



Ground-based Surveys for Dall's Sheep in Denali National Park

2008-2017 Report

Natural Resource Report NPS/DENA/NRR—2018/1611



ON THE COVER

Observers search for Dall's sheep during a ground survey on Mt. Margaret in 2016.

NPS Photo

Ground-based Surveys for Dall's Sheep in Denali National Park

2008-2017 Report

Natural Resource Report NPS/DENA/NRR—2018/1611

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Abstract

Ground-based Dall's sheep surveys were conducted annually along the Denali National Park Road corridor from 2008 to 2017. Previous ground surveys occurred from 1974 to 1996 but these were discontinued from 1997 to 2007. From 2008 to 2017, areas surveyed varied slightly from year to year depending on weather conditions and information gathered from aerial overflights prior to the surveys. From 2008 to 2017, a total of 41 to 184 sheep were counted and classified each year. Estimates of sheep productivity (expressed as the number of lambs per 100 ewes or ewe-like sheep) ranged from 3.57 (2013) to 50 (2016) lambs per 100 ewes. The estimate of productivity in 2012 (10.94) and 2013 (3.57) were the lowest recorded since 1993. The productivity estimate from 2013 was the lowest recorded during ground surveys since 1974. This drop occurred following a winter with very late snowmelt and record cold spring temperatures, which potentially covered spring forage and impacted natality and/or early survival of lambs.

Acknowledgments

The data in this report was collected by numerous volunteers and NPS staff from 2008 to 2017. In particular, L. Phillips was instrumental in resuming the ground-based surveys in 2008 and M. Snover, H. McKenny and W. Clark provided significant help with data collection, funding, and logistics. M. Raffaelli developed the methods for plotting sheep band locations. E. Goad formatted the report and added the 2017 data.

Introduction

The protection of Dall's sheep (*Ovis dalli dalli*) herds was the primary driving force in the creation of Mount McKinley National Park in 1917. Sheep populations in the park have always been of great interest to park staff and visitors. As a high-altitude species with very specific habitat needs, Dall's sheep serve as a sensitive indicator of climate and vegetation change. Because Dall's sheep are among the most widely viewed wildlife species by park visitors, changes in the distribution and numbers of sheep can be important for visitor experience and satisfaction.

For many years, staff in Denali National Park conducted ground-based sheep surveys along the Denali Park Road corridor to obtain information on Dall's sheep age and sex composition and estimates of sheep numbers (Dalle-Molle and Van Horn 1982, Stahlnecker 1995). The ground-based surveys were supplemented by aerial surveys in several years (Smith 1972, 1973; Troyer and Grosnick 1978, 1978; Singer et al. 1981; Dalle-Molle and Van Horn 1982, 1983, 1986, 1988; Taylor et al. 1988; Stahlnecker 1995). Aerial surveys in 1981 and 1987 were conducted with helicopters, all others with fixed-wing aircraft. Due to limited access to survey areas, ground-based Dall's sheep surveys did not provide good estimates of park-wide sheep numbers. However, results from the aerial surveys combined with the ground-based surveys in 1981 and 1987 indicated that the ground counts were representative for the eastern park lamb:ewe ratios (Singer et al. 1981; Taylor et al. 1988). Ground-based sheep surveys were conducted on an annual basis from 1979 to 1989 and 1991 to 1996 by Denali National Park staff. Methodology for the counts was adapted from ground surveys conducted by the Alaska Department of Fish and Game prior to that time. No sheep surveys were conducted in the park between 1996 and 2007.

In 2008, ground-based surveys were resumed and annual surveys were conducted from 2008 to 2017. The objective for recent ground surveys was to count and classify Dall's sheep visible or accessible from the road corridor in Denali National Park. Survey methods were meant to be comparable to past surveys in Denali, and to recent sheep survey work in other parts of Alaska (Arthur 2003; Lawler 2004; Lawler et al. 2004; Lawler et al. 2004b).

In recent years, aerial survey methods using distance sampling have been developed (Schmidt et al. 2012) and applied to obtain sheep population number estimates in Denali National Park and Preserve (Schmidt and Rattenbury 2013). Those methods and results are reported elsewhere and not included in this data series.

Methods

NPS staff and volunteers conducted ground surveys in accessible sheep habitat areas along the Denali Park Road corridor. Surveys were targeted for early June, after snow has melted in survey areas, but before lambs have grown too large to easily identify and before the sheep move to summering grounds in the Alaska Range.

Areas Surveyed

Survey locations were based on areas previously surveyed by NPS staff conducting ground-based counts in the 1980s. These areas include Primrose Ridge (Mt. Margaret), Mt. Wright, Igloo Mt., Sable Mt., Cathedral Mt., the west end of Polychrome Mt. above the Toklat bridge, areas west of Toklat Road Camp, areas in the Alaska Range along the east branch of the Toklat River and west of the west fork of the Toklat River (Figure 1).

The ground surveys depend on accurate identification of physical sheep characteristics with a spotting scope, so if visibility at a chosen survey location was poor and it was unlikely to change, observers had to alter or cancel planned surveys.

Hasty Aerial Surveys

When possible, a park pilot and observer conducted a hasty aerial count and located bands of sheep in road accessible areas prior to the ground surveys. Because the main focus of the ground counts was on nursery groups in order to obtain an estimate of annual productivity based on lamb:ewe ratios, information from the overflights allowed more efficient targeting of nursery groups from the ground. The pilot and observer determined group size and composition of each sheep group observed. During aerial surveys, sheep were minimally classified as ewe-like (ewes, yearlings, and small rams not clearly distinguishable from ewes), lamb, small ram (less than full curl), large ram (full curl or greater), or unknown. Observers also recorded the Global Positioning System (GPS) location of each group.

Ground Survey Data Collection

Teams of at least two people surveyed Dall's sheep groups using spotting scopes and binoculars to identify sheep by age and sex classes. For groups visible from the Park Road (such as on the far west end of Polychrome), only one observer was required. Each group counted was given a unique band number. Sheep were classified as ewes, lambs, yearlings, unclassified ewe-like, less than ½ curl ram, ½ to less than ¾ curl ram, ¾ to less than full curl ram, full curl or greater ram, unclassified ram, or unclassified sheep. An identification/classification guide was given to each observer group with the data sheets (Appendix 1). Observers recorded a waypoint (datum WGS84) for each sheep group at the observer's location using a hand-held GPS unit (Garmin, Olathe, Kansas, USA). Observers recorded the distance and direction of the group from the waypoint on the data sheet and recorded the location of the group on a map of the survey area by marking the location and the band number of the group. When possible, a picture of the group was taken with a digital camera. To link photos of groups with GPS waypoints, observers took a picture of the GPS unit each morning prior to conducting surveys to synchronize the time on camera and GPS unit.

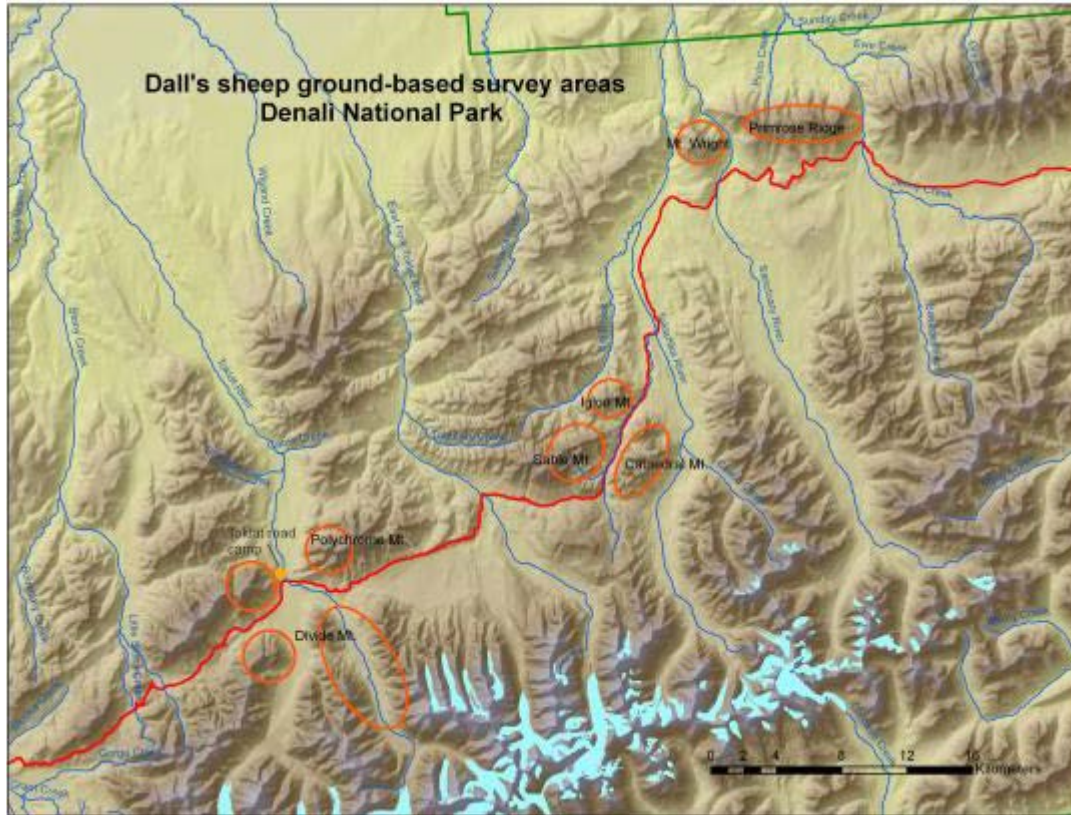


Figure 1. Areas targeted for ground-based Dall's sheep surveys in Denali National Park, 2008-2017.

Data Entry and Summary

Data were entered into a MS Excel spreadsheet after observers returned from the field. All GPS unit and camera data were downloaded and reviewed. Approximate sheep band locations were mapped following instructions in Appendix 2. All data were stored on a network drive (T:\ResMgmt\Wildlife\Sheep).

Data were reviewed to determine if any bands of sheep were double-counted (counted by more than one observer group) and care was taken to include only one count of such groups, as determined by the observer teams' confidence in their count.

Ram:ewe ratios were determined by calculating the total number of rams (all classifications) to ewes and ewe-like sheep. Lamb:ewe ratios are reported using the number of lambs to ewe and ewe-like and lambs to ewe, ewe-like and yearlings.

Results

Ground-based Surveys

Ground-based Dall's sheep surveys were generally conducted in early to mid-June from 2008 to 2017 (Table 1). Areas surveyed varied from year to year due to inclement weather and based partly on knowledge gleaned from prior aerial overflights. In 2011, the ground survey occurred in July in order to overlap with the timing of the aerial survey using distance sampling methods (Schmidt and Rattenbury 2013).

Table 1. Areas surveyed during annual ground-based Dall's sheep surveys 2008 – 2017.

Year	Date of survey	Areas surveyed
2008	July 9	Mt. Margaret, Mt. Wright, Igloo, Sable
	July 10	Cathedral East, Cathedral West, West Polychrome, East branch of Toklat, West branch of Toklat
2009	June 29	Mt. Margaret, Mt. Wright, Igloo, Sable
	June 30	Mt. Wright, Igloo, Cathedral, Sable
2010	June 8	West Polychrome
	June 9	Mt. Wright, Cathedral, Sable/Tattler, Polychrome, West Fork Toklat
2011	July 20	Igloo, Cathedral, Sable
2012	June 19	Mt. Margaret, Mt Wright, Road Survey from Mt. Margaret to Toklat
	June 20	Igloo, Cathedral, Sable/Tattler
2013	June 10	Mt. MargaretPrimrose, Mt. Wright, Road Survey from Mt. Margaret to Toklat
	June 11	Igloo, Cathedral, Sable/Tattler
	June 17-18	Road Survey from Mt. Margaret to Toklat
2014	June 9	Mt. Margaret, Mt Wright, Road Survey Mt. Margaret to Eielson
	June 10	Igloo, Cathedral, Tattler/Sable
2015	June 8	Mt. Margaret, Mt. Wright, Road Survey Mt. Margaret to Eielson
	June 9	Cathedral, Igloo

Table 1 (continued). Areas surveyed during annual ground-based Dall's sheep surveys 2008 – 2017.

Year	Date of survey	Areas surveyed
2016	June 6	Mt. Margaret
	June 7	Igloo, Cathedral, Road Survey Mt. Margaret to Eielson
2017	June 8	Mt. Margaret, Mt. Wright, Road Survey from HQ to Stony
	June 9	Igloo, Cathedral, Sable/Tattler

Total number of sheep observed during ground surveys ranged from 41 (2016) to 184 (2010, Table 2, Figure 2). The number of lambs seen varied from 36 (2010) to 1 (2013).

Table 2. Ground-based Dall's sheep survey results, Denali National Park 2008 – 2017.

Year	Ewes	Lambs	Year- lings	Unknown ewe-like	<1/2 curl rams	1/2 - 3/4 curl rams	3/4 - 4/4 curl rams	>4/4 curl rams	Unknown rams	Unknown sheep	Total
2008	41	29	15	31	18	12	14	5	3	9	177
2009	70	27	9	1	7	12	7	1	2	0	136
2010	61	36	6	63	2	2	4	2	8		184
2011	18	7	2	5	2	6	5	0	1	3	49
2012	54	7	3	10	7	22	20	6	3	3	135
2013	18	1	4	10	9	5	13	1	15	0	76
2014	20	3	0	0	3	2	15	5	22	13	81
2015	23	21	5	30	5	7	18	3	15	25	152
2016	9	6	0	3	2	4	9	3	5	0	41
2017	32	31	8	31	11	17	18	9	4	2	163

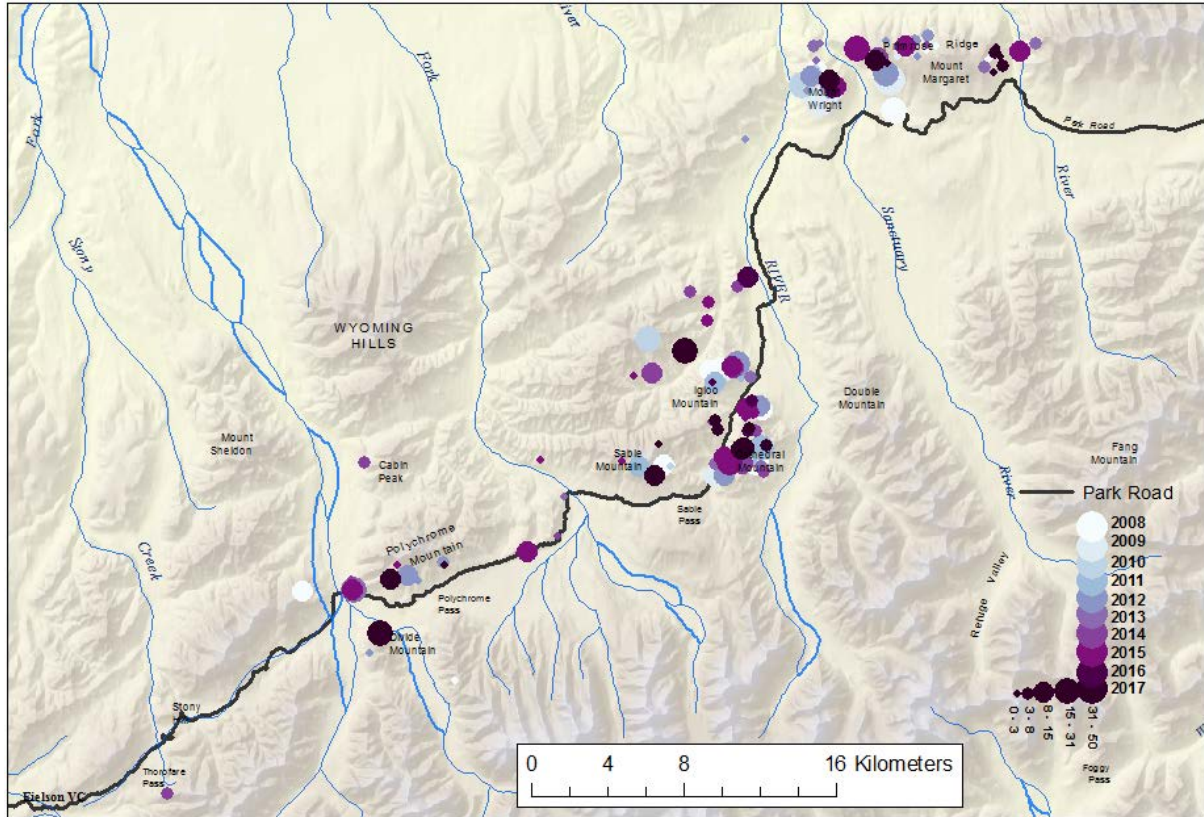


Figure 2. Locations of Dall's sheep bands from annual ground-based sheep surveys in Denali National Park from 2008 – 2017. Colors of dots indicate year of survey, size of dots corresponds to the number of sheep observed in the band.

Estimates of productivity ranged from 50 lambs per 100 ewe-like (including yearlings) in 2016 to 3.13 lambs per 100 ewe-like (including yearlings) in 2013 (Table 3, Figure 3). The average lamb:ewe-like ratio from 2008-2017 was 30.61 (SE 16.041) and the average lamb:ewe-like (including yearlings) was 28.12 (SE 14.734). The average lamb:ewe-like ratio from 1974-1996 was 46.04 (SE 16.644) and the average lamb:ewe-like (including yearlings) was 38.25 (SE 13.551).

Table 3. Age and sex ratios from ground-based Dall's sheep survey results, Denali National Park 2008 – 2017.

Year	Lambs:100 ewe-like	Lambs:100 ewe-like (including Yearlings)	Rams:100 ewes
2008	40.28	33.33	72.22
2009	38.03	33.75	40.85
2010	29.03	27.69	14.52
2011	30.43	28.00	60.87
2012	10.94	10.45	90.63

Table 3 (continued). Age and sex ratios from ground-based Dall's sheep survey results, Denali National Park 2008 – 2017.

Year	Lambs:100 ewe-like	Lambs:100 ewe-like (including Yearlings)	Rams:100 ewes
2013	3.57	3.13	153.57
2014	15.00	15.00	174.07
2015	39.62	36.21	90.57
2016	50.00	50.00	191.67
2017	49.21	43.66	88.50

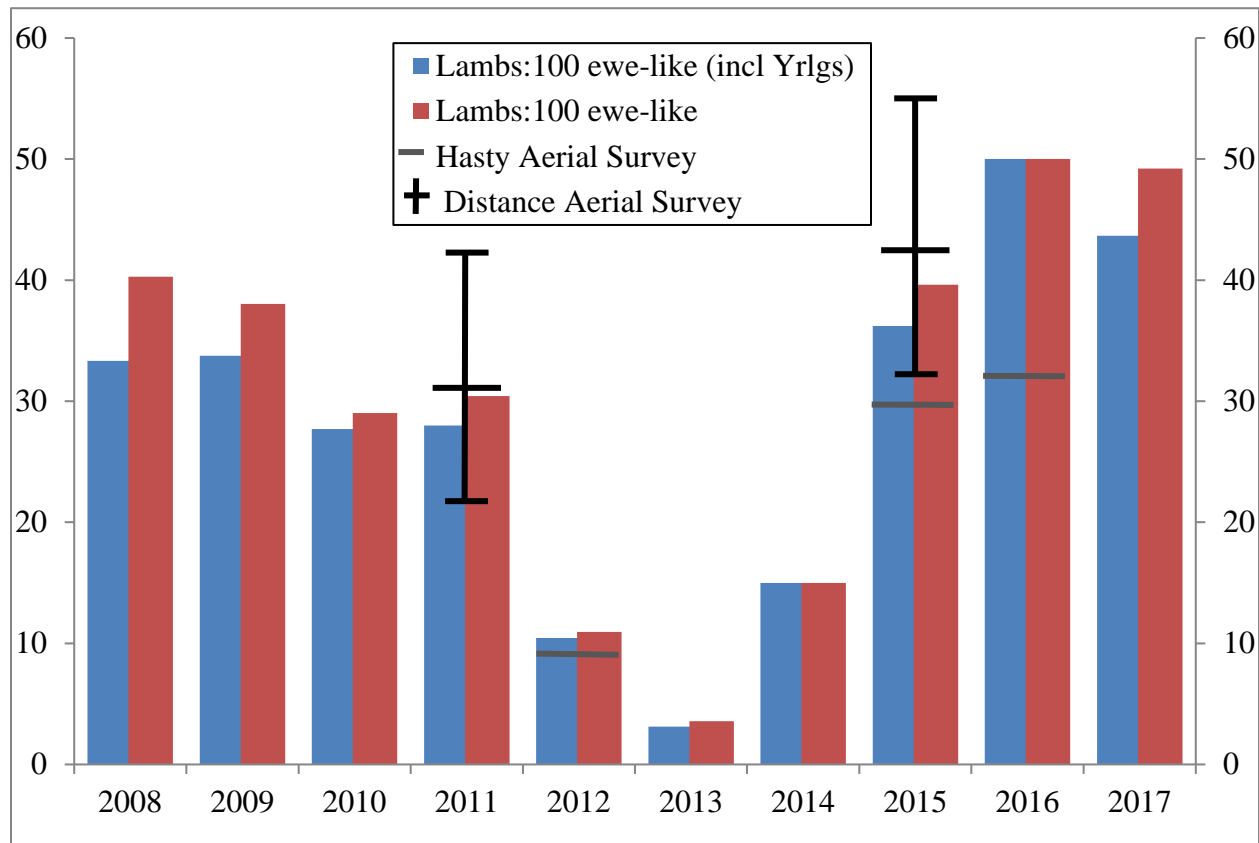


Figure 3. Estimates of Dall's sheep productivity, expressed as lambs per 100 ewe or ewe-like sheep. Estimates provided by ground-based survey results are shown in colored bars and point estimates from hasty aerial surveys and point estimates and 95% CrI (Credible Interval, see Schmidt and Rattenbury 2013) from distances sampling surveys are shown for comparison.

Hasty Aerial Surveys

The 2012 aerial survey included Primrose, Mt. Wright, west of Teklanika Canyon, Cathedral, Igloo and the East branch of the Toklat. We counted a total of 142 sheep in 13 bands, which included 67

ewe-like, 0 yearlings, 6 lambs, 2 small rams, 0 large rams, 63 unclassified rams, and 4 unclassified sheep. Lamb:ewe ratio was 9 lambs per 100 ewes or ewe-like (Figure 2).

The 2015 aerial survey included Primrose, Mt. Wright, west of Teklanika Canyon, Cathedral, Igloo and the East branch of the Toklat. We counted a total of 212 sheep in 23 bands, which included 104 ewe-like, 31 lambs, 72 unclassified rams, and 5 unclassified sheep. Lamb:ewe ratio was 29.8 lambs per 100 ewes or ewe-like (Figure 2, Appendix C).

The 2016 aerial distance sampling survey is shown in Figure 3 as a hasty aerial count, as final analyses are ongoing. This survey covered a large portion of the northern side of the Alaska Range, similar to the 2015 aerial distance sampling survey. During the 2016 aerial count, we counted a total of 79 sheep in 22 bands, which included 32 ewe-like, 10 lambs, 25 sub-curl rams, and 12 full-curl rams. Lamb:ewe ratio was 31.25 lambs per 100 ewes or ewe-like (Figure 3). 2017 aerial distance sampling numbers are pending analysis.

Discussion

Annual ground-based surveys were conducted in the park from 1974-1996 and from 2008-2017. From the time period for which we have productivity estimates from the ground surveys, productivity estimates from aerial and ground surveys in 2012 were the lowest recorded since 1993, when there was an estimated 6 lambs to 100 ewes. This estimate occurred after a very severe winter in 1992-1993 with a mid-September snowfall of 4.5 feet and harsh spring conditions (L. Adams, personal communication). The estimate from 2013 was the lowest recorded during ground surveys since 1974. This occurred following a winter with very cold spring temperatures and late snowmelt (Sousanes and Hill 2015), which potentially covered spring forage and impacted natality and/or early survival of lambs. This patterns of low lamb:ewe ratios was seen across Alaska and Canada in 2013 (K. Rattenbury, personal communication).

Estimates of lamb:ewe ratios from the ground-based surveys show good agreement with the results from both the hasty and distance sampling aerial surveys, with ground surveys indicating slightly greater estimates than those from the hasty aerial survey, but lower than the estimates from the distance sampling survey results (Figure 3).

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Appendix A

Dall's sheep survey data sheet

Dall's Sheep Survey – Data Sheet

Entry/Edit Date	Initials

General Survey Area _____ Survey Unit _____ Page ____ of ____

Date (e.g., 8 Jul 2008) _____
 Observer _____
 Scope type _____

Survey time: Start _____ Stop _____ Total _____
Start _____ Stop _____ Total _____
Total Elapsed Time (min) _____

Weather/Search conditions:

Cloud cover: Clear . . <1/2 . . . ≥1/2 . . . Overcast
Precipitation: None . . Rain . . . Snow
Turbulence: None . . .Light . . .Moderate
Light Intensity: High . . . Medium . . . Low

Comments / other conditions that might affect data quality:

Band #	Ewe-like/lamb				Rams				Un-class. Rams	Un-class. sheep	Total	Data Q*	Waypoint or Lat/Long (Datum?)	Comments/distance&direction of sheep from obs loc
	Ewes	Lambs	Year-lings	Un-class. Ewe-like	<1/2	1/2 to <3/4	3/4 to <4/4	≥4/4						
Total this page														
Total in unit														

*Data quality: 1)Excellent visual/count; 2)Good visual/count; 3)Poor visual/count

Dall's Sheep Survey – Data Sheet

General Survey Area _____ Date _____ Page _____ of _____

Band #	Ewes	Lambs	Yearlings	Un-class. Ewe-like	Rams				Un-class. Rams	Un-class. sheep	Total	Data Q*	Waypoints or Lat/Long (Datum?)	Comments
					<1/2	1/2 to <3/4	3/4 to <4/4	≥4/4						
Total this page														
Total in unit														

*Data quality: 1)Excellent visual/count; 2)Good visual/count; 3)Poor visual/count

Dall's sheep identification guide

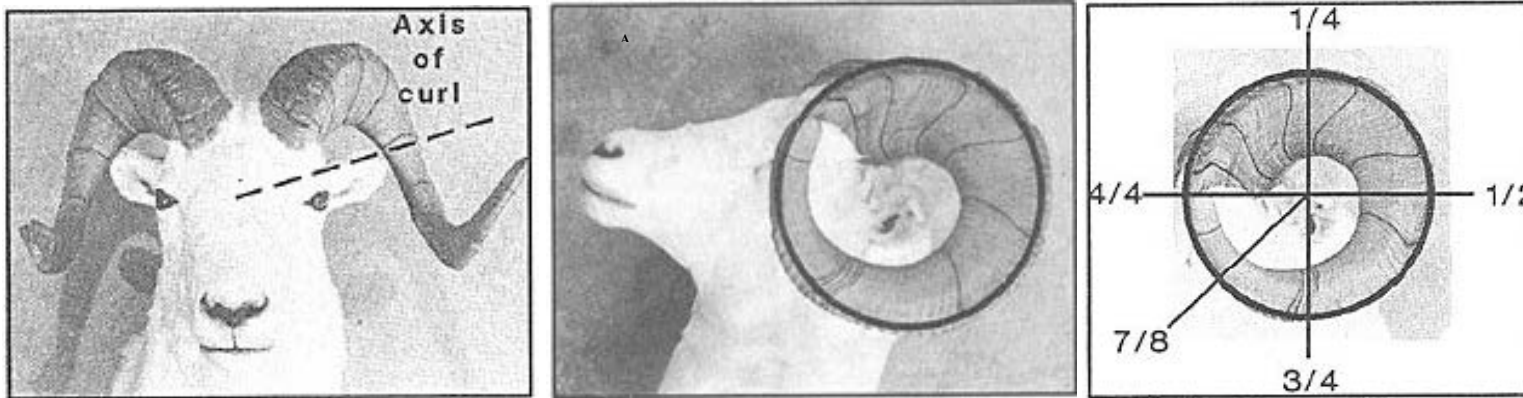


Figure 1: A. Front view, full curl ram; B. side view, full curl ram; C. Ram class. Figure provided by Alaska Department of Game and Fish

Appendix B

Data processing steps for marking approximate sheep band locations from ground surveys

1. Data preparation
 - a. Pair each survey data sheet with paper map. Check with survey crew if band locations on the map are missing and attempt to provide an approximate location for bands surveyed if possible.
 - b. Double check data entered in T:\ResMgmt\Wildlife\Sheep\Ground Survey Data.xlsx
 - c. Copy data for current year in Ground Survey Data.xlsx into GroundSurvey_ApproxBandLocations.xlsx to map band locations from paper maps
2. Plot approximate band locations
 - a. In ArcMap, open map document:
T:\ResMgmt\Wildlife\Sheep\GroundSurvey\GroundSurvey_ApproxBandLocations.mxd
 - b. Set coordinates on map to display as Degrees Decimal Minutes (View>Data Frame Properties>General>Units)
 - c. Using Select Elements tool, find new approximate band location data points on map
 - d. Copy down lat long
 - e. Enter approximate locations (as opposed to observer locations) into lat long of GroundSurvey_ApproxBandLocations.xlsx
 - f. If no location can be approximated, leave lat long blank
3. Map approximate band locations
 - a. Reimport GroundSurvey_ApproxBandLocations.xlsx into arc map as an event layer:
 - b. File>Add Data>Add XY Data
 - c. Choose GroundSurvey_ApproxBandLocations.xlsx as a table to import
 - d. Set lat (Y axis) and long (X axis) field (Z field to none)
 - e. Edit Coordinate System of Input Coordinates to be WGS 1984 (found under folders: Geographic Coordinate Systems>World>WGS 1984
 - f. Export as File and Personal Geodatabase feature classes to GroundSurvey_ApproxBandLocations (Right click>Data>Export Data> choose

SheepGroundSurvey_ApproxBandLocations.gdb>
GroundSurvey_ApproxBandLocations>name it
SheepGroundSurvey_ApproxBandLocations_2008toXXXX (where XXXX=current
year)

- g. Double check to make sure that number of features in attributes table matches number of entries in excel spreadsheet
 - h. Remove event layer (right click>remove)
 - i. Label data points with Survey Area, year, band #, and total sheep (Right click>Properties>Labels tab>Expression> pick labels to be displayed)
4. Double check accuracy of new data points entered into in GroundSurvey_ApproxBandLocations.xlsx in ArcMap. If points are in the wrong place:
- a. Start editing tool
 - b. Edit only the GroundSurvey_ApproxBandLocations_2008toXXXX layer
 - c. Select feature with arrow editor tool
 - d. Move to correct sheep band location
 - e. Recalculate geometry of lat (Y axis) and long (X axis) field
 - f. In Attributes Table, highlight Lat column
 - g. Right click>Calculate Geometry>(Y axis)
 - h. In Attributes Table, highlight long column
 - i. Right click>Calculate Geometry>(X axis)
 - j. Any time you leave the document, save edits and save changes to map
 - k. Be sure that any corrections made at this point in ArcMap are transferred back to the Excel spreadsheet
 - i. OR export attributes table as .txt
 - ii. Then open excel and Open Excel.
 - iii. Open the file. Choose “Delimited”, next.
 - iv. Delimiters = Tab, next.
 - v. Leave all defaults, Finish.

5. Check the number of records. (In Excel the number of records will = number of records + 1 (the column headings).

i) Save as “GroundSurvey_ApproxBandLocations.xlsx”

Arcmap References

- <http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//001t0000004z000000.htm>
- http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Selecting_features_while_editing/001t0000007s000000/

Appendix C

Table C-1. Data from 2015 hasty aerial survey

Latitude	Longitude	Comment	Ewe	Lamb	Ram	Unk	Total
63.74802	-149.23062	2E	2	-	-	-	2
63.75575	-149.29122	4U	-	-	-	4	4
63.74077	-149.43292	1U	-	-	-	1	1
63.75539	-149.45400	11E3L	11	3	-	-	14
63.75957	-149.37236	17R	-	-	17	-	17
63.75730	-149.34366	7E4L	7	4	-	-	11
63.74761	-149.47741	7R	-	-	7	-	7
63.74860	-149.49126	1R	-	-	1	-	1
63.74549	-149.47822	2R	-	-	2	-	2
63.73101	-149.59765	2R	-	-	2	-	2
63.64072	-149.73315	4E2L	4	2	-	-	6
63.62235	-149.71592	41E8L	41	8	-	-	49
63.60946	-149.72680	7R	-	-	7	-	7
63.59664	-149.74893	9R	-	-	9	-	9
63.60798	-149.62099	7E2L	7	2	-	-	9
63.57991	-149.56782	2E	2	-	-	-	2
63.59418	-149.60210	7R	-	-	7	-	7
63.57130	-149.62451	12E3L	12	3	-	-	15
63.52563	-149.99659	6R	-	-	6	-	6
63.53195	-149.83417	3E3L	3	3	-	-	6
63.59069	-149.44209	1R	-	-	1	-	1
63.60173	-149.33453	9R	-	-	9	-	9
63.61552	-149.35744	15E6L	15	6	-	-	21
63.62865	-149.34907	4R	-	-	4	-	4

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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