



Yukon North Slope Wildlife
Conservation and Management Plan
2021

Companion Report 13:
Dall's Sheep / Imnaiq



Publication Information

Cover photo:	Jay Frandsen, ©Parks Canada/Jay Frandsen, 2018
Copyright:	2021 Wildlife Management Advisory Council (North Slope)
Citation:	Wildlife Management Advisory Council (North Slope). (2021). <i>Yukon North Slope Wildlife Conservation and Management Plan – Companion Report</i> . Whitehorse, Yukon: Wildlife Management Advisory Council (North Slope).
Available from:	Wildlife Management Advisory Council (North Slope) P.O. Box 31539 Whitehorse, Yukon, Y1A 6K8, Canada
Download link:	https://wmacns.ca/what-we-do/conservation-plan/companion

Acknowledgements

Many individuals and organizations have contributed to the preparation of the *Yukon North Slope Wildlife Conservation and Management Plan – Companion Report*. Much of the western science and traditional knowledge research that is the evidentiary basis for this plan reaches back several decades.

Critical reviews by Environment Yukon, Parks Canada, the Canadian Wildlife Service, Fisheries and Oceans Canada have been helpful in addressing a wide-range of terrestrial, aquatic and marine conditions that inform the conservation requirements of the Yukon North Slope.

The principal writers of the Companion Report are Kim Heinemeyer and Joan Eamer. Kim is a conservation biologist with Round River Conservation Studies. She was ably supported by Julia O’Keefe, Maggie Triska, and Will Tyson. Joan is a former Council member, science writer, and environmental consultant. They were assisted with strong support from Mike Sutor - Environment Yukon biologist, Dave Tavares – Parks Canada science advisor, Craig Machtans – Environment and Climate Change Canada manager, and Tyler Kuhn – Environment Yukon biologist. Allison Thompson and Kaitlin Wilson – Council biologists, and Lindsay Staples – past chair – participated in all stages of report design, drafting and editing. Kirsten Madsen provided invaluable editing support.

The Aklavik Hunters and Trappers Committee assisted with and contributed to a substantial body of traditional knowledge of the wildlife and habitat, and traditional use mapping, of the Yukon North Slope that informs the report.

Jennifer Smith, Council chair, Council members and alternates, Tyler Kuhn, Matt Clarke, Craig Machtans, Billy Storr, Evelyn Storr, Colleen Arnison, and Michelle Gruben, and Council staff Allison Thompson and Kaitlin Wilson reviewed the final draft of the report

Companion Report to the Yukon North Slope Wildlife Conservation and Management Plan Number 13: Dall's Sheep / Imnaiq

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About the Companion Report

This report is a companion document to the *Yukon North Slope Wildlife Conservation and Management Plan* (WMAC (NS), 2022). The *Yukon North Slope Wildlife Conservation and Management Plan* (the Plan) is grounded in traditional knowledge and Western science. It addresses traditional use and wildlife conservation and management issues affecting the Yukon North Slope. Strategies in the Plan align with actions underway or planned by a range of agencies and organizations with jurisdiction on the Yukon North Slope.

This companion report summarizes the information that was used to support the objectives and strategies in the Plan, and provides references for the studies used in its development. The companion report draws from authoritative works, reports that synthesize knowledge and issues, and presentations of recent research findings. Sources include traditional knowledge and traditional use, scientific reports and journal articles, and management and conservation reports.

Companion Report Table of Contents

Selected Topics

1. Traditional Use
2. Climate Change Effects
3. Contaminants
4. Aullaviat/Aunguniarvik

Featured Species and Species Groups

- | | |
|-----------------|---------------------|
| 5. Caribou | 10. Broad Whitefish |
| 6. Moose | 11. Geese |
| 7. Grizzly Bear | 12. Furbearers |
| 8. Polar Bear | 13. Dall's Sheep |
| 9. Dolly Varden | 14. Muskox |

Each chapter is available for download at <https://wmacns.ca/what-we-do/conservation-plan/companion>.

There are fourteen companion reports, addressing four selected topics of key interest as well as ten wildlife species featured in the Plan. The featured species were selected by participants at a workshop held in Aklavik. The wildlife species in the companion reports:

- Have high cultural or economic value or are important as food for Inuvialuit;
- Have similar habitat needs to other wildlife species, so that conserving their habitat is key to conserving habitat for other species; and/or
- Are important for healthy ecosystems, including species that are main food items for top predators.

The Plan identifies key conservation requirements on the Yukon North Slope for each featured wildlife species. The Plan's objectives and strategies are designed to meet these conservation requirements. This companion report summarizes the information that guides the objectives, strategies and conservation requirements in the *Yukon North Slope Wildlife Conservation and Management Plan*.

Companion Report: Dall's Sheep / Imnaiq

This companion report provides information on the conservation requirements for Dall's sheep as identified in the *Yukon North Slope Wildlife Conservation and Management Plan*. It summarizes the information that guides the objectives, strategies and conservation requirements in the Plan. It includes information on traditional use, population status and trends, important habitat types and locations, threats to Dall's sheep, programs and measures for conservation and management, and selected studies and research relevant to the Yukon North Slope.

Conservation requirements for Dall's sheep on the Yukon North Slope

1. Conservation of key habitat types and locations used by Dall's sheep, including mineral licks, lambing cliffs, and winter ranges.
2. Management of disturbance so that human activities do not reduce the ability of the range to support sheep, while recognizing harvest rights and ecotourism potential.
3. Monitoring of sheep populations and habitat use so that management measures that protect important sheep areas and habitat types can be adapted to the effects of climate change.

From the *Yukon North Slope Wildlife Conservation and Management Plan* (WMAC (NS), 2022)

Dall's Sheep on the Yukon North Slope

Dall's Sheep (*Imnaiq*, *Ovis dalli dalli*) is one of two subspecies of thinhorn sheep. The other subspecies is Stone's sheep, found in the far south of the Yukon and British Columbia. Fannin's sheep, a hybrid of Dall's and Stone's sheep, is found in central Yukon (Environment Yukon, 2019).

Dall's sheep live in two separated regions of the Yukon North Slope: the British mountains west of the Firth River; and the Northern Richardson Mountains in the southeast of the region. Both of these sheep ranges are transboundary. In the British Mountains, sheep habitat extends into the Brooks Range in Alaska. The Northern Richardson Mountains Dall's sheep range extends into other land claims jurisdictions in Yukon and NWT. Within the Inuvialuit Settlement Region (ISR), Dall's sheep are only found on the Yukon North Slope.

Sheep are spotted along rocky ridges by Inuvialuit in summer and fall when people are hunting and travelling through these mountainous areas (WMAC (NS) & Aklavik HTC, 2018a). In summer sheep may be in the mountains or on slopes and valleys, close to mineral licks. They select areas near or on cliffs at lambing time. Rugged terrain and cliffs allow sheep to escape from predators. These windblown areas have less snow, making it easier for the sheep to access food. Dall's sheep generally return to the same winter, lambing, and summer areas year after year.

Traditional Use

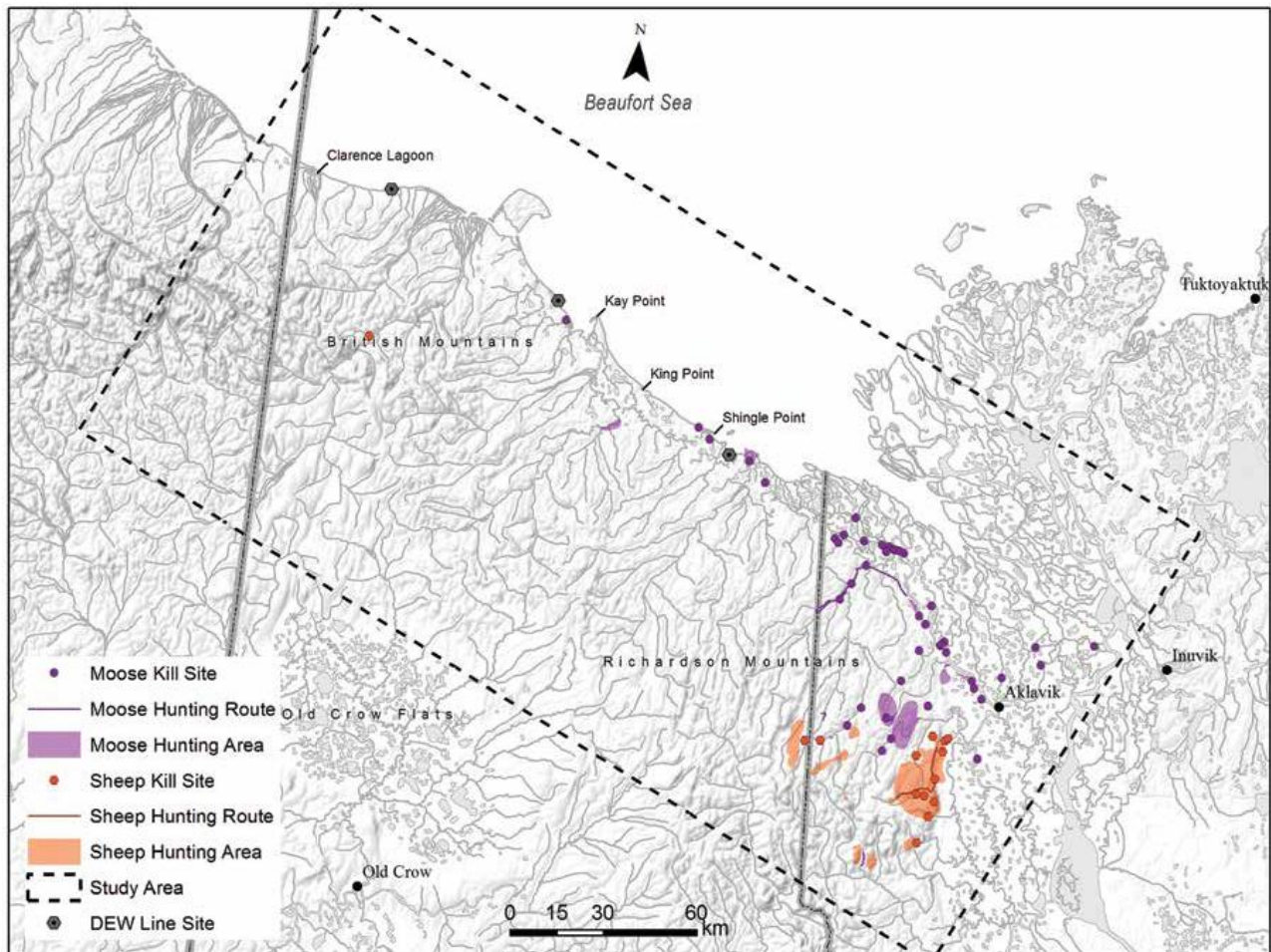
The Yukon North Slope Inuvialuit Traditional Use Study (WMAC (NS) & Aklavik HTC, 2018b) provides documentation of past and current sheep harvest locations on the Yukon North Slope (Map 13– 1).

Aklavik Inuvialuit travel by snowmobile to the Northern Richardson Mountains to hunt Dall's sheep and other animals. The Black Mountain (Mt. Goodenough) area southwest of Aklavik in the NWT is an important harvesting area (Lambert Koizumi, Carey, Branigan, & Callaghan, 2011; WMAC (NS) & Aklavik HTC, 2018b). In the 1940s and 1950s sheep were harvested in the British Mountains in what is now Ivvavik National Park, but there is currently no harvest in this area (WMAC (NS), 2012).

We always go up there when I was young. When we stayed at Qargialuk [Ptarmigan Bay] also at Itqiliqpik [Whale Bay]. We go hunt sheep when is long days after Christmas. When my dad get sheep and had enough for food, [then] we come back.

(1990 interview with Fred Inglangasuk, recorded by M. Nagy. From WMAC (NS) & Aklavik HTC, 2018b, p. 64)

Map 13–1. Moose and Dall’s sheep harvest locations identified in Inuvialuit traditional use interviews



The interviewers asked Inuvialuit land users to identify hunting routes and areas used within living memory.
Source: WMAC (NS) and Aklavik HTC (2018b), Map 8.

A 1991 dietary survey showed that sheep were not a major part of the diet of Aklavik Inuvialuit (Wein & Freeman, 1992). Of the 36 households surveyed, only 4 reported eating sheep at least once over the previous year.

Sheep are harvested in fall, winter, and spring, mainly using skidoos (ICC, TCC, & ACC, 2006). On average, 2 sheep were harvested annually by Aklavik Inuvialuit over the 10-year period from 1988 to 1997, as reported through the Inuvialuit Harvest Study (Inuvialuit Harvest Study, 2003, Table 21). Total harvest by Aklavik Inuvialuit from 2001 to 2010 ranged between 0 and 4 sheep per year (WMAC (NS), 2012). The average harvest

Importance of sheep

Meat from the Dall sheep is still a highly prized food. However, because of their distant range and low numbers, few people hunt them. There is still one hunter that gets them for their horns. These were traditionally used for making tools such as fishhooks and ulu handles, as you can boil and actually shape the horn. People also use it for carving.

Excerpt from *Inuvialuit Settlement Region Traditional Knowledge Report* (ICC et al., 2006), p. 11-69

was also 2 sheep per year (ranging from 0 to 4 sheep) over the 3-year period from 2016 to 2018 (IRC, 2019). These numbers include any sheep harvested in the Northern Richardson Mountains in the NWT to the south of Aklavik, in the Gwich'in Settlement Area.

Habitat for Dall's Sheep

Mostly the sheep would be in the high mountains—less snow—and [in] the springtime they would be heading down to the valley where there would be all the green grass. That's where they find the food, up in the high hills, but in the summertime where we are staying in the coastline because [of] the fresh tundra. Down the coastline it's all low ground so they [move down] more than on hills so it would be easy for them.

Inuvialuit Settlement Region Traditional Knowledge Report (ICC et al., 2006), p. 11-67

Suitable Dall's sheep habitats have steep, rocky areas that provide escape terrain, interspersed with alpine, meadow or mountain slope habitats that provide forage. During winter they are limited to winter ranges, such as exposed areas on wind-blown slopes, that provide both escape terrain and available forage. Dall's sheep need a diversity of habitat features:

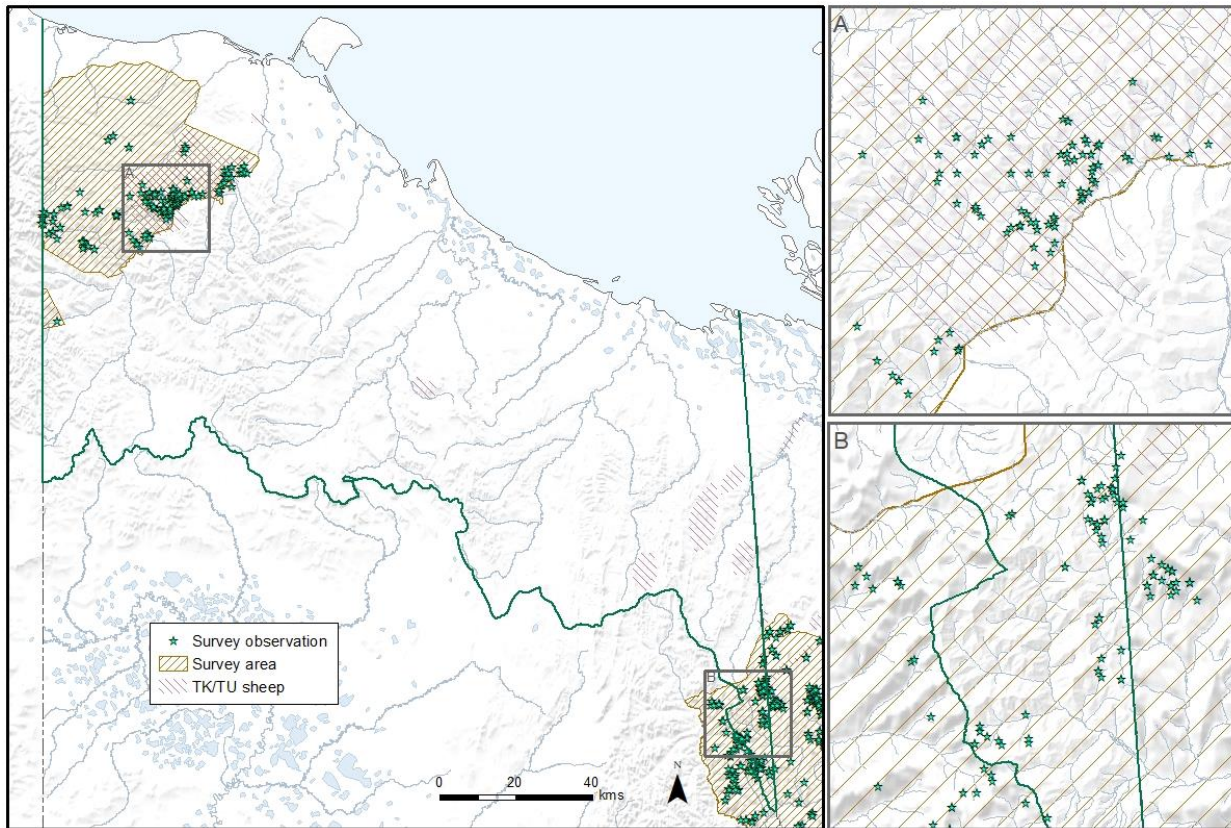
- Alpine ecosystems with a sufficient amount of food;
- Escape terrain;
- Birthing and resting areas;
- Mineral licks; and
- Unobstructed corridors for moving through the landscape over the seasons (Jex et al., 2016).

High quality winter range is particularly essential and may be the factor that limits populations (Barker, 2012). Dall's sheep are vulnerable to extreme weather events such as winter rain-on-snow and prolonged periods of cold spring rain (BCCDC, 2017; Jex et al., 2016; Lambert Koizumi et al., 2011).

Mineral licks are areas of highly mineralized soils that sheep (and other animals) consume to replenish important minerals, including sodium, magnesium and calcium (WMAC (NS), 2012). Dall's sheep herds typically have mineral licks they use frequently in the spring and summer. Lactating ewes appear to use the licks more than males or non-lactating ewes, likely reflecting the increased demands of milk production (Nichols & Bunnell, 1999).

Participants in the study documenting Inuvialuit traditional knowledge of Yukon North Slope wildlife habitat (WMAC (NS) & Aklavik HTC, 2018a) described sheep habitat in mountainous areas in the eastern and western edges of the Yukon North Slope (Map 13– 2). Sheep are generally seen in the summer and fall when land users are travelling through sheep habitat.

Map 13– 2. Dall’s sheep: observations of their locations and areas that they frequent, based on surveys and Inuvialuit traditional knowledge



This map is from the Plan (WMAC (NS), 2022, Appendix 1). It is compiled from surveys in Ivvavik National Park and in the Northern Richardson Mountains, and Inuvialuit observations of areas where sheep are seen or hunted. Data sources: observations by Inuvialuit (WMAC (NS) & Aklavik HTC, 2018a) and survey data (Environment Yukon and Parks Canada).

Northern Richardson Mountains

Lambert Koizumi & Derocher (2019), looked at seasonal habitat use by Dall’s sheep in the Northern Richardson Mountains. Habitat use by rams differed from habitat use by ewes over the seasons, with ewes and rams showing preferences for different slope aspects and different types of terrain. Choice of habitat appears to be influenced by two main factors: the quality and abundance of available food; and the risks from grizzly bear and wolf predation. Ewes and rams select different habitats at different times of the year. For example, ewes selected steep, rugged terrain suitable for escaping from predators during lambing and summer seasons, even though this terrain has poorer forage than the habitat types favoured by rams in those seasons. The highest densities of sheep occur in the Black Mountain area but concentrations also occur in other areas including the southeast most portion of the Inuvialuit Settlement Region in the Richardson Mountains.

British Mountains

The area between the Firth and Malcolm rivers is important sheep habitat throughout the year and sheep are often found in the Firth River canyon. Tors (rocky knobs on tops of hills), a landscape feature west of the Firth River, provide escape terrain in high alpine grazing areas in much of this area. The rugged high mountains located near the border with Alaska contain other important habitats. Dall's sheep are also occasionally found in other small, isolated pockets within the region. Mineral licks are found alongside Sheep Creek and likely occur in other areas within Dall's sheep range in the park.

Dall's Sheep Populations

Species Conservation Status

Table 13–1. Dall's sheep conservation status: Canada, Yukon, and global

Status assigned by	Applies to	Status	References
Species at Risk Act (SARA)	Canada	Not listed	(Canada, n.d.)
Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Canada	No COSEWIC assessment has been done; Dall's sheep is on the mid-priority list of terrestrial mammal species that are candidates for assessment (list date: Mar. 2020).	(COSEWIC, n.d.)
Canadian Endangered Species Conservation Council (General Status of Species in Canada)	Canada	N5: Secure*	(Canadian Endangered Species Conservation Council, 2016)
Yukon	Yukon	S4: Apparently Secure*	(Canadian Endangered Species Conservation Council, 2016)(Yukon, 2020)
NatureServe	Global	G5: Secure*	(NatureServe, n.d.-b)

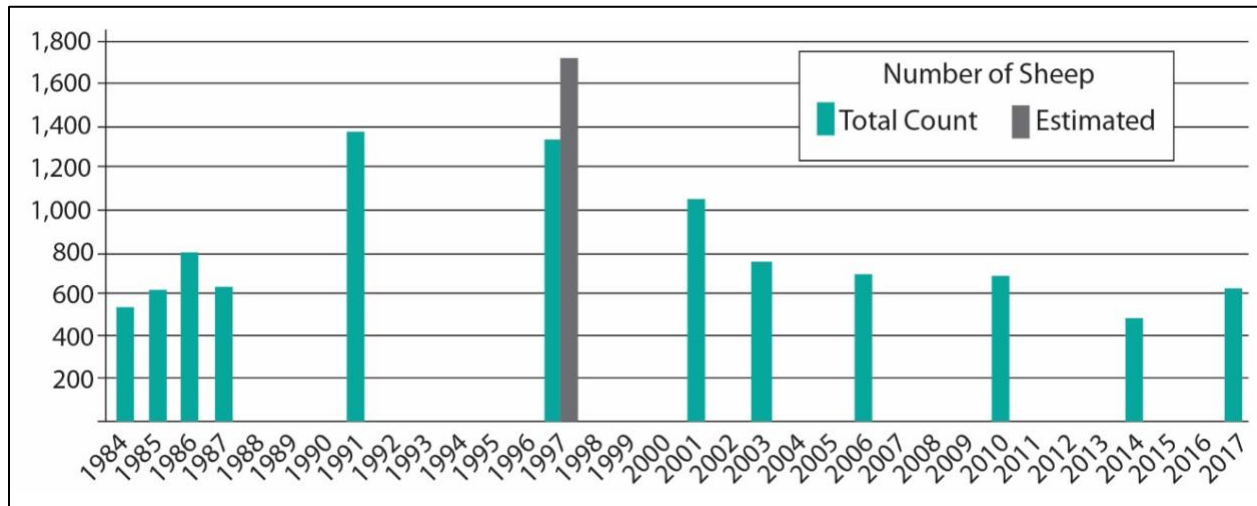
*Following the ranking system developed by NatureServe, an international network of conservation data centres (NatureServe, n.d.-a). G=Global; N=National; S=Subnational

Northern Richardson Mountains

The range of Dall's sheep in the Northern Richardson Mountains includes a relatively small area at the southeast edge of the Yukon North Slope. The range extends east to the NWT and south in the Yukon.

The number of Dall's sheep that range in the Northern Richardson Mountains increased in the 1980s and 1990s, and then rapidly declined from about 1,700 sheep in the 1990s to about 700 sheep in the early 2000s (Figure 13– 1). Predation by grizzly bears and wolves, climate change impacts, and harvest pressure are potential causes of the decline (Davison, Russell, & Belanger, 2018).

Figure 13– 1. Dall's sheep population size: aerial survey results, Northern Richardson Mountains, 1984 to 2017



Source: Davison et al. (2018), Figure 4

Dall's sheep in the Northern Richardson Mountains are at the northern edge of their range and are isolated from other populations. There is likely limited genetic mixing between different populations, particularly at the northern edge of the range. This may reduce the population's resilience to negative effects. The population is vulnerable to a range of factors, including adverse weather conditions, predation, and harvest (Lambert Koizumi & Derocher, 2019; WMAC (NS), 2012; Working Group for Northern Richardson Mountains Dall's Sheep, 2008).

Mapping the home ranges of several Dall's sheep and their main predators, grizzly bears and wolves, showed that the home range of the wolves coincided with most of the Dall's sheep range; and within the core area of Dall's sheep distribution, the overlap with grizzly bears was larger than with wolves (Lambert Koizumi & Derocher, 2010). In the areas most used by Dall's sheep, encounters with grizzly bears are likely more common than encounters with wolves.

British Mountains

Dall's sheep in the British Mountains are located in Ivavik National Park. Before the park was created, a placer mine operated on Sheep Creek, from 1979 to 1986 (Parks Canada, 2017). Mining activity was a source of disturbance and displacement of the sheep from mineral licks (WMAC (NS), 2012). Dall's sheep are now an attraction for park visitors rafting the Firth River and staying at Imniarvik Fly-in Base Camp.

In Ivvavik National Park, incidental observations have been recorded since 1973, and aerial surveys for Dall's sheep have been conducted sporadically since 1984. Surveys are often conducted in subsequent years to better understand both summer and winter ranges. Given the number of years between surveys, population trends of Dall's sheep are currently unknown. However, the latest survey (winter 2019) did indicate a stable population, due to the age and sex composition.

Winter surveys were conducted in 2002 and 2019, and found between 71 and 188 sheep, mainly west of the Firth River. Total observations can be lower in winter surveys compared to summer ones due to the fact that Dall's sheep are often found on snow, making the observation challenging. The sheep that overwinter at the western edge of the Yukon North Slope are likely part of the larger population that extends through the Brooks Range in Alaska (Parks Canada, 2002). Summer surveys occurred in 1984, 1986, 2001, and 2017, and 84 to 221 total Dall's sheep were observed.

During June 2001 and March 2002 surveys and again in summer 2017 and winter 2019, Parks Canada determined the population size, structure, and types of habitat used by Dall's sheep in Ivvavik National Park (Parks Canada, 2001, 2002; WMAC (NS), 2003). Habitat was assessed by helicopter and sheep sightings were recorded and mapped. The surveys located lambing cliffs and key winter habitat. The summer 2017 survey found 221 Dall's sheep, including 139 adults and 32 yearlings. The winter 2019 survey found 188 Dall's sheep, of which 153 were adults. The age and sex composition of both these surveys indicated a stable population. The 2019 winter survey was also carried out to confirm winter range location and habitat use (WMAC (NS), 2019).

Dall's sheep numbers declined in the 1990s in the Brooks Range in Alaska, adjacent to the western edge of the Yukon North Slope (Battle & Stantorf, 2018). The 1985 estimate for the eastern Brooks Range was 12,000 sheep. The current number is not known, but the population is believed to have stabilized at a lower level. Annual surveys are conducted to detect trends (Battle & Stantorf, 2018).

Population Dynamics and Management

Inuvialuit harvesters have exclusive rights to harvest Dall's sheep in Ivvavik National Park. They have a preferential right to harvest sheep on the Eastern Yukon North Slope (WMAC (NS), 2008). There are no restrictions (such as quotas) placed on Inuvialuit sheep harvest on the Yukon North Slope. Sheep hunting by non-Inuvialuit Yukon residents is not permitted within the Yukon North Slope portion of the range of the Northern Richardson Mountains sheep population, but a limited hunt is permitted in Game Management Subzones south of the Yukon North Slope (Yukon Government, 2019b).

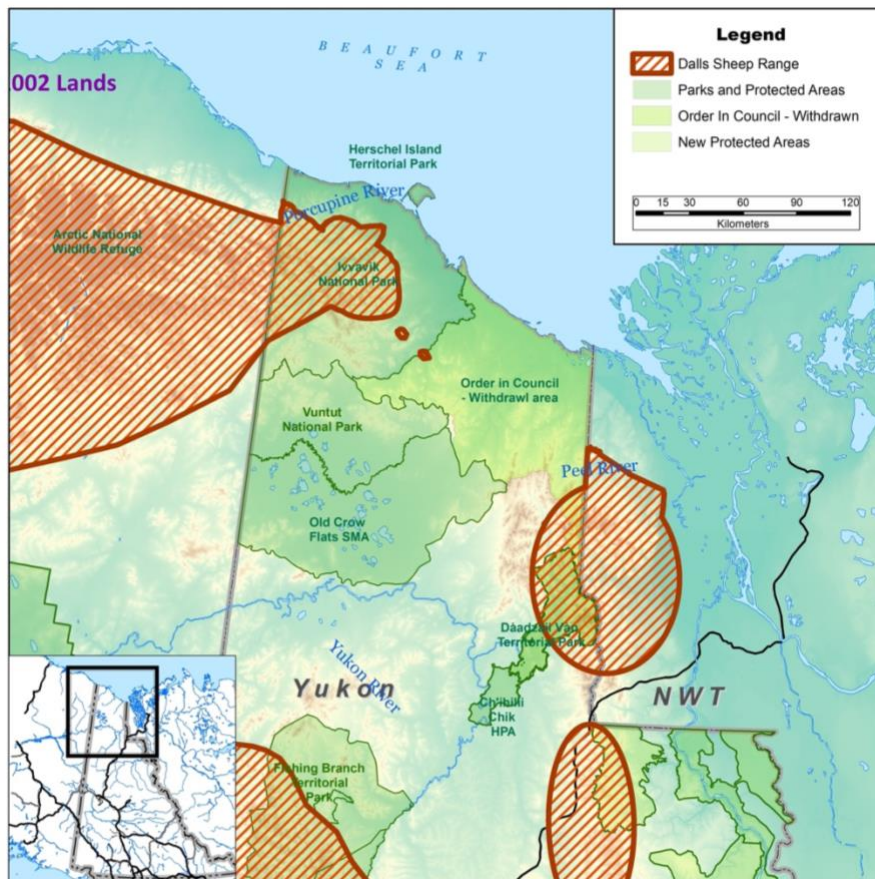
Sheep may be limited by availability of winter range (Parks Canada, 2002) and/or other factors, such as high mortality rates. Predation is important in sheep population dynamics as is habitat selection (Lambert Koizumi & Derocher, 2019). A study in Alaska indicated that causes of

mortality vary from mountain range to mountain range. In addition to predation and habitat limitations, they include disease, accidents such as falling or drowning, and adverse weather conditions (ADF&G, 2017). Overharvest has been a cause of Dall's sheep declines in the past (Jex et al., 2016). Harvest of the Northern Richardson Mountains population in the 1970s was considered unsustainable (Lambert Koizumi et al., 2011). Although the harvest pressure is currently low on Dall's sheep on the Yukon North Slope, both populations are at the edge of larger ranges that extend into other jurisdictions and they are harvested elsewhere.

Transboundary Considerations

Dall's sheep live only in the mountainous regions of northwestern North America—in Alaska, Yukon, western NWT, and the far north of British Columbia (Map 13– 3). The total number of Dall's sheep is not known, but may be as high as 100,000 animals (Jex et al., 2016). International cooperation is facilitated through the Wild Sheep Working Group, made up of government and Indigenous organization representatives from jurisdictions over the range of wild sheep in North America (Jex et al., 2016).

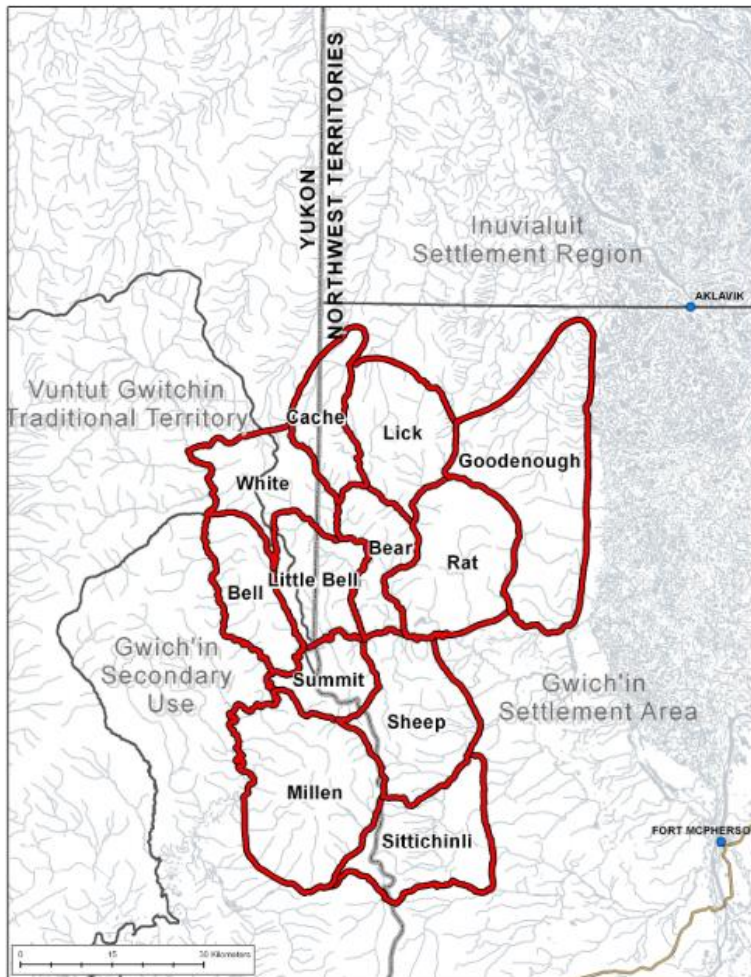
Map 13– 3. Dall's sheep range in regions adjacent to the Yukon North Slope



Dall's sheep range on the Yukon North Slope and nearby ranges in Alaska, Northwest Territories, southern Yukon. Map source: Yukon Department of Environment unpublished data, 2020.

The range of the Northern Richardson Mountains Dall's sheep population crosses territorial and land claims boundaries (Map 13– 4). Management of the population over its entire range is addressed in the draft *Management Plan for Dall's Sheep In the Northern Richardson Mountains* (Working Group for Northern Richardson Mountains Dall's Sheep, 2008).

Map 13– 4 Dall's sheep aerial count blocks in the Northern Richardson Mountains, showing territorial and land claim boundaries



Working Group for Northern Richardson Mountains Dall's Sheep (2008), Figure 2; figure data provided by the Gwich'in Renewable Resources Board.

Observations, Concerns, and Threats

Impacts of Climate Change

Climate change may have varied effects on Dall's sheep. Warmer weather and longer growing seasons mean that more forage may be available in spring. However, changes to vegetation

communities, including an increase in shrubs, may reduce the quality of forage. Changes in weather patterns, such as more frequent ice-on-snow events that limit access to foraging, are likely to be harmful to sheep populations. In particular, warmer climates over the range of this northern species may increase the incidence and variety of parasites. There are also many indirect climate change effects, including changes to the distribution and habitat use of sheep predators and other ungulates, changing patterns of human use of the environment, and increased spread of pathogens.

Dall's sheep may be particularly vulnerable to changes in snow conditions, especially during peak snow cover in late winter (Boelman et al., 2019). Snow cover properties, including depth, distribution, and how hard the snowpack is, affect Dall sheep's feeding efficiency, ease of travel through snowy areas, and predation rates. The Western Brooks Range Dall's sheep population in Alaska experienced a rapid, weather-related decline in 2013. The snowpack that year was about three times the average, leading to significant mortality (ADF&G, 2017). Alaskan research on how snow properties affect Dall's sheep movement (Sivy, Nolin, Cosgrove, & Prugh, 2018) concluded that sheep age and the density of the top layer of snow were the most important factors in how much the sheep sank into snow when walking. A study that looked at how to integrate snow science and wildlife ecology (Boelman et al., 2019) recommended development of a suite of snow measurements to improve tracking the effect of changing snow on Dall's sheep and other wildlife.

Lamb recruitment and climate

Models based on sheep survey results and climate data over the entire range of Dall's sheep indicate that spring snow cover has a strong influence on lamb recruitment—more so than temperature or the amount of precipitation. Better lamb recruitment is associated with higher snowline elevations, earlier snow-melt, and fewer snow-covered days, especially in the northern part of Dall sheep's range. This suggests that northern sheep populations are more sensitive to changes in snow conditions than sheep living further south. This is particularly relevant for the Yukon North Slope because its sheep populations are at the far northern edge of the species' range (see Map 13–3). Most climate models are forecasting earlier springs for the Yukon North Slope (earlier snow melt and green up).

Van De Kerk et al. (2018), Van De Kerk et al. (2020), Severson et al. (in press)

Survival rates of lambs and adults have been examined through analyses combining available information on Dall's sheep from across their range (Van de Kerk et al., 2020). Lamb survival was linked most closely with plant productivity (using an index from satellite imagery), and higher plant productivity in the summer was associated with higher lamb recruitment. Adult sheep survival was lower in years with more freeze-thaw events, a climate phenomenon that affects sheep ability to access forage and one that is predicted to increase into the future.

Impacts from Human Activities

Sheep are easily disturbed by aircraft flights (particularly rotary wing aircraft) and by humans close by on the ground, although they can become habituated to human presence. Industrial development, including mineral exploration, is a potential source of disturbance on sheep ranges. Sheep were displaced from important mineral licks in Sheep Creek due to placer mining, but have resumed using these since the cessation of mining activity (WMAC (NS), 2012).

When disturbed by aircraft, sheep stop activities such as foraging or resting and become vigilant (Frid, 2003; Laberge Environmental Services, 2002). Sheep stand and scan the surroundings and often flee the perceived danger by walking or running, anywhere from a few steps to over a kilometre. Yukon research showed that sheep do not resume their previous activity for up to 45 minutes after an aircraft is out of sound range (Frid, 2003). This reaction to disturbance is damaging because of the energy cost to the animal. If disturbances are frequent, body weight and reproductive success can be lowered. Research also showed that, although the sheep may react less over the course of a day with multiple overflights, they do not become habituated over the longer term. They react to disturbance as strongly on the first flight on subsequent days as they did to the first flight on the first day. Research also showed that helicopters disturb sheep more than fixed wing aircraft (Frid, 2003).

Disease and Parasites

Elders and harvesters have reported that Northern Richardson Mountains Dall's sheep are generally healthy, with few parasites (Lambert Koizumi et al., 2011, based on Shaw et al., 2005, a Dall's sheep local knowledge report published by the Gwich'in Renewable Resource Board). The emergence of new parasites due to climate change, however, is a concern for the long-term health of Dall's sheep populations (Lambert Koizumi et al., 2011). The types of parasites infecting wild sheep, their abundance, and their impacts on the health of sheep, are all highly sensitive to climate and climate change (Kutz et al., 2012).

Gastrointestinal parasites are common in Northern Richardson Mountains sheep, generally at low levels of infection (Lambert Koizumi et al., 2011). These parasites can have impacts on sheep populations if the parasites become more abundant. For example, intense infections in ewes of a common nematode parasite of Dall's sheep (*Marshallagia marshalli*) are associated with poorer body condition and lower pregnancy rates (Kutz et al., 2012).

Dall's sheep are susceptible to pathogens transmitted from other wildlife or domestic animals (Jex et al., 2016). As wildlife species ranges expand or shift, new parasites, bacteria and viruses may be spread between species.

The most significant disease threat to both thinhorn and bighorn sheep are pathogens that lead to respiratory disease (BCCDC, 2017; Jex et al., 2016). Pneumonia caused by bacterial infection has led to outbreaks of disease with significant mortality in bighorn sheep populations (BCCDC, 2017), but health assessments indicate that thinhorn sheep have had less exposure to the

pathogens causing respiratory disease (Jex et al., 2016). However, the bacterium *Mycoplasma ovipneumoniae* (*M. ovi*), was detected in 2018 in Dall's sheep in Alaska (ADF&G, 2019). *M. ovi* is one of the most frequent causes of outbreaks of pneumonia in bighorn sheep (BCCDC, 2017). Nevertheless, the strain of *M. ovi* found in Alaska is different from the *M. ovi* affecting southern wildlife, and to date there is no evidence that this strain causes pneumonia. Testing for these bacteria in sheep is ongoing to ensure it does not become an additional source of mortality to the Dall's sheep populations on the Yukon North Slope.

The Orf virus (*Parapoxvirus*), which results in lesions, can be transmitted between sheep and goats, and between wildlife and man. Research shows that most of the wild ungulates in Alaska can carry and be affected by this virus (Tryland, Beckmen, Burek-Huntington, Breines, & Klein, 2018). Orf has been detected in muskox on the Yukon North Slope and likely occurs in a number of northern species, both domestic and wild.

Research in the early 2000s addressed concerns that a lungworm common in muskoxen east of the Mackenzie River (*Umingmakstrongylus pallikuukensis*) might infect Northern Richardson Mountains Dall's sheep if the muskoxen's range were to expand west of the Mackenzie (WMAC (NS), 2005). The results showed that this parasite is not able to transfer from muskoxen to Dall's sheep. However, another type of lungworm (*Protostrongylus stilesi*) that has been found in muskoxen on the Yukon North Slope has been detected in Northern Richardson Mountain sheep (Lambert Koizumi et al., 2011). Sheep are considered to be the original carrier of this lungworm.

Links to Plans and Programs

This section lists plans and programs that link to the objectives and strategies of the *Yukon North Slope Wildlife Conservation and Management Plan*. These plans and programs informed the development of the Yukon North Slope Plan and are an integral part of its implementation.

Dall's Sheep Conservation and Management

- *Management Plan for Dall's Sheep in the Northern Richardson Mountains (Working Group for Northern Richardson Mountains Dall's Sheep, 2008)*

Plan partners include the Aklavik HTC and Inuvialuit Game Council, Gwich'in and Vuntut Gwitchin governments and organizations, the Yukon Fish and Wildlife Management Board, and Yukon and NWT governments. The Working Group recommended that a cooperative management plan should also be developed for the Southern Richardson Mountains.

This recommended draft plan includes actions for harvest monitoring and regulation (for beneficiaries and for other hunting) and plans for surveys and additional monitoring that are based on the size and trend of the sheep population. The plan contains recommendations and action items on community-based monitoring and research, including on population dynamics, predation, disease, and parasites. Other actions focus on monitoring changing conditions, mapping seasonal habitats, and managing effects of access and disturbance on sheep range use, while recognizing harvest rights and interest in tourism opportunities.

Dall's sheep management goals for the Northern Richardson Mountains

1. Ensure long-term conservation by making sure human use of sheep is sustainable and that other activities do not diminish sheep numbers or reduce the ability of the land to support sheep in the future.
2. Provide for traditional and other uses of sheep that benefit all people.

- *Aklavik Inuvialuit Community Conservation Plan (Aklavik HTC, Aklavik Community Corporation, WMAC (NWT), FJMC, & Joint Secretariat, 2016)*
Identifies the eastern Yukon North Slope (Special Designated Lands Site 725DE) as important for Dall's sheep for winter range, lambing areas, and migration corridors; mineral lick sites are in the Northern Richardson Mountains.
- *Ivvavik National Park of Canada Management Plan (Parks Canada, 2018)*
Conservation and management of Dall's sheep is part of the plan's strategy "to protect and conserve natural ecosystems, habitat, wildlife, cultural resources and Inuvialuit practices, based on the best available scientific and traditional knowledge" (Parks Canada, 2018).
- *Science-based management guidelines for Thinhorn Sheep in Yukon (Environment Yukon, 2019a)*
These update the 1996 sheep guidelines for Yukon (Yukon Renewable Resources, 1996).
- *Northern Yukon Regional Land Use Plan (Vuntut Gwitchin Government & Yukon Government, 2009)*
The planning area includes part of the range of the Northern Richardson Mountains population of Dall's sheep. A best management practice is to "avoid sensitive sheep habitats and key areas, with emphasis on winter range avoidance."
- *Thinhorn Sheep: Conservation Challenges and Management Strategies for the 21st Century (Jex et al., 2016)*
This assessment and plan was produced by the Wild Sheep Working Group of the Western Association of Fish and Wildlife Agencies (of the US, Canada, and Mexico). It includes objectives and strategies for thinhorn sheep (Dall's and Stone sheep) management throughout their range in northwestern North America. The focus is on developing common, collaborative management and monitoring approaches and standardized guidelines for use

across jurisdictions. Habitat conservation is considered a cornerstone of thinhorn sheep conservation and management.

Research and Monitoring Programs

➤ Sheep surveys

Aerial surveys of Dall's sheep ranges provide information on populations and habitat use.

- Surveys in the Northern Richardson Mountains in Yukon and NWT (Davison et al., 2018; Lambert Koizumi et al., 2011) (**Error! Reference source not found.**) have been conducted periodically from 1984 to 2017. See Figure 13– 1 for a summary of results.
- Surveys in the British Mountains were conducted in Ivavik National Park in 1984, 1986, 2001, and 2017 (summer) and in 2002 and 2019 (winter) (Antoniuk, 1989; WMAC (NS), 2019; WMAC (NS), 2005; Parks Canada, 2002; Parks Canada, 2020).

➤ Harvest monitoring: Inuvialuit Harvest Study (IRC, 2017, 2018, 2019)

Annual harvest monitoring in the ISR was led by the Inuvialuit Game Council and the Inuvialuit Regional Corporation. This program included Dall's sheep harvest monitoring. The ISR Community-Based Monitoring Program was revised after 2014 to focus on harvest. Aklavik Inuvialuit Community Resource Technicians (CRTs) collected harvest information, including harvest locations, through annual interviews with active harvesters. This program built on previous harvest monitoring methods and data (Inuvialuit Harvest Study, 2003).

Selected Studies and Research Relevant to the Yukon North Slope

There are different knowledge sources for each of the two regions where Dall's sheep occur on the Yukon North Slope. Sheep surveys, traditional knowledge, research, and consultations for a management plan provide information on Dall's sheep in the Northern Richardson Mountains. Observations and surveys in Ivavik National Park provide information on Dall's sheep in the British Mountains. Recent research in Alaska and Canada provides insight into the effects of changes in snow conditions on Dall's sheep and the risks to Dall's sheep from disease and parasites.

This section is an annotated listing of selected reports, scientific papers, and other resources that provide support to the *Yukon North Slope Wildlife Conservation and Management Plan* and highlight issues and research directions that will be important to consider during its implementation.

Traditional Knowledge Studies

- *Yukon North Slope Inuvialuit Traditional Use Study* (WMAC (NS) & Aklavik HTC, 2018b) and *Inuvialuit Traditional Knowledge of Wildlife Habitat, Yukon North Slope* (WMAC (NS) & Aklavik HTC, 2018a)

These two studies were undertaken by the WMAC (NS) and the Aklavik HTC to document traditional use patterns and knowledge about wildlife habitat on the Yukon North Slope. Both studies were based on interviews with Aklavik Inuvialuit land users. The results were used in developing the Plan and are described and referenced throughout this chapter.

Assessments and Syntheses of Survey Results

- *Thinhorn Sheep: Conservation Challenges and Management Strategies for the 21st Century* (Jex et al., 2016)

This international plan and assessment reviews knowledge about Dall's sheep throughout the species' range.

- *Status of Dall's Sheep (*Ovis dalli dalli*) in the Northern Richardson Mountains* (Lambert Koizumi et al., 2011)

This status report includes information from surveys, research, and Inuvialuit and Gwich'in traditional knowledge about Dall's sheep in the Northern Richardson Mountains.

Research

- *Research on grizzly and wolf predation and Dall's sheep habitat use in the Northern Richardson Mountains Dall's sheep* (Lambert Koizumi & Derocher, 2010, 2019)

Research included satellite tracking to establish home ranges of Dall's sheep, wolves, and grizzly bears, analysis of predators' diets, and seasonal habitat selection by rams and ewes. Results show the import role of predation in Dall's sheep use of different habitat types (see the section on Habitat for Dall's Sheep).

- *Research on disease and parasites*

- *Parasites in Ungulates of Arctic North America and Greenland: A view of contemporary diversity, ecology, and impact in a world under change* (Kutz et al., 2012)

This review paper provides information on the distribution and effects of Arctic ungulate parasites and the relationship of these parasites with sheep. It includes discussion of risks of parasite range shifts or expansions due to climate change, and the risks of transfer of parasites among ungulate species.

Recent research on disease and parasites in Dall's sheep includes Alaskan research on the Orf virus in wildlife (Tryland et al., 2018) and detection of *M. ovi* infection in Dall's sheep (Environment Yukon unpublished data, ADF&G, 2019).

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