

Dall's Sheep News



Research and Management Update, Winter 2017
Alaska Department of Fish and Game, Division of Wildlife Conservation

Welcome to ADF&G's Dall's sheep news

In recent years, increased public interest in Dall's sheep management has resulted in proposed regulatory changes that could substantially alter current sheep management and harvest strategies.

Many of the proposals submitted to the Alaska Board of Game address dissatisfaction among some hunters regarding sheep harvest opportunities and crowded hunting areas. Competition between hunters and guides for quality sheep hunting areas, unethical hunter behavior, challenges regarding hunting access, and the perception that fewer full-curl rams are available for harvest are some key concerns.

These issues have been reflected in complaints to the Alaska Big Game Commercial Services Board and by the large numbers of regulatory change proposals submitted to the Alaska Board of Game over the past several board cycles. We hope that the information within this newsletter provides insights to help clear up some misunderstandings that hunters may have about the status of Dall's sheep in Alaska and to clarify current sheep management strategies.

Current management strategies have maintained a consistent, long-season, general-harvest sheep hunt in Alaska for many decades. Issues do exist, but long term data sets indicate that sheep populations are doing well and hunters are largely successful. The Alaska Department of Fish and Game (ADF&G) hopes the current broad opportunities for sheep hunting will continue well into the future.

Is it Dall or Dall's sheep?

Both terms are commonly used, which can lead to some confusion. Organizations and agencies, including ADF&G, tend to use Dall sheep on websites and on public materials. However, most scientific journals require the proper name, Dall's sheep, which follows correct grammar for a possessive adjective. In this publication, we use Dall's sheep, the proper scientific name. Dall's sheep were named after William H. Dall, a prominent American naturalist and early explorer of Interior Alaska.



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Read more inside:

Preliminary results from a horn study initiated in 2016 demonstrate that more than 50 percent of the 484 rams that were examined during sealing were legal for one or more prior hunting seasons based on 360 degrees of curl. This research shows that more than half of mature rams that are available to hunters in a given season are escaping the hunt, surviving the rigors of the rut and winter, and are available for future harvest.

Natural History

General description

Dall's Sheep (*Ovis dalli dalli*) inhabit the mountain ranges of Alaska. These white creatures are most notable for the males' massive curled horns. Females (known as ewes) also grow horns, but theirs are shorter and more slender, and only slightly curved. Rams tend to resemble ewes and remain in ewe groups until they reach two years of age. After that, continued horn growth makes the males easy to recognize. Horns grow steadily during spring, summer, and early fall. In late fall or winter, horn growth slows and eventually stops. This start-and-stop growth results in a pattern of rings, called annuli, which are spaced along the length of the horn. A sheep's age can be determined by counting the annuli. Rams are considered old at about 12 years, although rams as old as 16 have been harvested on rare occasion. Ewes have been known to reach 19 years but their ability to reproduce diminishes at about 13 or older. For more information on basic Dall's sheep biology, visit the Dall Sheep Species Profile at <http://www.adfg.alaska.gov/index.cfm?adfg=dallsheep.main>.



Range and habitat

Dall's sheep are found in rugged mountains throughout Alaska and western Canada (see map on page 3). They are generally high country animals but sometimes are found below timberline. Dall's sheep are found in relatively dry country and frequent a special combination of open alpine ridges, meadows, and steep slopes with extremely rugged escape terrain in the immediate vicinity. When danger approaches they flee to rocks and crags to elude pursuers. They use ridges, meadows, and steep slopes for feeding and resting. In winter they rely on areas of dry, light snow that is blown away by winds to reveal underlying vegetation. Because winter habitat is limited, winter home ranges are generally smaller than summer home ranges. The extent and location of winter habitats largely determines seasonal movements of Dall's sheep. Winter range food availability is likely a limiting factor in sheep populations.

Diet

Dall's sheep are primarily grazers and utilize a wide variety of alpine forbs, grasses, and sedges. Their diets vary seasonally and by location. During summer, food is abundant, and the sheep consume a wide variety of plants (research on diet shows that some populations of sheep utilize more than 100 species of plants). Their winter diet is much more limited and consists primarily of dry, frozen grass and sedge stems available when snow is blown off the winter ranges. Some populations eat significant amounts of lichen and moss during winter. Many Dall's sheep populations visit natural mineral licks where they obtain essential mineral nutrients, especially during the spring.

Growth and reproduction

Lambs are generally born between mid-May and mid-June. As lambing time approaches, ewes seek solitude and protection from predators in the most rugged cliffs available. Lambs have a fully functional rumen by midsummer and begin feeding on vegetation within a week after birth but many ewes still nurse lambs into the spring of the following year. Ewes typically have their first lamb at three or four years old and produce a lamb annually if they are in adequate nutritional condition. The first weeks of a lamb's life are precarious. About 50 percent of lamb mortality occurs in the first 30 to 45 days of life when they are most vulnerable.

Adult rams live in bands which remain segregated from ewe groups for most of the year. They interact during the rut which occurs from mid-November to mid-December. The horn clashing that rams are so well known for is not a result of fighting over ewes, but is a means of establishing a dominance hierarchy among male sheep. These clashes take place throughout the year on an occasional basis, but occur more frequently just before the rut when rams are moving among the ewes and may meet unfamiliar rams of similar horn size.

Climate change

Climate change has the potential to affect sheep populations in Alaska and is likely already having an effect on their population dynamics through changes in alpine vegetation and snowpack. Dr. Roman Dial, a biologist at Alaska Pacific University, has documented that shrub and brush lines have advanced up to 300 vertical feet into sheep habitat in alpine tundra over the last 50 years in some locations in the Kenai and Chugach mountain ranges. As dwarf birch and alder replace the succulent forbs, grasses and sedges that sheep depend on for food, the carrying capacity of summer habitat may be decreasing. Warmer, drier summer conditions may also result in decreased forage quality of the same grass and sedge species, which may mean that ewes are getting less food of lower quality overall and are in poor body condition going into winter. This may mean that they are unable to get pregnant, or, once pregnant, they may be unable to carry the developing fetus to term. Decreased pregnancy and birth rates will lower the recruitment rate, which is defined as the number of young animals entering the population.

Changes in winter snowpack, snow density, snow water content, rain on snow events, icing, and snow persistence will also influence sheep foraging ecology and have great potential to decrease the carrying capacity of winter range. Wet, heavy snow will not be transported by wind as light dry snow is; and ice layers, crusted, or dense snow can make it difficult or impossible for sheep to use their hooves to dig to expose forage - a behavior called "cratering."

Climate also plays an important role in the dynamics of disease in wildlife, including Dall's sheep. Warmer winters may allow parasites or disease to have a greater effect on sheep populations. Also, wildlife species not currently present in Alaska could arrive due to range changes, possibly bringing diseases with them from other locations.

Research into the effects of climate change on sheep is already underway; ADF&G researchers are collaborating with Dial to study the impacts of climate change and alpine environmental factors on Dall's sheep populations. This work may have important ramifications for future sheep management.



Receding glaciers can create sheep habitat, though at lower elevations it may be a rather short period before the new habitat is overtaken by shrubs and trees.

The Status of Sheep in Alaska

Sheep hunting opportunities are stable

From a biological standpoint, sheep harvest management in Alaska has been successful. In Interior Alaska (the area with the majority of Alaska's sheep range and the largest percentage of the sheep), sheep managers report that, by and large, the way hunts have been structured and managed has resulted in stable opportunities and hunter success. In 2016, 2,345 hunters reported hunting sheep in Alaska, with a reported harvest of 797 animals. The majority of this take was from the general season hunt which has been in place for decades and provides all hunters with an opportunity to harvest a sheep.

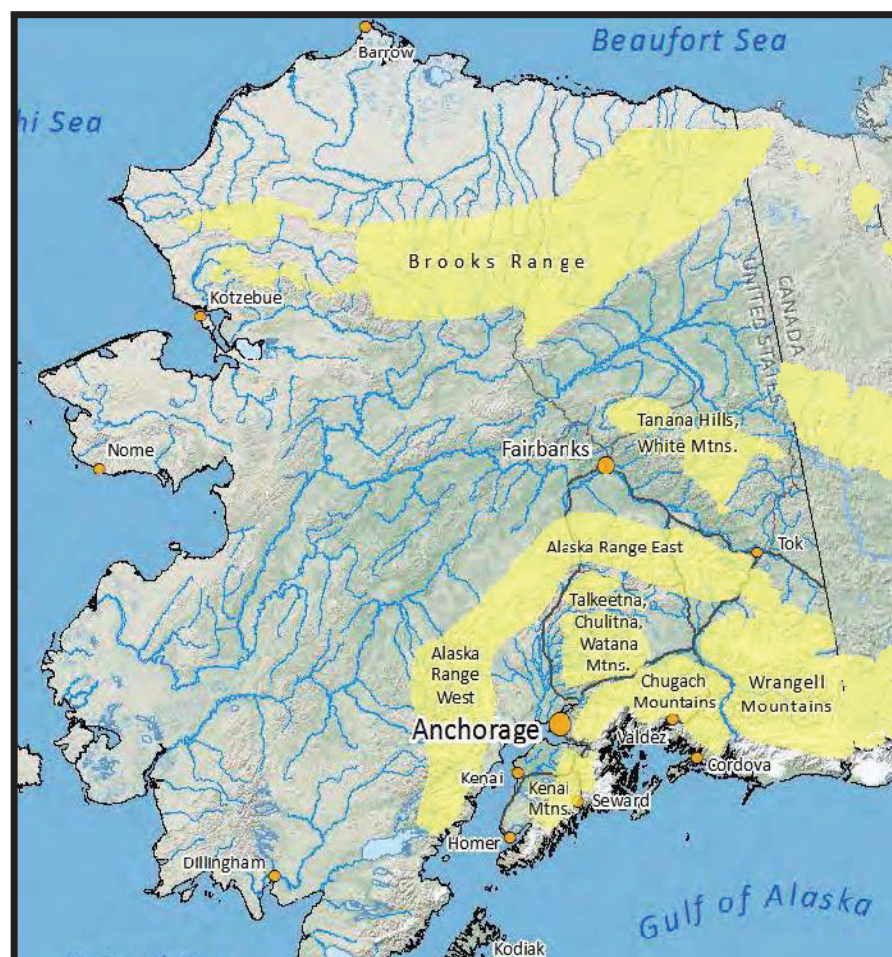


Harvest management

It is logistically difficult and expensive to count sheep populations in vast rugged terrain where inclement weather is common. Observation conditions are often dependent on the short window of time between snow melt and the start of hunting season. Most sheep populations are not monitored on a regular basis and in many circumstances are counted only to obtain sex and age composition of the population, not for population estimates. Population data on animals are normally collected by ADF&G so biologists can ensure that harvest strategies are sustainable. This information is not as necessary for Dall's sheep populations as it is for moose and caribou because restricting harvest to older, mature rams (full curl) ensures that harvest does not negatively impact sheep numbers. Without rigorous population estimates, small to moderate fluctuations in population abundance cannot be detected. Based on available but limited data analyzed by area managers, it appears that most of Alaska's sheep populations are stable.

One population in decline due to weather

The western Brooks Range population, which is at the very edge of Dall's sheep range on this continent, has experienced a recent, rapid and significant decline in sheep numbers. The weather plays a major role in driving sheep populations, and severe winter conditions in 2013 persisted into May where snowpack in some areas was three times the average. The western Brooks range sheep population experienced significant mortality across age and sex classes (including mature rams). Other sheep populations experienced mortality from this severe winter as well, but not to the extent of the western Brooks Range sheep. This population has yet to recover and hunting has been closed there since 2014. One good sign is that the ratio of lambs to ewes has significantly increased in the past two years.



This map shows the major mountain ranges in Alaska with sheep populations.

Eight major mountain range areas

Sheep range, habitat, and populations vary greatly across the large geographic area inhabited by sheep in Alaska. Sheep management strategies are consequently diverse and depend on many factors. Within the state of Alaska, Dall's sheep are found in eight major mountain ranges: Kenai, Chugach, Talkeetna, Wrangell-Saint Elias, Alaska Range, Brooks Range, White Mountains, and Yukon-Tanana uplands.

Survey and inventory report areas

For management purposes, the sheep mountain range areas are further divided into survey and inventory report areas so that ADF&G area biologists can keep track of sheep populations and harvest within their management area. These survey and inventory report areas include **Kenai Peninsula; Alaska Range west; south Wrangell Mountains; Chugach Mountains; Mentasta, Nutzotin Mountains and north Wrangell Mountains; Tok Management Area; Talkeetna Mountains and Chulitna-Watana Hills; Delta Controlled Use Area; north Alaska Range, east of the Nenana River, and west of the Delta River; White Mountains; Tanana Hills; western Brooks Range; central Brooks Range; eastern Brooks Range.**

Over the long term

Some people refer to the good old days of sheep hunting as though there were significantly more sheep in the past. However, sheep populations fluctuate both over the long term and within the short term. There were times when the various sheep populations in Alaska were higher and lower than they are now. A timeline history of sheep season lengths presented on page seven reflects those fluctuations. It may surprise some people to know that there were three sheep season closures – no sheep season at all – in the 1940s. Some of the longest running sheep counts that we have on record are from Unit 20A. We will look at this data set in more detail on the following pages as one example of population fluctuations.



Unique Aspects of Sheep Management

How biologists monitor sheep populations

When monitoring Dall's sheep populations, management biologists usually do not conduct population estimates as they do for other big game species. Instead, they fly elevation contours across sheep habitat in specific trend count areas within various mountain ranges annually. During these flights every sheep seen is counted. The result is a "minimum population count." Minimum population counts allow sheep managers to monitor trends in populations over time and to keep an eye out for any major changes that may occur within a population.

The main reason ADF&G does not get actual population estimates, as with moose and caribou for example, is that the full-curl regulation allows for less intensive monitoring. Full-curl management of sheep focuses harvest on older rams. This targeted approach limits harvest to a small segment of the population and protects a large segment from harvest. It is conservative management that works well when the exact population size is not known.

If managers had to obtain actual population estimates for Dall's sheep across the state, a combination of other factors would also come into play. These include staff time, cost, and survey technique development. It would require an unrealistic number of high-risk flying hours to attempt a complete survey of sheep populations within the state.

Because of the high alpine rugged habitat where sheep live, survey conditions are often challenging and dangerous. Biologists must fly near the summits of mountains (usually in July) where sheep spend most of their time. Conditions can be variable. Sheep can be easier or harder to see from the aircraft depending on snow cover, shadows, the angle of the sun, turbulence and whether they are standing on grassy slopes, rock, or snow. For all these reasons, a minimum count is used to monitor trends in populations.



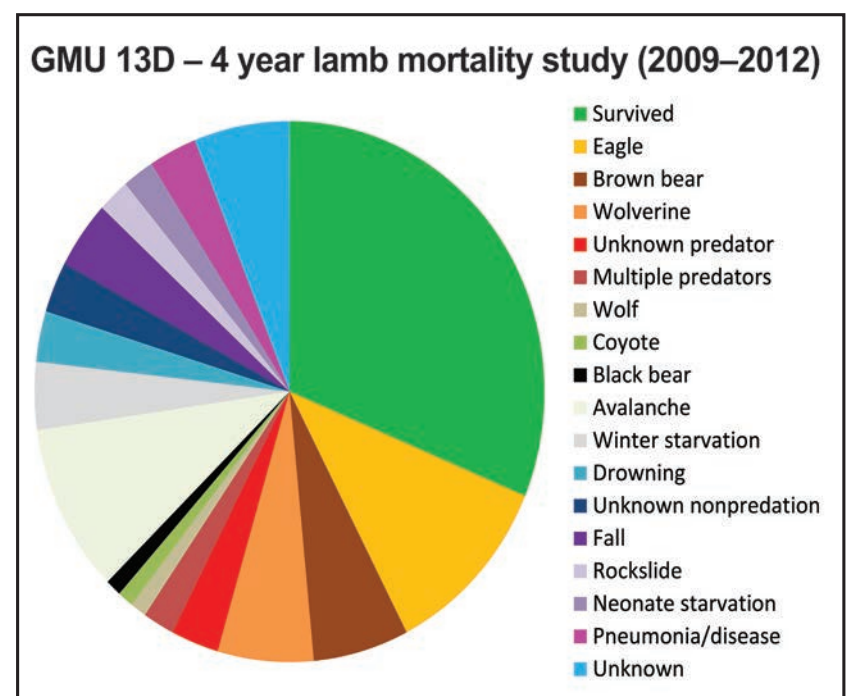
Sheep are viewed by aircraft during a sheep count.

Sheep mortality

It may seem intuitive yet it is important to emphasize that for any population to maintain itself, every animal that dies in a given year must be replaced by a new one. Any variation in this will cause the population to decrease – or increase if there is a higher survival than mortality rate.

Dall's sheep live in an extreme environment with many hazards and pressures facing each population. These include predation, disease, falls, drowning, habitat limitations, and weather. There are a few short-term studies describing sheep mortality in specific populations. Overall mortality rates (the percent animals dying each year) on both adult ewes and lambs are similar between the Brooks Range, Alaska Range, and Chugach Range populations. However, the causes of the mortality are very different between the mountain ranges.

In general, sheep mortality is highest in the first year of life, tapers off between the ages of 2-8, and then increases again as sheep age.

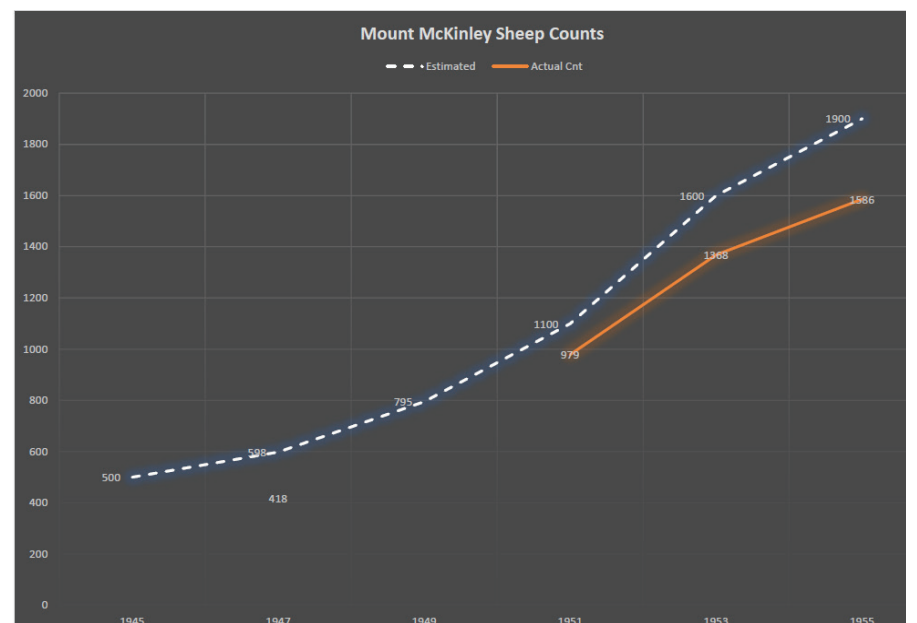


Sheep mortality was studied by ADF&G biologists in GMU 13D during 2009-2012. The cause of mortality was highly variable among the 101 lambs studied during this research, with no single factor resulting in the majority of lamb deaths.

Weather plays a major role

Research indicates that weather is among the most significant factors affecting sheep populations. Dall's sheep have a limited amount of time to acquire food necessary for reproduction and overwinter survival. To maximize protein intake during short summers, sheep select vegetation in early growth stages when protein and digestibility are high. In northern latitudes, mountain sheep are generally limited to foraging areas with snow depth less than 12 inches during the winter — patterns of diet selection can be affected by as little as 4-6 inches of snow. Cold springs with persistent snow and late storms can have a big impact on sheep populations by reducing the number of surviving lambs while also killing older sheep. One or more years of poor lamb production can cause a steep decline in the population.

Just as there are bad years when harsh weather events have an impact on various animal populations, there are also good years where weather conditions favor survival. If a sheep population experiences a series of good years the population can grow because lamb survival increases and mortality decreases. Older animals that would have died in a typical winter may survive. During these times a population can grow substantially as seen in the population of the Denali National Park area (then-called Mt. McKinley National Park) during the mid-1940s to mid-1950s. However, when a normal or severe winter occurs, the lamb survival will immediately drop and the older animals will also die. This can happen quickly and does not mean the population is declining; it may simply be returning to a more standard population level.



This graph shows rapid population growth for Denali area sheep during the mid-1940s to mid-1950s due to a series of mild winters.

Lessons from a Long-Term Data Set

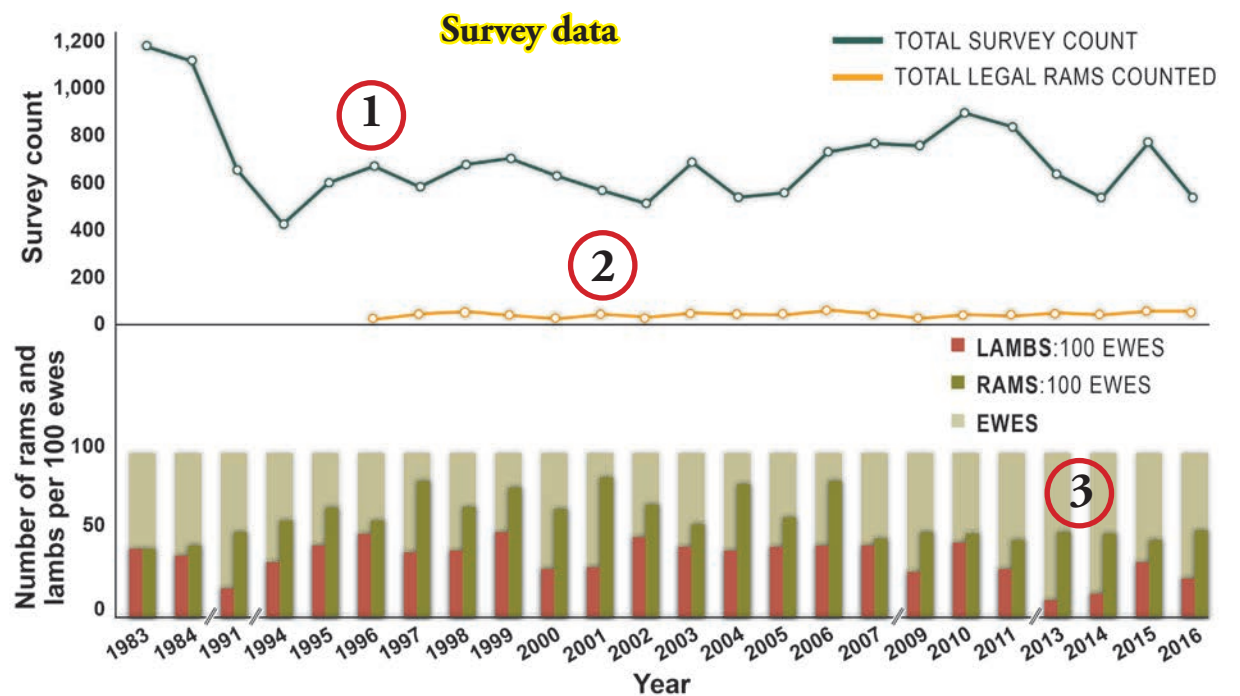
GMU 20A offers one of the longest consistent data sets for sheep counts

The mountains of Unit 20A are one of the most popular Dall's sheep hunting areas in Interior Alaska. Sheep numbers in the 1960s were relatively high within the unit, possibly due to favorable weather conditions. Aerial sheep surveys conducted before 1978 indicated a minimum estimate of 3,576 sheep in Unit 20A. In 1989 there was estimated to be 5,000 sheep in the unit (although the technique utilized that year may have overestimated the population). An extensive aerial survey conducted in 1994 indicated the sheep population declined during the early 1990s to about 2,000 sheep. The population experienced a sharp decline from reduced productivity and increased mortality due to a series of years with unfavorable weather, particularly the heavy snowfalls in 1993. Overharvest of sheep was not a concern because hunting was restricted to the taking of older rams.

This data from a portion of Unit 20A is interesting because of its longevity; it also helps illustrate how variable sheep populations can be and how susceptible they are to weather.

By looking at the survey data from a portion of the unit we can tell:

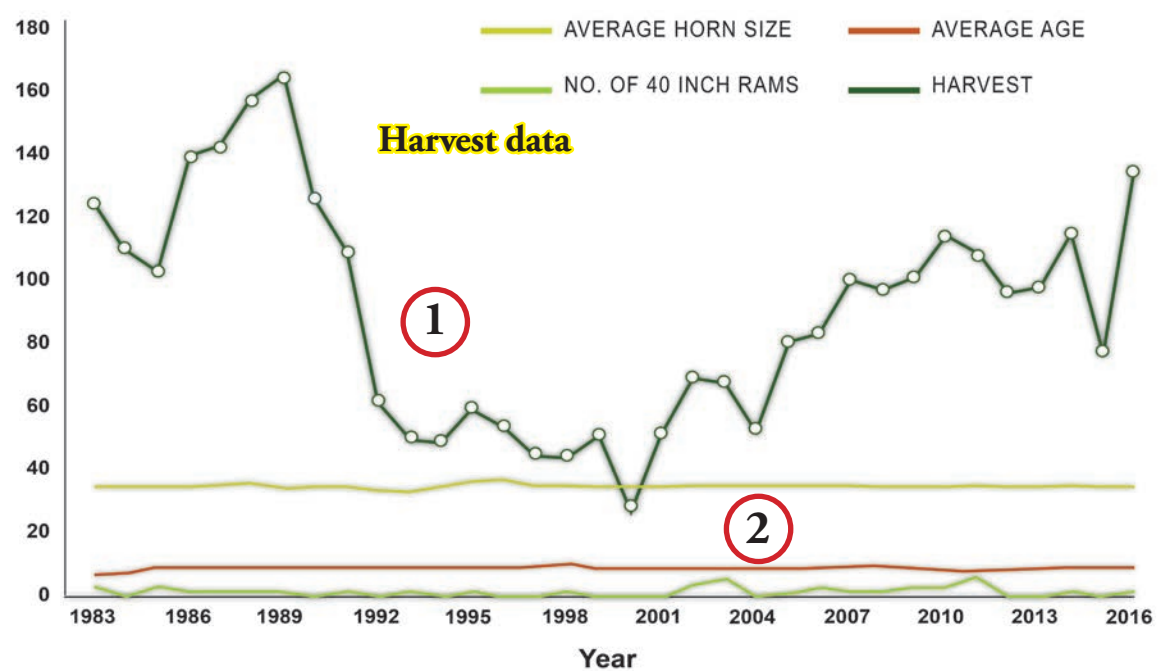
- 1 The total number of sheep observed in the survey area is highly variable each year but does not necessarily represent long-term fluctuations in population size. Cloud cover can influence visibility of sheep during surveys and environmental conditions such as green-up and mosquito abundance can alter sheep behavior and sightability.
- 2 The number of legal rams surveyed remained fairly constant and a low proportion of the surveyed population.
- 3 In 2013 and 2014 hard winters and late springs resulted in low lamb to ewe ratios. Although the ratio of rams to ewes was not impacted, low lamb production may be reflected in low ram ratios several years down the road when the 2013 and 2014 newborns reach adulthood.



Results from aerial sheep surveys from a portion of Unit 20A (1983–2016). With over 30 years of survey and harvest data, Unit 20A provides an example of how biologists use long-term sheep survey data to understand trends and productivity of sheep.

By looking at this harvest data we can tell:

- 1 Harvest varies as much as the sheep numbers and is independent of how many legal rams are counted during the sheep survey. Other factors, such as weather, have more of an influence on hunter participation and success than actual sheep numbers.
- 2 The average horn size, average age of sheep and the number of 40-inch rams harvested has remained relatively consistent for over 30 years.



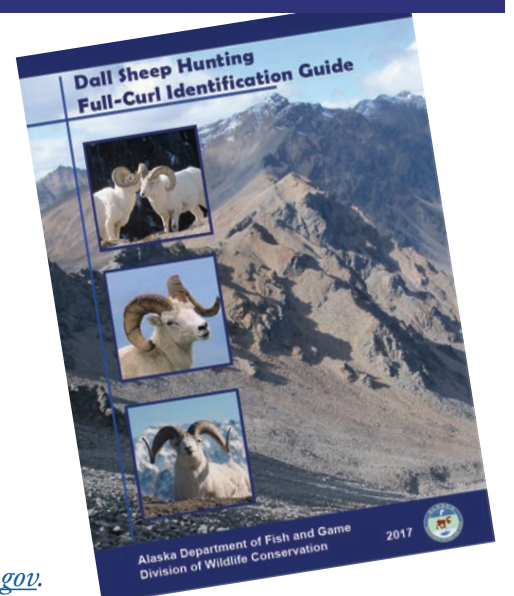
Harvest data from Unit 20A extending back to 1983 when full-curl regulations were instituted. The number of rams harvested each year is highly variable, but ram age and horn size has not changed.

Public Involvement and the Regulations

It is important to remember that ADF&G does not create the hunting regulations. The seven-member Board of Game, appointed by the governor and confirmed by the Alaska State Legislature, make those regulatory decisions based on proposals submitted by the public, local advisory committees, and/or ADF&G. ADF&G also provides management and research data to the board to help them make decisions.

We welcome your feedback and constructive criticism about this newsletter, the Dall Sheep Hunting Guide, our Dall Sheep web pages, or other information on Dall's sheep produced by ADF&G. Please tell us what you think. Do you appreciate these materials? Are they helpful? Would you like to see any other type of education and outreach about Dall's sheep hunting or management? Please send your comments to dfg.dwc.sheep@alaska.gov.

Pick up a free copy of this guide at your local ADF&G office.
Visit the new identification materials online at www.hunt.alaska.gov.



Sheep Management History in Alaska

History of Dall's Sheep Management

1902: Sheep season established from Sep 1-Dec 15; four ram limit.

1908: Nonresidents required to purchase a hunting license.

1914: Sheep season extended from Aug 20-Dec 31. Bag limit decreased to three rams.

1920-1925: Mt. Denali (formerly Mt. McKinley) sheep thought to be in decline.

1925: Resident hunting licenses required. Alaska Game Commission created to help regulate hunting.

1930: The reported sheep harvest in Alaska was 242.

1935: Territorial Governor and Alaska Game Commission discuss concerns over airplane use for sheep hunting. No action taken.

1941: The sheep season was shortened to Aug 20-Nov 15 with a one ram limit in selected areas in southern Alaska. Two ram limit in remainder of state.

1942-1944: No open hunting season for sheep anywhere in Alaska in 1942 and 1944, and in 1943, only south of the Alaska Range.

1945: Sheep hunting reopened. The statewide estimated sheep harvest was 300.

1949: Again, no open season for sheep anywhere in Alaska.

1950: Season open from Aug 20-31, one ram limit. Limited permits (20 each) and 3/4-curl requirement for Chugach and Talkeetna Mtns.

1951: Season open Aug 20-31, one ram limit, unlimited permits for Chugach and Talkeetna; 3/4 curl requirement added throughout Alaska.

1952: Season open Aug 20-31, one ram. Unlimited permits for Chugach and Talkeetna but 3/4 curl and horn salvage required.

1953: Season open Aug 20-31, general season throughout Alaska except for special closed areas. Estimated and recorded sheep harvest was 420.

1954: Season open Aug 20-Sep 10 for south of the Yukon River. Season open Aug 15-Sep 10 north of the Yukon River.

1955: The estimated sheep harvest in Alaska was 535.

1962: A harvest ticket was added to the requirements for sheep hunting.

1963-1964: The season in the Brooks Range was extended from Jul 20-Sep 20, with a 3/4 curl requirement and a two sheep bag limit.

1967: The statewide estimated sheep harvest was 915, with a success rate of 33 percent.

1971: Delta Controlled Use Area created.

1974: Tok Management Area created.

1979: 7/8-curl or greater requirement established statewide.

1980: The Alaska National Interest Lands Conservation Act (ANILCA) enacted.

1990s: Full curl or greater, age 8 or greater, or both horns broken (lamb tips missing) requirement for most sheep hunts.

2004: Mandatory statewide sealing of sheep horns implemented.

Why Full-Curl Management

Hunting management and regulation are needed to prevent harvest from exceeding the recruitment of new animals into a population. When areas have heavy hunting pressure and face increased limitations, one way to keep opportunity open for more people is for managers to limit the sex or age class of the animals available for harvest. For example, the spike/fork-50 inch regulation for moose hunting has allowed more people to hunt moose for a longer season, while keeping harvest at sustainable levels.

Full-curl management is a similar approach to preserve sheep hunting opportunity while conserving sheep. Limiting harvest to older full-curl rams ensures that the population's productivity is not affected by harvest. Compared to the harvest of other ungulates, the harvest rates of sheep in Alaska are low and expected effects of human take on sheep populations is accordingly, negligible.

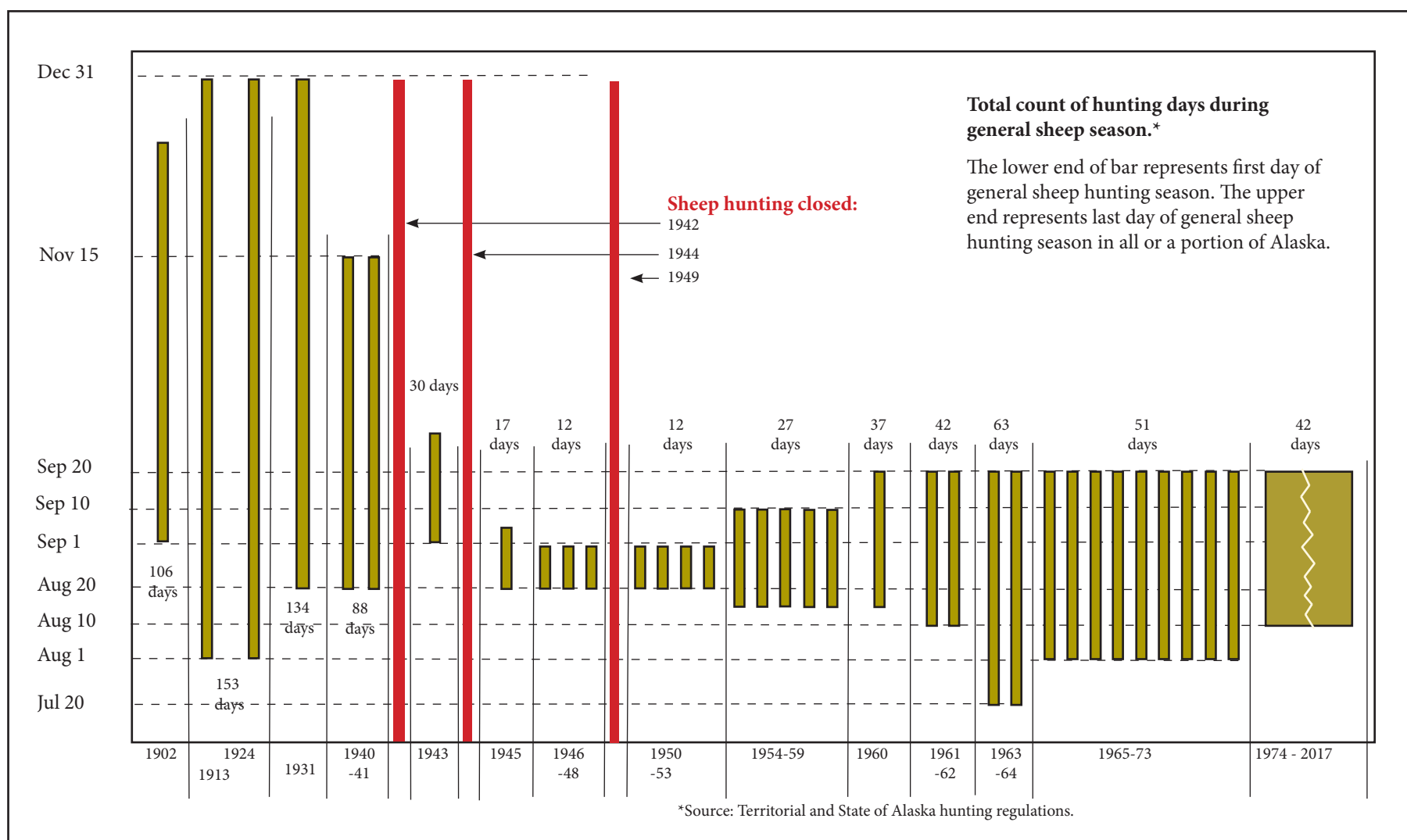
The primary reason that the regulation eventually ended up at full curl, however, is that some influential hunters and guides wanted bigger sheep on the mountain. There has also been an ongoing, inaccurate perception that too many rams are being harvested.



Even as curl restrictions have increased over time, success rates remained about the same. This may indicate that sheep hunters were already setting full curl as their standard of harvest and that there were more mature rams available for harvest than what was previously thought.

Sheep Seasons and Harvest Strategy

Looking at historical sheep harvest data and management strategies can give us an idea of Alaska's sheep populations since territorial times. Many variables have changed over the years – the number of sheep hunters, historic commercial hunting, the use of airplanes, new roads and railroads, to name just a few. Managers respond to variables as best they can based on information they can gather. This timeline helps illustrate the change over time from very long seasons with liberal bag limits to extremely conservative management in the 1940-50s, and then eventually to a stabilization of the hunting season over the past 50 years. See page six for a more detailed timeline.



How did we get to the full-curl regulation?

The management of Dall's sheep in Alaska started with the passage of the 1902 Alaska Game Act by the U.S. Congress. This act established the first bag limits and seasons for Dall's sheep in Alaska and made the killing of ewes or yearlings illegal, established an annual limit of four rams, and established a season. Though concerns about sheep populations on the Kenai Peninsula, and later, areas around Anchorage and Turnagain Arm were expressed early in the 1900s, seasons and bag limits remained relatively unchanged with lengthy seasons until the early 1940s. In addition to bag limits and season lengths, specific areas closed to sheep hunting were also created, notably on the Kenai Peninsula and in the Anchorage area.

Sheep populations were thought to be high in the early 1900s and slowly declined until about 1940 and reached a low point in about 1945. The 1940s were years of dramatic changes in season lengths and total territorial-wide closures to sheep hunting. For three years, 1942, 1944 and 1949, sheep hunting was completely closed. In 1943 everything south of the Alaska Range was closed. Season lengths decreased from 30 days in 1943, 17 days in 1945, to 12 days for the remaining years during the 1940s.

The challenge: Providing sheep hunting opportunities while ensuring conservation of the population

The 1940s was a major challenge for game managers. Sheep survey counts in Denali Park and on the Kenai Peninsula, started in the mid-1940s, indicated sheep populations were increasing. These counts, when considered with counts conducted in other parts of the territory in 1948 and 1949, also suggested sheep populations were increasing. After the closure of sheep hunting in 1949 the season was opened for 12 days for most of the Territory of Alaska, and twenty permits each issued for the Talkeetna and Chugach mountains. **Permittees in the Talkeetna and Chugach mountains were restricted to harvesting 3/4-curl or greater rams. This was the first use of curl size to regulate sheep harvest in Alaska.**

In 1951 the 3/4 curl requirement was expanded from the Chugach and Talkeetna mountains to include all open sheep hunting areas in the territory. The number of permits issued for the Chugach and Talkeetna mountains was expanded from 40 to 583 permits in 1951. Of the 583 permits issued about 400 hunted and about 90 successfully harvesting 3/4 curl or greater rams. Unlimited permits (906) were issued in 1952. In 1953 the Talkeetna and Chugach mountains reverted to general seasons with 3/4 curl or greater being the minimum harvest standard.

The first three seasons of the 3/4-curl requirement demonstrated:

1. Hunting pressure could be focused on a specific segment of the sheep population.
2. Hunters were capable of complying with a minimum curl requirement.
3. Ewes could be better protected from incidental harvest.

From the early 1950s until the late 1970s a minimum of 3/4 curl was the standard for most Dall's sheep hunts. In the late 1960s concerns were expressed that removal of all, or a large percentage of older mature rams might negatively affect the survival of younger rams and the reproductive dynamics of ewes. **These concerns (although unproven), along with strong support for harvesting full-curl sheep by sheep hunters, eventually resulted in the statewide full-curl regulation for most hunts.**

Statewide Sheep Research

Horn Morphometric Research: What do sheep horns tell us?

Annual rates of sheep horn growth may be considered an index of sheep body condition for a given location. Since sheep horns grow incrementally on an annual basis, segments between annuli effectively log growing conditions during the life of a ram. Managers may use this information in conjunction with survey data to assess and possibly predict the future production of legal rams in a specific area.

Comparing past and present horn dimensions

When horns are sealed, total length, base circumference and ages are recorded. In 2016, ADF&G began a three-year study to assess if additional horn morphometric data could be used as a management tool. Additional data were collected on a subset of harvested rams, including:

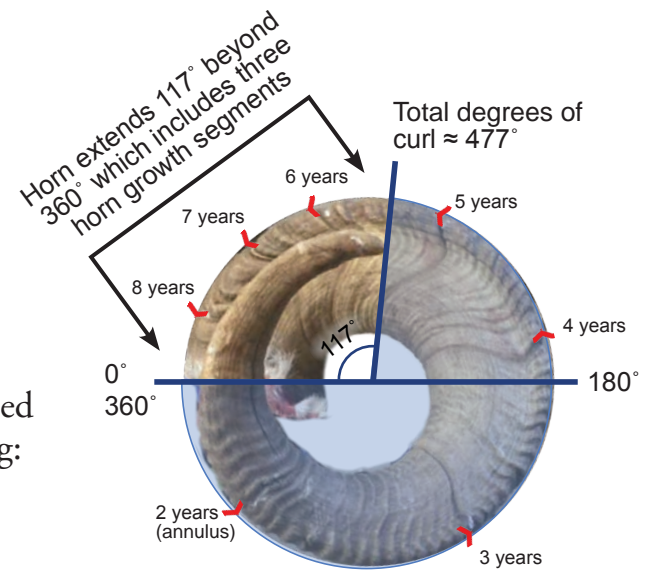
- 1) distance between annuli,
- 2) measuring the degree of curl for each horn

Some objectives of this research include the following:

- 1) examine the relationship between degree of curl and a) age and, b) horn length
- 2) estimate the proportion of rams harvested that would have been legally available for harvest in previous hunting seasons based on degree of curl; and
- 3) assess changes in horn size over time

Biologists used measurements from rams brought to the Fairbanks, Anchorage and Palmer ADF&G offices for sealing (474 ram horns were measured in 2016), as well as from 527 rams measured by staff biologists harvested under 3/4-curl regulations from 1968 to 1970.

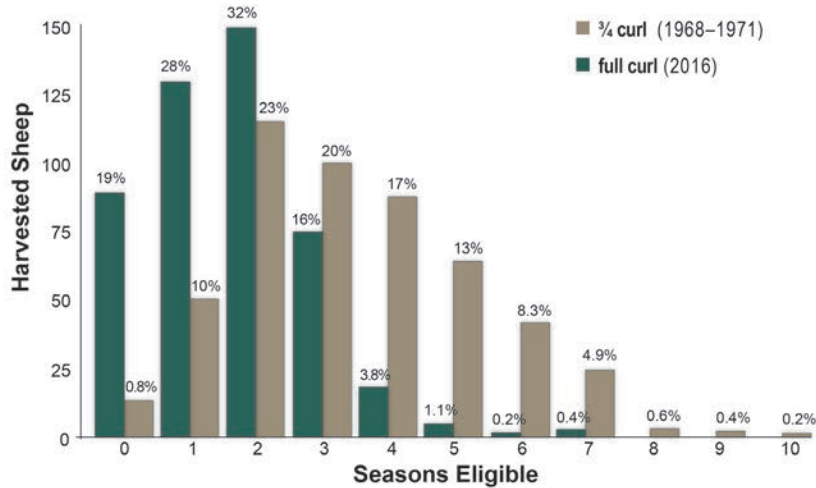
Future analyses will compare horn growth between mountain ranges, and explore the relationship between weather, habitat, and population variables on horn growth.



This 8-year-old ram has 477° degrees of curl. By counting the annuli in the section that extends beyond 360° we can tell that this ram was legal for at least three hunting seasons prior to being harvested.

Results: Do any legal rams survive the hunting season?

Knowing the ram's age, and degree of curl per growth segment allows us to calculate how many years the animal had been legally available for harvest. This tells us if all full-curl and 8-year-old rams are harvested the first year they become legal. Comparing current and 1968–1971 data helps us understand if the number of seasons that a ram was eligible for harvest has changed over time.



Percentage of Dall's sheep harvested based on the number of seasons they were legal to be harvested under 3/4-curl regulation, 1968-1971 (grey bars), and full-curl regulation in 2016 (green bars). For example, under full-curl regulation (green bars), 28% of rams were harvested in the first year they were legal based on degree of curl. Note: column 0 represents the percentage of rams that were harvested that did not meet the minimum degree of curl standard (but were legal based on age or missing lamb tips, or harvested in an any ram area).

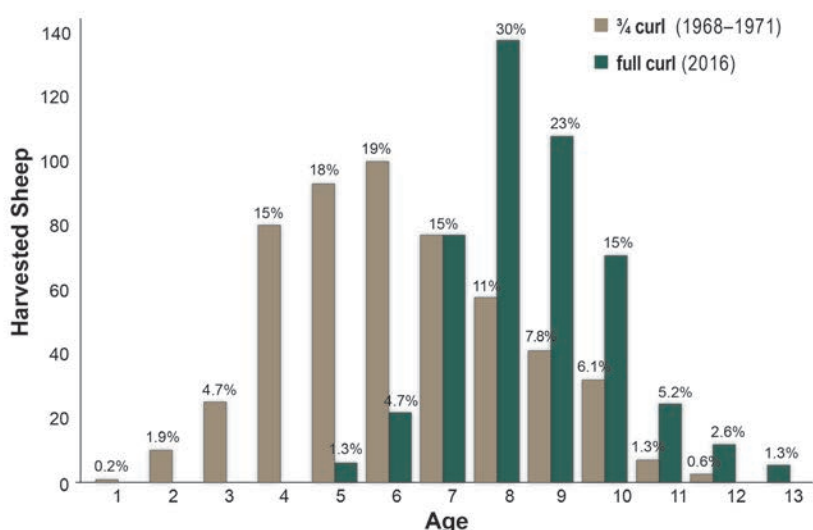
Results: Has horn size changed over time?

There are questions and speculation about whether the focus on full curl rams may alter the size and shape of ram horns over time. The suggested hypothesis is that rams with naturally tight horn curls or fast growing horns may be removed out of the population because they reach full curl faster and are more likely to be shot. Over time, this selective harvest could theoretically favor slower growing rams within populations.

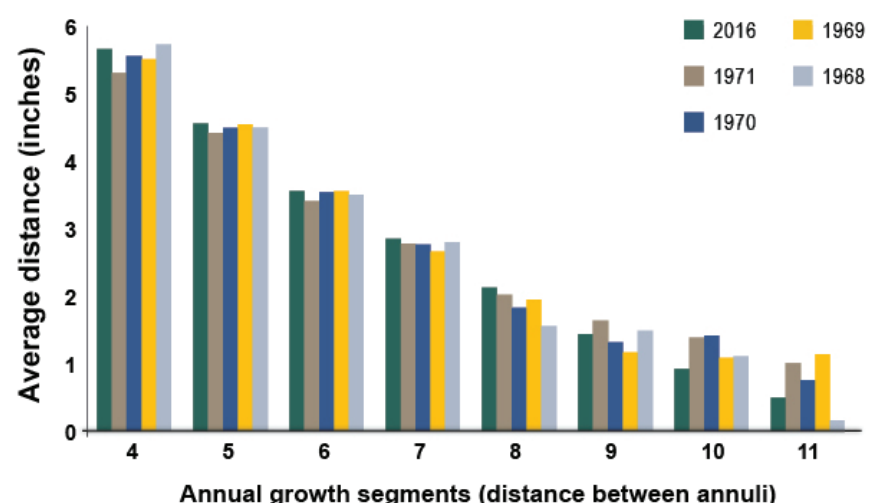


Data is collected on all sheep that are brought in during the sealing process.

There is no evidence that this occurs in Alaska but continued horn morphometric research can help answer this question over time. Examination of old horn measurements (1968-1971) compared to new data (2016) indicate that there has been no change in annual horn growth. Furthermore, factors affecting horn growth are complex and include genetic contribution of females, nutrition, population density, among others. The science is not yet clear on the effects of selective harvest.



Number of Dall's sheep harvested compared to their age. Almost half the rams harvested in 2016 were 9-years old or older. Although the age structure of harvested rams has shifted over time, older rams were not completely eliminated from the population due to full-curl regulation.



Average length of annual horn growth (the distance between annuli). Initial results show no difference in annual horn growth of sheep harvested under full-curl regulation (2016) compared to 3/4-curl regulation (1968-1971).

Southcentral Alaska Sheep Research

What drives Southcentral Alaska sheep populations?

In the last 20–30 years sheep populations in the Chugach Mountains (Units 13D and 14C) have declined by roughly half.

Research by ADF&G into the driving factors behind this population decline began in 2009 and continue today. Habitat, nutrition, and weather appear to be the biggest factors behind the decline.

In 2009 a subset of 40 adult ewes from Unit 13D were captured and fitted with radio collars to track locations. These same sheep were recaptured annually until 2014. Each time the sheep were handled samples were taken to assess disease, body condition, and pregnancy rates. From 2012 to 2016, 35 adult ewes were similarly studied in Unit 14C. Lambs were also tracked to determine mortality rates in both units.



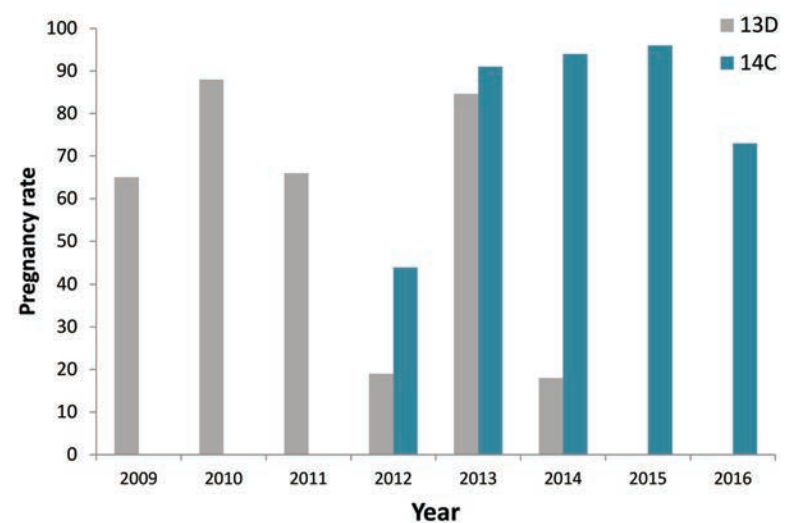
Biologists fit a radio collar on a Dall's sheep. This allows them to track and study the animal.

Factors causing a decline

The results from those studies suggest that the primary causes of decline in the Chugach Mountains were habitat, nutrition, and weather – factors that are unfortunately difficult to control. Changes in sheep habitat due to climate change appear to be a significant contributor. Ongoing research will provide more data and insight about current questions.

Ewes in both study areas were in poor body condition, with Unit 13D ewes faring worse than ewes in Unit 14C. These ewes were noticeably thin, with little subcutaneous fat, and low pregnancy rates compared to the rest of the state. A 1999-2003 study by former ADF&G biologist Steve Arthur in the Alaska Range found that typical pregnancy rates ranged from 85 to 100 percent. In Unit 13D, rates ranged from 88 percent (2010) to 18 percent (2014). In Unit 14C, rates ranged from 44 percent (2012) to 96 percent (2015).

This research also showed that predation, disease, and hunting were not major factors affecting sheep in Southcentral Alaska. Disease was present, but not higher than elsewhere in Alaska. Predation by bears, wolves, wolverines, or other predators was relatively rare on both ewes and lambs compared to other portions of the state, such as in the Alaska Range. In fact, avalanches killed more adult ewes in the Southcentral studies than did predators. Lamb survival rates varied greatly from year to year, and were consistent with other populations, though the causes were substantially different.



Pregnancy rates of ewes in Units 14C and 14D. Rates were highly variable and at times much lower than in other portions of the state.

Future research

How has climate change affected sheep forage in the Chugach Mountains? Researchers from ADF&G and Alaska Pacific University are collaborating to investigate the specific ways climate change affects sheep habitat and forage. One factor they are investigating is how protein content in grasses has decreased over time. Protein consumption is critical during pregnancy. Without enough protein, pregnancy rates drop and body condition of ewes and lambs diminishes.

As temperatures rise in the Chugach Mountains, drier summers have replaced wet, cool summers. This change has caused a drop

in the protein content of grasses important to sheep. Climate change has also led to shrubs, such as willow and alder, expanding to higher elevations. Sheep are mainly grazers, and cannot survive on shrubby vegetation. As shrubs replace alpine tundra once dominated by grasses, sheep lose important forage.



Dall's sheep research requires a lot of helicopter use. Here, a sheep is about to be captured with a net gun.



Grasses and sedges found in alpine tundra are critical to Dall's sheep.

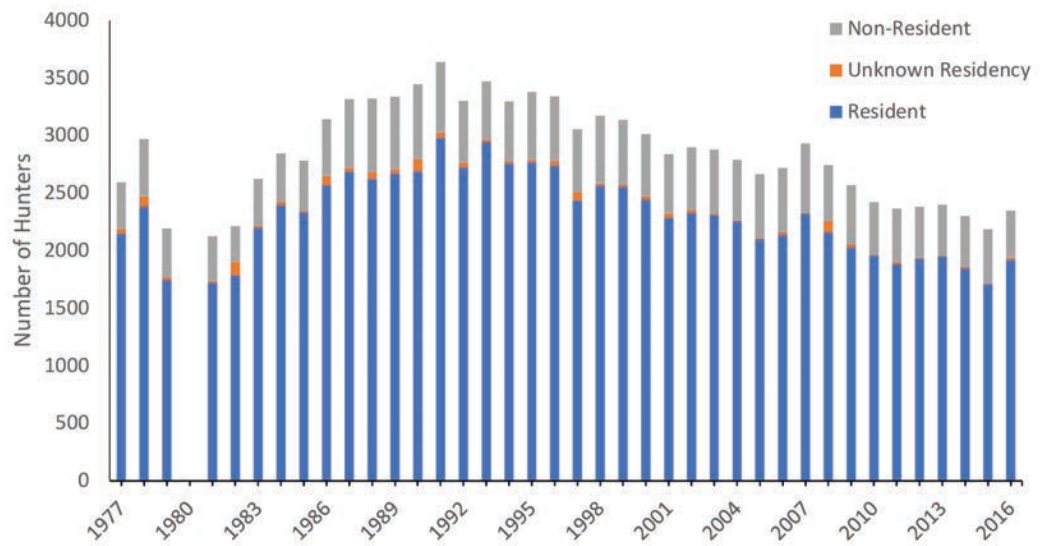
Hunting and Harvest Information

What report statistics indicate about sheep populations and sheep hunting

The number of sheep hunters has declined over 20 years

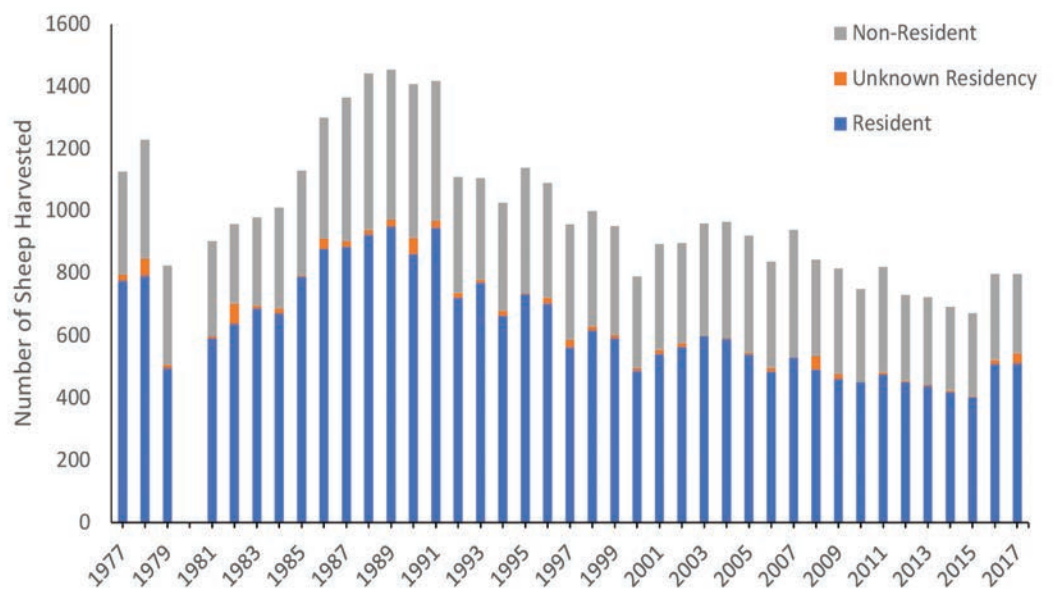
The number of sheep hunters in the field each year seems to fluctuate with the sheep populations. When sheep numbers are high, more hunters attempt a sheep hunt.

There are no data to explain the decline in sheep hunter numbers over time. It is possible that when sheep numbers are low, hunters may be less willing to put in the time, money, and physical suffering required to hunt Dall's sheep, preferring other opportunities that are less demanding. There have been dips in hunter numbers in the past, beyond the years shown in this graph. And even in the early 1980s, hunter numbers were lower than now. Interestingly, the number of nonresident hunters seems to remain stable regardless of the overall fluctuation of hunter numbers.



Sheep harvest fluctuates

As sheep hunter numbers decline so does the number of sheep harvested each year. There are no data that indicate the reason for a decline in sheep hunters although hunters are declining nationwide. However, in 2016 and 2017 sheep harvest was approximately 100 animals greater than it was in 2014-2015, for an upward trend.



Success rates for resident and nonresident hunters

Residents had lower success rates than nonresidents for all mountain ranges and for all of these time periods with reported harvest. This is expected because most nonresidents hunt with a guide, are more likely to use airplanes and horses to hunt, and spend more time in the field on average, than resident hunters.

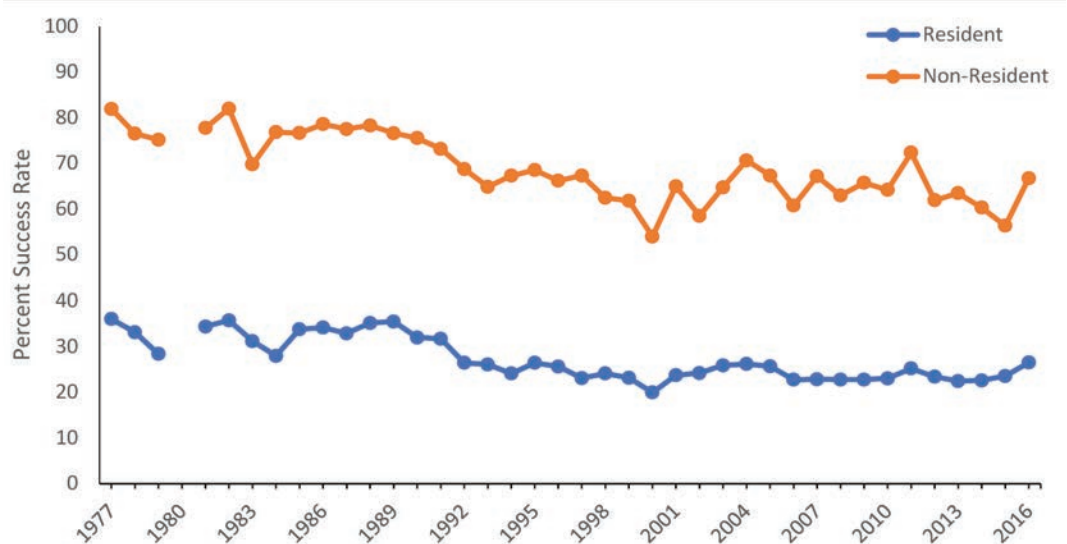
What affects success rates?

One might think the number of rams available for harvest would be the most important factor, but that is not necessarily the case. Current research indicates that hunters harvest less than 50 percent of the available legal rams each year.

If hunter numbers go up dramatically, success rates will likely show a drop simply because many of the hunters may not be skilled at sheep hunting or may not put in as much effort to get a sheep.

Weather conditions play a major role in success rates. Snow, rain, and fog during sheep season can have a serious impact on hunters ability to see and harvest sheep.

Overall, the success rate of resident sheep hunters has hovered around 25-30 percent for a long time.



What does hunter effort tell us?

The average number of days hunted by successful sheep hunters and success rate can be a possible indicator of changes in the number of available rams. If total days hunted significantly increases, it could mean fewer sheep were available and more effort was required to harvest an animal.

In general, the amount of days hunted for successful and unsuccessful hunters has remained the same for decades.

The greatest difference observable is the days hunted for unsuccessful nonresident hunters. They hunt longer than resident hunters, likely because most are in a guide camp or they persist because of the investment that they have put into their hunt.

This is a sample of data collected from hunter harvest reports from a few of the major mountain ranges.

It demonstrates that the average number of days hunted has not significantly changed for hunter effort in the past several decades.

These data are also available for all mountain range areas for resident and nonresident hunters.

Average number of days hunted for successful residents

	1972-80	1981-88	1989-2000	2001-2013	Average
Alaska Range E.	4.0	5.2	5.0	4.7	4.9
Alaska Range W.	4.6	4.8	5.1	4.5	4.8
Brooks Range	4.6	6.0	5.7	5.4	5.6
Chugach Mtns.	4.1	5.3	4.3	4.4	4.5

Average number of days hunted for unsuccessful residents

	1972-80	1981-88	1989-2000	2001-2013	Average
Alaska Range E.	5.2	5.1	5.6	5.6	5.5
Alaska Range W.	5.2	6.0	5.7	5.8	5.8
Brooks Range	6.4	6.3	5.9	6.2	6.1
Chugach Mtns.	4.8	4.9	4.7	5.0	4.8

Sheep Disease and Health Monitoring

Diseases in Dall's sheep

Several bacteria, viruses, and parasites occur at low prevalence in Dall's sheep and are enzootic (naturally occurring) to Alaska. Screening of ewes and rams suggests that herds are largely healthy. Even when disease is present, mortality usually only occurs in individuals that are young, weakened or otherwise stressed. The following diseases are among the most common in Dall's sheep:

- * **Contagious ecthyma** - Contagious ecthyma, also known as sore mouth, is a viral disease that causes crusty lesions on the face, ears, and nose. It is contagious to people (called "orf") and is usually expressed as a mild skin sore.
- * **Lungworm**- Lungworms are parasites that can obstruct breathing and make infected animals vulnerable to secondary bacterial pneumonia.
- * **Respiratory disease (pneumonia)**- Respiratory disease is a complex disease that can be caused by a number of viruses, bacteria, and parasites. Several respiratory disease causing bacteria (*Mannheimia haemolytica* and *Bibersteinia trehalosi*) are enzootic (always found at a low level). One study found that 50–60% of Dall's sheep had previous exposure to these bacteria. Enzootic strains usually only cause mortality in stressed animals.
- * **Foot rot**- Foot rot is caused by a bacteria naturally present in the soil and digestive tracts of some wildlife. Pus-filled abscesses develop between the hooves of infected animals causing the foot to swell two to three times its normal size. The infection can spread up the leg and through the blood and cause death. Foot rot has caused mass mortality in Dall's sheep.



Crusty lesions caused by contagious ecthyma on the face of a Dall's sheep.



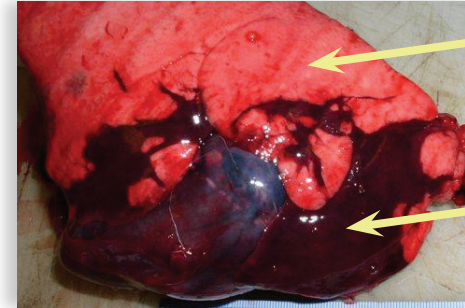
Young Dall's sheep with severe pneumonia.



Lung tissue infected by lungworms.



Scabs caused by contagious ecthyma on the leg of a young Dall's sheep.



Inflamed lung tissue infected by bacterial pneumonia.

Normal lung tissue

Infected lung tissue

For a comprehensive list of diseases visit www.adfg.alaska.gov > Species > Parasites & Diseases > Information by Host Species <http://www.adfg.alaska.gov/index.cfm?adfg=disease.main>

Pneumonia related die-offs in bighorn sheep

In the lower 48 states, respiratory disease has caused large-scale die-offs in bighorn sheep. These outbreaks are thought to take place when enzootic bacteria exist concurrent with the bacteria *Mycoplasma ovipneumoniae* (often referred to as *M. ovi*). *M. ovi* is not enzootic (naturally occurring) to wildlife in North America and wild sheep and goats have few natural defenses against it. In some cases, *M. ovi* related respiratory disease outbreaks in wild bighorn populations have been linked to contact with domestic sheep and goats.

Disease surveillance

ADF&G conducts both targeted and opportunistic disease surveillance. Animals are tested for a variety of diseases when they are captured in conjunction with other research efforts. Samples are also opportunistically taken when animals are found dead or when hunters suspect a harvested animal is diseased.

Why did ADF&G collect samples from my harvested sheep head?

Starting in 2017, nasal swabs were taken from select hunter-harvested sheep that were brought to ADF&G offices for sealing. These nasal swabs are being analyzed for the presence of *M. ovi* and other similar respiratory disease causing organisms.

Studies have shown diseases are easily spread between domestic livestock and wild sheep. To reduce contact and the spread of disease, Alaska law prohibits the use of domestic goats and sheep as pack animals when hunting sheep, goat, or muskoxen.



What if I find a diseased animal?

Can I eat the meat? Edibility of the meat should not be affected by these diseases. However, affected parts should be trimmed off and meat cooked thoroughly. Severely diseased animals may be in poor condition, reducing the quality and taste of the meat. **It is not recommended to eat sick animals or meat that smells rotten (although the meat still must be salvaged).**

How do I report? Please report Dall's sheep (or other wild mammals) that show signs of disease or parasites by sending the location and a photo to dfg.dwc.vet@alaska.gov. **If you find a Dall's sheep with abnormal lung tissue (lungs should be spongy and uniform pink other than blood shot areas) immediately call or text the Wildlife Disease Surveillance reporting line at 907-328-8354.** Record the location, take photos of the carcass and abnormal tissue and collect a lung for submittal to ADF&G.

More Information and Future Priorities

Age and size of harvested rams

Age and size of harvested rams over time can provide managers with an index of the effects of sheep hunting and especially of targeting older rams. If, for example, there was a sudden change or trend change in the age or horn length of sheep that hunters bring in, it would raise a red flag.

Over decades of hunting we see little variation in the average horn length or age of sheep which indicates that hunters are having no perceivable impact on the condition of rams.

Because of the low percentage of harvest of these animals, and the new research indicating that hunters are harvesting less than 50 percent of full-curl or 8-year-old rams, this is no surprise.

These are a sample of data collected from hunter harvested sheep.

This is just a sample to demonstrate that horn length and age of harvested sheep over the past several decades has not changed.

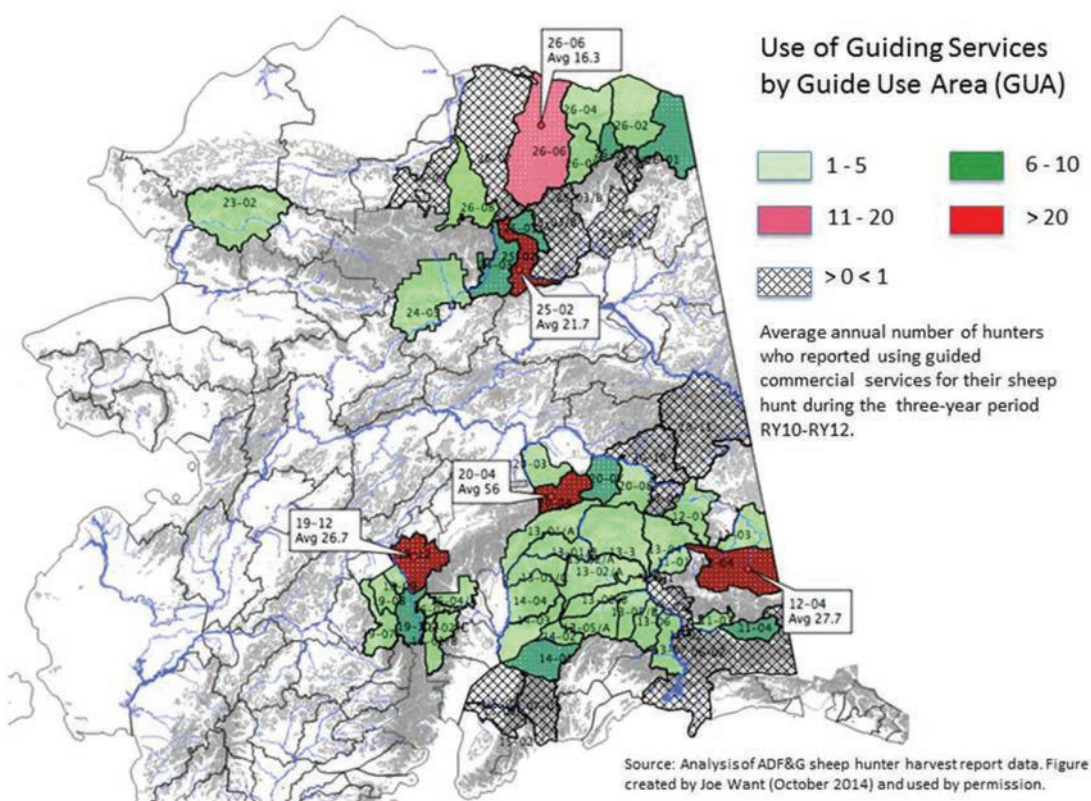
These data are also available for all mountain range areas for resident and nonresident hunters.

Mean horn length of resident harvested rams

	1972-80	1981-88	1989-2000	2001-2013	Average
Alaska Range E.	33.3	34.7	35.5	35.1	35
Alaska Range W.	33.7	35	36	35.8	35.4
Brooks Range	34.2	34.4	34.3	35.2	34.6
Chugach Mtns.	34.7	34.8	34.6	35	34.7

Mean age of resident harvested rams

	1981-88	1989-2000	2001-2013	Average
Alaska Range E.	8.2	8.9	8.6	8.6
Alaska Range W.	8.4	9.0	8.6	8.7
Brooks Range	8.7	9.3	9.1	9.1
Chugach Mtns.	7.7	8.0	8.1	8.0



Are guides taking all the sheep?

This has been a major concern voiced at the Board of Game and other venues. In an effort to investigate these concerns a map of the guide use areas was colored-coded according to the reported number of hunters using guide services. The map demonstrates that indeed, a few areas showed greater than 20 hunters used guides services, but in most areas only one to five people reported using guide services.

ADF&G priorities for sheep conservation and management

Staff involved in sheep management have identified several priorities related to Dall's sheep conservation and management. These include:

- **Public outreach and education-** Efforts to include full-curl management, hunt structures/issues, federal land issues, climate change effects on sheep, disease issues/risk, basic sheep life history, sheep distribution and habitat requisites.
- **Federal lands issues-** Maintain access to sheep on federal lands for both hunting and state management activities.
- **Climate change-** Research, collaborate, and address climate change and the potential impact to sheep distribution and abundance in Alaska. Inform users and others from the public regarding sheep habitat change as influenced by changes in climate and ultimately vegetation. Provide leadership and guidance in the discussion regarding the effects of climate change on sheep and sheep habitat management in a changing environment.
- **Selective harvest research-** Identify and study the effects, if any, of selective harvest strategies on Dall's sheep. This includes research on ram cohort survival, growth rates, age-class distribution, and possible factors related to population productivity.
- **Disease monitoring-** Dall's sheep disease monitoring including screening for the bacterial pathogens *Mycoplasma ovipneumoniae* and the Pasteurellaceae family including *Mannheimia hemolytica* and *Bibersteinia trehalosi*. This will include data collection from animals found dead, animals captured for other research/management purposes, health screening from opportunistic captures, and samples collected from harvested sheep provided by guides and hunters. ADF&G will also support the State Veterinarian's Office within the Alaska Department of Environmental Conservation (DEC) to evaluate the presence of respiratory pathogens in domestic sheep and goats in Alaska.
- **Domestic livestock-** ADF&G and the DEC State Veterinarian are working together with all stakeholders to assess and minimize the risk that domestic sheep and goat diseases could pose to wild Dall's sheep.
- **Sheep operational plans-** Prepare, write, draft and finalize 5-year sheep operational plans and reports for the 15 survey and inventory report areas as currently described in the 2014 survey and inventory report published in 2016.