter fatality in the Mackenzie Mountains), and two years ago there was a second mauling under similar circumstances in the same zone (S/OT/02). The hunter was seriously injured but survived. This year, grizzly bear-human conflicts were limited to two nuisance bears being destroyed even with the number of grizzly bears observed being the highest reported in 22 years; there were no maulings.

There have been no demographic studies on grizzly bears in the Mackenzie Mountains since field research conducted in 1973-1977 in a remote area of just 3,000 km² near the YT border (Miller et al. 1982). Miller et al. (1982) documented a low reproductive rate for female grizzly bears. No sows less than eight-years-old produced cubs, the average inter-litter interval was 3.8 years, and there was a mean litter size of 1.8. From 1996-2017 we used voluntary hunter observation forms and estimated litter size from only those observations where cubs were present with a single adult bear. We report a mean litter size of 1.7 based on annual estimates (range 1.3-2.1). Comparisons of our results with Miller et al. (1982) must take into account that we do not have a large sample size of observations annually and that these observations are potentially from all zones of the Mackenzie Mountains, not a small area. Also, in the 1970s grizzly bears were hunted by non-residents; non-resident hunting ceased in the Mackenzie Mountains in 1982. Although resident hunting still occurs, it is extremely limited. Therefore grizzly bears observed during 1996-2017 and the current grizzly bear population have really not been exposed to human harvest for at least one generation.

In a recent summary of grizzly bear harvest in the Gwich'in Settlement Area, the population for the Mackenzie Mountains zone was 110 bears (≥ 2 years old) (ENR 2014). This zone overlaps about 75% of zone G/OT/01 and a small portion of zone S/OT/01 (see Figure 1). Does the recent increase in bear observations and bear-human interactions translate into increasing bear numbers in the Mackenzie Mountains, or have conditions changed since 2014? At the 2015 AMMO annual general meeting, ENR and AMMO members agreed that there was a need to get a better idea of grizzly bear numbers throughout the Mackenzie Mountains. Studies employing the use of hair snagging and DNA analyses, similar to those used by Paetkau et al. (1998) and Weaver (2006) were discussed at length.

Six grizzly bear hair samples voluntarily collected in summer 2015 by AMMO members were forwarded to Wildlife Genetics International for analyses. Unfortunately, three of the samples could not be analyzed because of substandard quality. The remaining samples

identified three individual bears, one female and two males. None of these bears were matched to the bears involved in the two human incidents. ENR agreed to plan a pilot hair snagging project during summer 2017.

An area along the Canol trail, in the southwestern Sahtú, was chosen for the pilot hair snagging project which operated out of the ENR check station at Mile 222 (Figure 13). From 20-23 June, 86 hair snagging stations (posts) were set up, spaced 9 km apart over a 7,000 km² grid. Reconyx trail cameras were set-up at 25 of the posts. Posts were checked at four times during the summer: 2-6 July, 14-19 July, 28 July-2 August, and 11-16 August. All posts were removed during the last visit. An A-Star helicopter was used for post deployment and removals. An R-44 helicopter was used for post checks. At each post check individual hair samples were carefully collected and fresh lure added.

The number of posts visited by grizzly bears ranged from 16-27 per session, an average 24% visitation rate. Bear hair samples (n=1,533) were submitted to Wildlife Genetics International for genetic analyses. Genotyping was carried out on up to eight samples per active post. There was a high (77%) success rate of DNA extraction, likely due to a short sampling interval and little rain. The DNA analysis identified 91 different individual grizzly bears (35 males and 56 females) at the posts. Further modelling and statistical analyses are required in order to derive a density estimate for the grid. ENR hopes to conduct hair snagging in two more areas of the Mackenzie Mountains in future.

An initial scan of the 800,000 plus trail camera images, detected a number of different grizzly bears and one black bear as well as a range of other wildlife species including moose, caribou, Dall's sheep, wolverine, red fox, porcupine, marten and ground squirrels.

Table 20: Observations of grizzly bear reported by non-resident hunters in the Mackenzie Mountains, 1995-2017; total number of bears observed, percentage of cubs/adults, number of hunters reporting grizzly observations, number of hunters seeing at least one cub/adult, the mean and maximum number of cub/adults observed.

	2017		2016		2015		2014		2013		2012		2011		2010		2009	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad
Total # Observed	140	655	69	337	90	566	123	509	69	355	79	345	72	275	71	255	100	290
% of Total #	18	82	17	83	14	86	19	81	16	84	19	81	21	79	22	78	26	74
# Hunters Reporting	65	182	36	126	37	177	56	155	29	123	46	138	38	123	33	104	47	109
# Hunters Saw ≥ 1	41	124	24	83	24	111	39	103	20	74	24	71	28	65	25	53	36	64
Mean # Observed	2.2	3.6	1.9	2.7	2.4	3.2	2.2	3.3	2.4	2.9	1.7	2.5	1.9	2.2	2.2	2.5	2.1	2.7
Maximum # Observed	10	23	6	11	10	19	9	14	6	15	5	14	4	10	5	11	6	20

	2008		2007		2006		2005		2004		2003		2002		2001		2000	
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad
Total # Observed	99	294	54	288	93	279	110	402	63	333	40	283	69	341	59	222	113	281
% of Total #	25	75	16	84	25	75	21	79	16	84	12	88	17	83	21	79	29	71
# Hunters Reporting	48	139	28	127	50	122	49	150	34	131	19	120	34	128	136	171	108	131
# Hunters Saw ≥ 1	31	64	17	56	32	70	10	65	15	57	9	53	11	48	28	104	51	97
Mean # Observed	2.1	2.1	1.9	2.3	1.9	2.3	2.0	2.3	1.9	2.5	2.1	2.4	2.0	2.7	0.4	1.3	1.1	2.1
Maximum # Observed	6	12	5	15	5	12	10	16	4	15	12	7	8	20	5	10	8	12

	1999		1998		1997		1996		1995
	Cub	Ad	Cub	Ad	Cub	Ad	Cub	Ad	All Bears ¹
Total # Observed	52	225	68	343	70	306	96	377	389
% of Total #	19	81	17	83	19	81	20	80	nil
# Hunters Reporting	98	117	139	177	110	170	49	132	138
# Hunters Saw ≥1	28	81	31	105	32	129	46	129	123
Mean # Observed	0.5	1.9	0.5	1.9	0.6	1.8	2.0	2.9	2.8
Maximum # Observed	4	12	6	16	12	17	5	15	16

¹ All bears not separated out by cubs and adults.

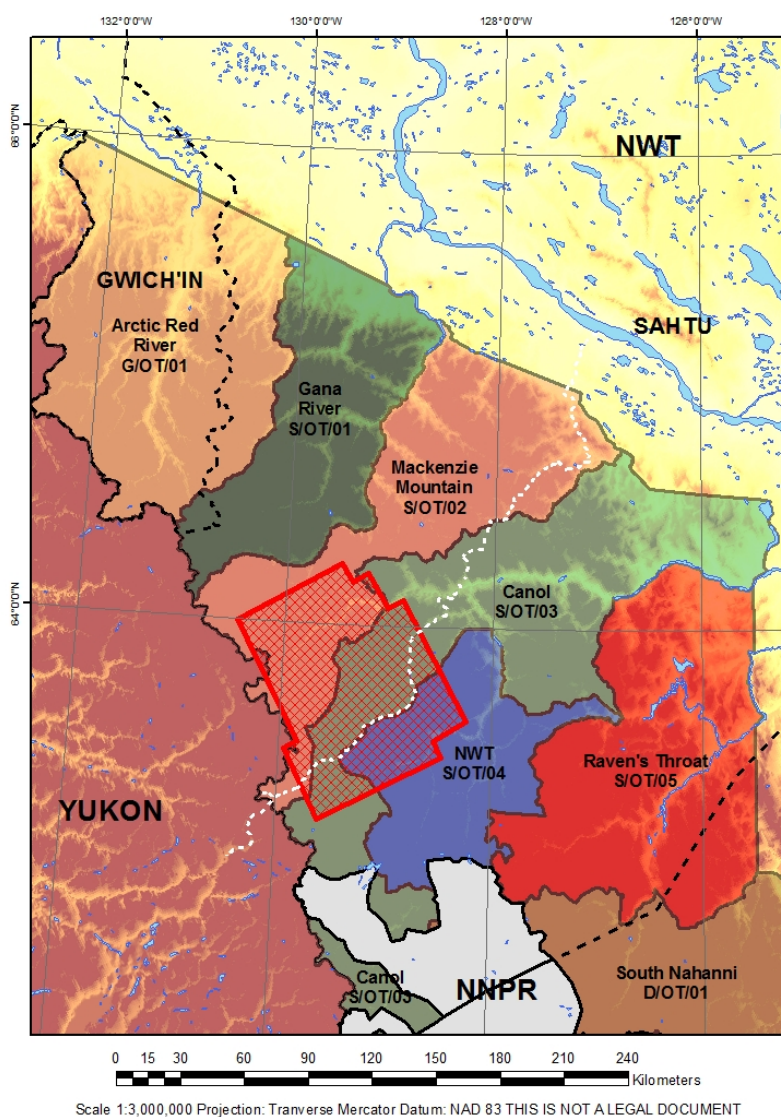


Figure 13: The location of the 7,000 km² pilot hair snagging project (red polygon). All snagging posts were established within the grid boundaries in the NWT.

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APPENDIX A. Outfitters Licenced to Provide Services to Non-resident Hunters in the Mackenzie Mountains, NWT – 2017.

D/OT/01 – SOUTH NAHANNI OUTFITTERS LTD.

Werner Aschbacher and Sunny Petersen
P.O. Box 31119
Whitehorse, YT Y1A 5P7
P: (867)399-3194
F: (867)399-3194
E: info@huntnahanni.com
Website: www.huntnahanni.com

S/OT/02-MACKENZIE MOUNTAIN OUTFITTERS

Stan and Helen Stevens
P.O. Box 175
Dawson Creek, BC V1G 4G3
P: (250)786-5118
F: (250)786-5404
E: mmostanstevens@gmail.com
Website: www.mmo-stanstevens.com

D/OT/02 – NAHANNI BUTTE OUTFITTERS

Jim Lancaster
PO Box 3854
Smithers, BC VOJ 2N0
P: (250)846-5309
P: (250)263-9197
E: jladventures@xplor.net
Website: www.lancasterfamilyhunting.com

S/OT/03 – CANOL OUTFITTERS

Glenda Groat
PO Box 59
Norman Wells, NT, X0E 0V0
P: (867)444-4868
E: canoloutfitters@gmail.com
Website: www.canoloutfitters.ca

G/OT/01 – ARCTIC RED RIVER OUTFITTERS

Tavis Molnar
PO Box 1
Whitehorse, YT Y1A 5X9
P: (867)633-4934
F: (867)633-4934
E: info@arcticred-nwt.com
Website: www.arcticred-nwt.com

S/OT/04 - NWT OUTFITTERS

Clay Lancaster
13397 Parkside Crescent
Lake Country, BC V4V 2S7
P: (250)263-7778
E: jladventuresxplor.net
Website: www.lancasterfamilyhunting.com

S/OT/01 – GANA RIVER OUTFITTERS

Harold Grinde
P.O. Box 528
Rimbey, AB T0C 2J0
P: (403)357-8414
E: ganariver@pentnet.net
Website: www.ganariver.com

S/OT/05 – RAVEN'S THROAT OUTFITTERS

Griz and Ginger Turner
P.O. Box 58
Whitehorse, YT Y1A 5X9
P: (867)332-7286
E: hunts@ravensthroat.com
Website: www.ravensthroat.com

APPENDIX B. Summary of Fees, Bag Limits and Seasons for Big Game Species Available to Non-resident Hunters in the Mackenzie Mountains, NWT - 2016. (Note: all prices are in Canadian funds.)

Species	Status	Tag Fee	Harvest Fee	Bag Limit	Season
Black Bear	Non-resident	\$44.00	\$220.00	1 adult bear not accompanied by a cub	15 Aug - 31 Oct
	Non-resident alien	\$110.00	\$220.00		15 Aug – 30 June
Woodland Caribou	Non-resident	\$44.00	\$440.00	1	25 Jul - 31 Oct
	Non-resident alien	\$110.00	\$440.00		
Mountain Goat	Non-resident	\$44.00	\$440.00	1	15 Jul - 31 Oct
	Non-resident alien	\$110.00	\$440.00		
Moose	Non-resident	\$44.00	\$440.00	1	1 Sep - 31 Oct
	Non-resident alien	\$110.00	\$440.00		
Dall's Sheep	Non-resident	\$44.00	\$440.00	1 adult male with min. $\frac{3}{4}$ curl	15 Jul - 31 Oct
	Non-resident alien	\$110.00	\$440.00		
Wolf	Non-resident	\$44.00	\$220.00	1 or 2 ²	25 Jul - 10 Oct
	Non-resident alien	\$110.00	\$220.00	2	1 Aug - 15 Apr
Wolverine	Non-resident	\$44.00	\$220.00	1	25 July - 31 Oct
	Non-resident alien	\$110.00	\$220.00	1	25 July - 31 Oct

Source: Environment and Natural Resources. 2017. Northwest Territories Summary of Hunting Regulations. Yellowknife, NWT. 42pp.

² Limit of one wolf from D/OT/01-02 and G/OT/01; limit of two wolves from S/OT/01-05.

APPENDIX C. Comments Provided from Non-resident Hunters in the Mackenzie Mountains, NWT on Voluntary Hunter Wildlife Observation Report Forms, 2017. We have not printed actual names of outfitters or their guides (XXX).

Excellent Outfitter with very good reputation in Europe. A few Belgian friends who had also a successful hunt with XXX.

Excellent all around experience. I plan to return for moose hunting.

Excellent operation.

I shoot a ram and after this + waiting 1/2 hour we go to that killed ram and the rest of these group, 6 other young age, stands hear us (30-40m) are watching us, they never saw human being.

The number of grizzly bears was alarming. We had to chase one off moose kill. No more calves.

Amazing experience.

Wonderful experience, adventure, everything how it should be! Thanks!!!

Spectacular job. Very much appreciated.

Last wild place remaining in North America.

I would like to come back.

Just perfect.

This was a once in lifetime hunt for us. We would love to return - but circumstances will likely not allow an opportunity.

Hunted together with XXX.

Excellent organized. Very good guide.

Saw 2 porcupines, multiple pika's, chipmunks, some hawks and falcon's.

Excellent country, lots of sheep + grizzly bears

Excellent!

Great outfitter.

Great country

Good hunt.

Phenomenal experience, 1st Class - best I've ever experienced in 45 years.

Great hunt. Should be able to hunt grizzly bears.

Game rich area

Do not understand rationale of loss of hunting land to national park.

Lots of old rams.

Outstanding camp + hunt! First class outfit + guides!

I took my bow, but shot with my rifle. Animals in good shape.

All sheep looked in good health with the exception of 1 skinnyish 8 yr old ram. Also seen one very very fat gopher.

Great hunt, great rams, weather issues. Almost caribou ran out of time.

Very hot and smokey, animal looked in good shape.

Hot and smokey animals in good shape.

All animals appeared healthy, wealthy and wise.

Lots of animals too many griz. Animals healthy big old ram.

Healthy animals, good hunt weather issues later in hunt.

Ram was fat for 11 year old ram.

Absolutely incredible experience. The hunting drew me to the area initially and exceeded all expectations. But the real joy was the rugged experience of living in the Mackenzies and with the animals they provide.

Ram harvested with gun, caribou bull with bow. Great experience. All animals appeared healthy and happy with the exception of one bull caribou that looked very skinny.

Absolutely amazing experience, thank you.

For a very lucky & fortunate 24 year old. This was an amazing experience with an abundance of animals to see!

Hot, hot, hot. Lots of animals broken horn ram and nice caribou. Lots of ewes and lambs.
 All animals seemed healthy and wise.
 Too many grizzly bears! Every one of them came 1-3 times to camp! Overall great experience!!!
 Thanks for everything.
 Truly a wilderness experience, I enjoyed my hunt immensely. I thought we would see more game but was very pleased to fill sheep + caribou tags with mature animals.
 Great experience.
 Very hot out sheep and caribou up very high.
 Hot weather lots of sheep and caribou lots of ewes + lambs.
 Hot weather lots of sheep and caribou lots of lambs this year.
 Hot weather hunting slow pasted a few 390s looking for bigger.
 All animals in great shape. Bow hunting is why no kills.
 Experience of a lifetime. Thank you.
 Beautiful, rugged country!
 XXX and entire staff provided an excellent hunt, as well as first class service. The Mackenzie Mtns are a priceless treasure of the NWT.
 Hunted with a bow, but ended up harvesting with a rifle.
 Should have a grizzly bear hunt.
 I had an amazing time; my guide and wrangler were great and very encouraging and helpful and pushed me to achieve a great hunt and adventure.
 This was the most incredible hunting experience of my life. My guide, XXX was the best guide I have ever had. The privilege to hunt with smile of her face every day. Optimistic, enthusiastic, attentive and concerned for my welfare, great horse person. The rest of the crew made up an A+ group of professionals. XXX is far and away the best hunting outfit I have ever hunted with. Thank you.
 XXX and his team are the best! *With all of the grizzlies seen, it's a shame that hunting them is not allowed. A valuable resource simply going to waste.
 Had some warm weather which may have adversely affected game sightings.
 Great trip!
 Thank you XXX to a great hunt. I loved it! Food was impeccable!
 Hardest working outfitter and guides I have ever had on any hunt. Planning on coming back first hunt 2019 for sheep.
 Don't understand not hunting grizzly bears, while I only saw 5, others in camp were seeing 3-4 a day. Let an outfitter take 1 or 2 a year would probably not reduce numbers by much since they would be targeting boars.
 1st class operation from top to bottom.
 Beautiful country! You should hunt these grizzly bears and thin them out a bit.
 Awesome.
 Excellent hunt.
 Excellent hunting experience. Hard, demanding and fun!!! Looking forward to returning to the great Northwest.
 Fantastic experience.
 Traditional archery hunter. Opportunities but no harvest.
 Great place - will return.
 I saw the once - in - a - lifetime ram!!!! I had a great time with my guide XXX. The food is great.
 Thank - you XXX.
 A great hunt is sometimes measured by success... A better hunt is measured by the people running the operation. XXX + team run a well-oiled machine and do everything in their power to maximize your experience hunting (vacationing).
 Great experience @ XXX.
 Great hunt and outfitter to hunt with.
 Excellent hunt. Excellent outfitter. Beautiful country.
 Awesome area. Grizzly bears need to be killed. Safety risk. Thank you.
 It was an awesome experience.
 Very organized outfitter. Very beautiful country.

XXX & XXX run an amazing outfit. The crew is very knowledgeable & respectful of the area. I had a wonderful experience & hope to return soon.
 This was the best hunt I have ever experienced. Our guide was great. Entire staff from other guides to the cook was exceptional. We will be back to hunt with XXX again soon.
 Awesome outfit great people excellent game rich area.
 Awesome.
 Wonderful experience
 Outstanding adventure and service
 Incredible!!! No words can describe the experience. Thank you.
 Great camp! Wonderful staff! Outstanding game!
 Great - got very nice bull caribou with bow - guide was great.
 Way too many grizzlies in this area. Disappointed that the gov't values grizzlies over human life. Tags need to be opened.
 Great bunch of people from XXX on down. Hard working always on point. Beautiful untamed mountains, rivers & valleys, absolutely the way God made it! Thanks.
 I loved the pristine mountains, water + air. Very good experience with a great outfitter. XXX is a professional, well-run organized operation.
 This was the best I was ever treated by outfitter, guides and cooks.
 Very good hunt, 39" ram
 Young happy hunter!!! Drop the age to 12.
 Fantastic.
 The most beautiful place you could ever imagine.
 XXX is an excellent operation, nothing but 1st class, best experience of my life
 Lots of bears in a short amount of space on the river. Would be great to be able to hunt them.
 Awesome time.
 You need to start a grizzly season!!
 Awesome!!!
 Excellent hunt, great outfitter.
 Taking meat with me. Not leaving it with outfitter.
 Excellent outfitter/guide. Missed a wolverine at 50 yards. Looked for a monster caribou passed on some big bulls for caribou.
 Fantastic hunt! First class outfitter!
 Great hunt.
 Great experience.
 Taking meat home.
 Great experience. Had a blast. My guide XXX was great. He took care of me.
 Grizzly hunting should be considered for non-residents. Seem to be abundance.
 Grizzlies were everywhere. Too many bears. Tons of wildlife, great hunt all around. I'll be back.
 Beautiful place, the outfitter and guide were one of the best I have ever hunted with.
 The hunt was perfect; outfitter is one of the best I ever hunted with.
 Awesome hunt. This wilderness is one of the greatest places in North America. It was a privilege to hunt here and experience this amazing place.
 Hunt was really well organized.
 Best outfitter ever had (20 yrs.). No harvest lack of sheep in area due to helicopter bear study.
 Sheep hunted and harvested a ram - then observed on a caribou hunt. The Mackenzie Mountains were some of the most spectacular I've ever seen and this was the experience of a lifetime. NWT is spectacular.
 This place is amazing! The XXX team are the absolute best outfitters we've ever hunted with. And we hunt all the time and all over the world. XXX & XXX are 100% first class.
 Excellent outfit. Highly professional & organized. XXX has provided a brilliant hunting experience.
 Great bunch of people working for the outfitter. I would recommend XXX to anyone & I intend to return for another hunt.
 Excellent camp + operators. Great area, great staff. Best outfit I've been to in the NWT.
 Truly one of the best experiences of my entire life. It is so comforting to know truly wild places like

this exist and are being preserved.

Love the Territories, love the outfit! Excellent in every way! Coming back soon.

Excellent overall experience, nearly flawless in every way. Outfitter, guides, cook, pilots all fantastic, no exceptions!

XXX camp was awesome! Including the area, the people, and everything else. I can't thank everyone enough for this amazing hunt, I would come back whenever I could be able to.

Awesome land, awesome people.

Outstanding 1st class hunt with XXX! Plan to return as soon as possible.

Appears sheep + caribou numbers are strong. But amount of bears and wolf are too heavy. Seen way to many bears to close to spike camps.

Hunt of a lifetime. Highly recommend. A+

Vast array of game. Great experience.

Had a great experience. Outfitter and area exceeded all expectations.

Everything was great I will be back.

I was the helicopter pilot for XXX for most of the 2017 season. Excellent outfitters who don't cut corners.

NWT Mackenzie Mountains are spectacular. I had a great experience hunting and hope to return.

XXX were fantastic. They will do a great job managing and caring for their area.

Crew member, did not hunt

APPENDIX D. Summary of 2017 Voluntary Hunter Comments Broken Down into Specific Topics.

No. of Hunters Reporting	No. of Hunters Mentioning Good Quality Hunts	No. of Hunters Mentioning Abundance/ Quality of Animals	No. of Hunters Mentioning Grizzlies	No. of Hunters Mentioning Wolves	No. of Hunters Mentioning Park Expansion	No. of Hunters Mentioning Bad Weather
146	95	28	16	1	1	9

APPENDIX E. Number, Age and Horn Length Measurements of Dall's Sheep Rams Harvested by Non-resident Hunters in the Mackenzie Mountains, 1967-2017. Number harvested includes 10¹, 2², 6³, 8⁴, 7⁵, 9⁶, 4⁷, 11⁸, and 5⁹ harvested by resident hunters.

Year	Number of Sheep Harvested	Age (Years)		Length of Right Horn	
		Mean	Sample Size	Mean (cm)	Sample Size
1967-1968	223	8.4	Unknown	86.4	168
1969	110	-	-	-	-
1970	94	-	-	-	-
1971	88	-	-	-	-
1972	110	8.5	96	86.2	90
1973	89	8.9	86	84.4	88
1974	93	9.2	85	88.6	91
1975	129	7.6	67	84.6	127
1976	144	7.8	46	88.0	144
1977	132	5.7	69	86.8	132
1978	187	8.5	115	88.9	165
1979	200	8.7	108	90.8	154
1980	188	-	-	90.1	127
1981	183	8.1	101	92.7	157
1982	126	8.7	98	89.7	124
1983	100	9.0	80	90.9	94
1984	102	8.4	98	91.2	99
1985	123	8.1	115	89.7	112
1986	154	8.8	132	88.4	153
1987	148	8.9	148	89.4	148
1988	177	9.8	166	91.7	161
1989	207	9.9	199	90.4	203
1990	219	9.8	200	90.2	218
1991	170	9.7	161	89.1	170
1992	203	9.7	199	88.0	202
1993	191	9.7	181	87.6	190
1994	199	9.5	191	89.8	196
1995	189	9.6	189	88.9	189

Year	Number of Sheep Harvested	Age (Years)		Length of Right Horn	
		Mean	Sample Size	Mean	Sample Size
1996	201	9.5	200	88.7	201
1997	210	10.0	206	89.9	203
1998	215	10.0	207	90.0	209
1999	204	10.2	183	88.8	184
2000	194	10.0	188	88.9	188
2001	199	10.1	183	87.7	184
2002	173 ⁶	9.9	166	89.2	166
2003	213 ³	9.7	210	89.8	212
2004	201 ¹	10.0	199	89.3	200
2005	203 ⁷	10.2	196	89.4	199
2006	208 ⁸	10.4	206	88.4	207
2007	216 ³	10.8	216	88.3	216
2008	192 ⁴	10.6	192	88.8	192
2009	179 ⁵	10.9	178	88.2	178
2010	193 ⁶	10.8	191	88.7	192
2011	181 ⁷	10.8	181	90.5	181
2012	207 ⁶	10.9	205	89.9	206
2013	193 ⁴	10.5	193	87.5	193
2014	208 ⁷	10.5	207	88.4	208
2015	219 ⁹	10.6	219	88.0	218
2016	192 ²	11.0	187	89.1	189
2017	186 ⁷	10.7	183	88.5	186
Mean 1972- 2017	177	10	161	89.0	171

APPENDIX F. Outfitted Non-resident Hunter Harvests in the Mackenzie Mountains, 1991-2017. Number harvested includes 10¹, 2², 6³, 8⁴, 7⁵, 9⁶, 4⁷, 11⁸ and 5⁹ harvested by resident hunters.

Year	Number of Licences Sold	Number of Animals Harvested						
		Dall's Sheep	Mountain Caribou	Moose	Mountain Goat	Wolf	Wolverine	Black Bear
1991	354	170	179	40	6	14	3	1
1992	364	203	142	32	4	7	0	0
1993	382	191	191	56	9	7	3	0
1994	356	199	164	46	5	15	2	0
1995	344	189	180	49	6	14	1	0
1996	387	201	175	46	4	9	4	0
1997	352	210	168	44	2	17	1	0
1998	345	215	160	52	5	9	0	0
1999	321	204	117	36	1	11	3	0
2000	332	194	127	44	1	14	0	0
2001	332	199	128	41	2	15	2	0
2002	338	173 ⁶	168	42	5	11	1	0
2003	350	213 ³	143	48	6	12	0	0
2004	347	201 ¹	135	55	6	18	0	0
2005	398	203 ⁷	160	75	18	19	1	0
2006	418	208 ⁸	188	72	12	23	1	0
2007	405	216 ³	165	74	21	12	0	0
2008	399	192 ⁴	167	75	21	17	1	2
2009	339	179 ⁵	125	59	20	20	3	1
2010	384	193 ⁶	158	75	13	19	3	0
2011	400	181 ⁷	181	78	20	21	2	1
2012	405	207 ⁶	168	85	12	24	0	0
2013	409	193 ⁴	182	81	11	16	2	0
2014	407	208 ⁷	179	69	14	23	1	0
2015	447	219 ⁹	190	71	17	20	2	2
2016	389	192 ²	191	76	8	29	2	0
2017	390	186 ⁷	195	64	6	17	0	1
Mean 1991-2017	373	198	165	59	9	16	1	0

APPENDIX G. Summary of Age and Sex Ratios Calculated from Non-resident Hunter Observation Reports in the Mackenzie Mountains, 1995-2017.

Year	Dall's Sheep		Mountain Caribou		Moose	
	Lambs: 100 Ewes	Rams: 100 Ewes	Calves: 100 Cows	Bulls: 100 Cows	Calves: 100 Cows	Bulls: 100 Cows
1995	67	82	36	34	30	95
1996	44	82	45	40	26	76
1997	57	55	36	21	30	107
1998	60	84	35	34	30	95
1999	58	90	43	25	20	100
2000	47	90	41	39	26	89
2001	59	89	56	61	28	120
2002	58	89	59	31	29	96
2003	50	83	39	36	25	129
2004	53	93	42	38	30	101
2005	51	98	42	42	33	110
2006	53	96	43	37	33	137
2007	64	83	52	37	36	101
2008	49	98	41	40	31	115
2009	55	94	45	39	31	90
2010	49	93	45	46	35	101
2011	56	91	44	35	33	123
2012	53	86	40	46	33	88
2013	52	92	36	43	29	106
2014	55	93	36	41	29	103
2015	58	72	43	50	34	98
2016	49	81	33	42	31	105
2017	57	71	37	41	29	96
Mean 1995-2017	55	86	42	39	30	104

APPENDIX H. Summary of Age and Sex Ratios Calculated from Non-resident Hunter Observation Reports of Mountain Goats, 2002-2017.

Year	Kids:100 Nannies	Billies:100 Nannies	Total Animals
2002	55.2	75.9	69
2003	61.5	70.5	182
2004	57.1	77.1	84
2005	66.0	50.4	306
2006	61.5	51.4	245
2007	71.2	57.7	393
2008	54.3	97.1	264
2009	64.6	59.0	327
2010	78.3	46.2	239
2011	64.0	59.0	243
2012	51.8	71.9	257
2013	69.6	75.0	144
2014	67.8	58.5	277
2015	67.5	92.5	212
2016	67.6	85.3	90
2017	58.1	36.5	148
Mean 2002-2017	63.6	66.5	217.5