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ABoVE: Dall Sheep Lamb Recruitment and Climate Data, Alaska and NW Canada, 2000-2015

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Summary

This dataset contains estimated annual average Dall sheep (Ovis dalli dalli) lamb-to-ewe ratios for each year from 2000-2015 across the full species range in Alaska and Northwestern Canada. Sheep population data are from surveys conducted over the 14 major mountain ranges encompassing the range of Dall sheep. For this study, the mountain ranges were divided into 24 mountain units due to differing climate gradients. Estimated covariate environmental and climate data used to examine the relationship between environmental conditions and Dall sheep population performance (per mountain unit) are also provided and include precipitation, temperature, snow cover, elevation, and distance to the center of the range.

Sheep survey data originated from state and federal monitoring surveys. Raw sheep counts were not comparable across surveys therefore the ratio of lambs per 'ewe-like' sheep was calculated and used as an indicator of recruitment. Daily snow extent was estimated using MODIS imagery. Distance to the center of the Dall sheep range, latitude, longitude, and elevation were estimated from the Global Multi-resolution Terrain Elevation Data 2010 produced by the United States Geological Survey, and monthly gridded climate products were estimated from the Scenarios Network for Alaska + Arctic Planning (SNAP).

There are two data files in this dataset: one file in comma-separated format with the sheep survey and covariate data, and one shapefile (.shp) provided as a compressed .zip file, with mountain unit locations.



Figure 1. A herd of Dall sheep ewes and lambs are dwarfed by the mountainous landscape in Wrangell St. Elias National Park, Alaska, March 2017. Photo credit: Laura Prugh.

Citation

van de Kerk, M., D. Verbyla, A.W. Nolin, K.J. Sivy, and L.R. Prugh. 2018. ABoVE: Dall Sheep Lamb Recruitment and Climate Data, Alaska and NW Canada, 2000-2015. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1640

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1. Data Set Overview

This dataset contains estimated annual average Dall sheep (Ovis dalli dalli) lamb-to-ewe ratios for each year from 2000-2015 across the full species range in Alaska and Northwestern Canada. Sheep population data are from surveys conducted over the 14 major mountain ranges encompassing the range of Dall sheep. For this study, the mountain ranges were divided into 24 mountain units due to differing climate gradients. Estimated covariate environmental and climate data used to examine the relationship between environmental conditions and Dall sheep population performance (per mountain unit) are also provided and include precipitation, temperature, snow cover, elevation, and distance to the center of the range.

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Planning (SNAP).

Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign based in Alaska and western Canada between 2016 and 2021. Research for ABoVE links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis and modeling capabilities needed to understand and predict ecosystem responses and societal implications.

Related Datasets:

Mahoney, P., G. Liston, B. Mangipane, and L.R. Prugh. 2018. ABoVE: Dall Sheep Response to Snow and Landscape Covariates, Alaska, 2005-2008. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1602

Sivy, K.J., A.W. Nolin, C.L. Cosgrove, and L.R. Prugh. 2018. ABoVE: Dall Sheep Track Sinking Depths, Snow Depth, Hardness, and Density, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1583

Related Publication:

van de Kerk, M., D. Verbyla, A.W. Nolin, K.J. Sivy, and L.R. Prugh. 2018. Range-wide variation in the effect of spring snow phenology on Dall sheep population dynamics. Environ. Res. Lett(13),7. https://doi.org/10.1088/1748-9326/aace64

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2. Data Characteristics

Spatial Coverage: Dall sheep range in Alaska and northwest Canada

ABoVE Reference Locations:

Domain: Core ABoVE

ABoVE Grid cells:

Ah0Av0Bh6Bv2	Ah0Av0Bh4Bv5	Ah0Av0Bh5Bv5	Ah0Av1Bh3Bv6
Ah0Av1Bh4Bv6	h0Av1Bh4Bv7	Ah0Av1Bh5Bv6	Ah0Av1Bh5Bv7
Ah1Av0Bh6Bv2	Ah1Av0Bh6Bv3	Ah1Av0Bh6Bv4	Ah1Av0Bh7Bv3
Ah1Av0Bh8Bv3	Ah1Av0Bh8Bv4	Ah1Av0Bh9Bv4	Ah1Av0Bh10Bv5
Ah1Av1Bh6Bv6	Ah1Av1Bh6Bv7	Ah1Av1Bh6Bv8	Ah1Av1Bh6Bv9
Ah1Av1Bh7Bv8	Ah1Av1Bh7Bv9	Ah1Av1Bh8Bv6	Ah1Av1Bh8Bv7
Ah1Av1Bh9Bv6	Ah1Av1Bh9Bv7	Ah1Av1Bh10Bv9	

Spatial resolution: Multiple points

Temporal coverage: 2000-01-01 - 2015-12-31

Temporal resolution: Annual

Study Areas (All latitude and longitude given in decimal degrees)

Site	Westernmost	Easternmost	Northernmost	Southernmost
	Longitude	Longitude	Latitude	Latitude
Dall sheep range, Alaska and northwest Canada	-163.281	-123.547	69.70735	59.59776

Data File Information

There is one data file in comma-separated (.csv) format and one shapefile (.shp) provided as a compressed .zip file. The shapefile is also provided as a .kmz for viewing in Google Earth.

Table 1. File names.

File name	Description	
lamb_ewe_ratios_by_mountainunit.csv	This file provides the sheep survey and covariate data	
mountainunits.zip	This compressed file contains a shapefile (.shp) with data for 24 polygons representing the mountain range units.	
Companion file		
mountainunits.kmz	The shapefile data in .kmz format for viewing in Google Earth	

Table 2. Variables in the file lamb_ewe_ratios_by_mountainunit.csv.

Column name	Units/format	Description
mountain_unit		There were 14 mountain ranges divided into 24 mountain units for the study
year	YYYY	Year
lamb_ewe_ratio	ratio	Average lamb-to-ewe ratio
surveys		Number of surveys
elevation	m	Mean mountain unit elevation
snow_line_elevation	m	Snowline elevation on May 15
snow_disappearance	DOY	Snow disappearance day of year mean
snow_cover_duration	days	Snow cover duration mean
temp	degrees C	Annual average temperature for that year
precip	mm	Total annual precipitation for that year
may_temp	degrees C	Average temperature in May for that year
winter_precip	mm	Total winter (October-April) precipitation preceeding lambing season in that year
latitude	decimal degrees	Mean mountain unit latitude
longitude	decimal degrees	Mean mountain unit longitude
distance	km	The distance from the center point of each mountain unit to the range center
density	adult sheep/km2	Sheep density was calculated by dividing the number of adult sheep in an area by the survey area. Note that the survey area was not always known. There are numerous missing values (-9999).

Shapefile information

The shapefile contains the following data for 24 polygons representing the mountain units.

Table 3. Variables in the shapefile mountainunits.shp (and .kmz companion file).

Name	Mountain unit name, e.g. "AK Range Central North Slope"	
Hectares	Area of polygon	
Label	Alphabetical (A through X)	

Table 4. Mountain range units.

A = Western Brooks North Slope
B = Central Brooks North Slope
C = Eastern Brooks North Slope
D = Western Brooks South Slope
E = Central Brooks South Slope
F = Eastern Brooks South Slope
G = Richardson Mountains
H = Ogilvie Mountains
I = Tanana Uplands
J = Mackenzie Mountains
K = Central Alaska Range North Slope
L = Eastern Alaska Range North Slope
M = Central Alaska Range South Slope
N = Western Alaska Range North Slope
O = Eastern Alaska Range South Slope
P = Western Alaska Range South Slope

Q = Kluane Mountains R = Ruby Range
S = Talkeetna Mountains
T = Chugach Mountains
U = Kenai Mountains
V = North Wrangell Mountains
W = South Wrangell Mountains
X = Coast Mountains

3. Application and Derivation

In wildlife population studies, the impacts of changing Arctic snowpacks are not well understood. Dall sheep (*Ovis dalli dalli*) inhabit northern alpine ecosystems, which may be especially sensitive to environmental change because they occur at both high elevations and high latitudes. Knowing whether the relationships between climate factors and population performance are spatially consistent or variable is critical for improving predictions of climate-induced range shifts.

4. Quality Assessment

Sheep count and composition data originated from state and federal monitoring surveys, and consisted of 127, 833 records of sheep sightings from 1,570 surveys conducted over a 634, 271 km² area. Raw sheep counts were not comparable across surveys due to differences in survey methods, locations, and areas. Therefore, the ratio of lambs per 'ewe-like' sheep was used as an indicator of recruitment.

5. Data Acquisition, Materials, and Methods

Dall sheep are endemic to northern alpine ecosystems in Alaska and northwestern Canada and require open, rugged terrain to forage efficiently and to provide for detection and evasion of predators. They require year-round access to forage and generally occupy areas between 900 m and 2100 m in elevation. Sheep survey data used in this study originated from 14 major mountain ranges, encompassing the global distribution of Dall sheep. The Dall sheep range was divided into 24 mountain units (Figure 2 and Table 4) (van de Kerk et al., 2018).



Figure 2. The study domain in Alaska and northwestern Canada, depicting survey units (red outlines) across the global range of Dall sheep (shaded grey areas) (van de Kerk et al., 2018).

Survey Data

Sheep survey data collected during 2000–2015 were obtained throughout Alaska and Canada from Alaska Department of Fish and Game, National Park Service, Parks Canada, Environment Yukon, and Government of Northwest Territories. Sheep count and composition data originated from state and federal monitoring surveys, and consisted of 127, 833 records of sheep sightings from 1,570 surveys conducted over a 634, 271 km² area. The surveys were mostly performed during summer using aircraft. Raw sheep counts were not comparable across surveys due to differences in survey methods, locations, and areas. Therefore, the ratio of lambs per 'ewe-like' sheep was used as an indicator of recruitment.

Covariates

Daily snow cover extent was estimated from April through July. The MODIS snow covered-area and grain size (MODSCAG) product was used to estimate the fraction of each 500-m pixel that was covered by snow (Painter et al., 2009).

For each pixel, the annual first date without snow cover was estimated and the annual snow disappearance date (SDD) for each mountain unit was calculated by averaging over all the pixels within the unit. The mean SDD was computed for each 100 m elevation zone and linear regression (all R^2 values >0.95) was used to estimate the snowline elevation for each mountain unit as a function of the day of the year. The regression equations were then used to estimate the annual snowline elevation on May 15 (SLE), since lambing typically occurs mid-May.

The number of days each year, from August through July, during which snow cover was observed in each pixel was calculated using the 500 m MODIS

daily snow cover data (MOD10A1 v6) to evaluate the effect of snow cover duration (SCD) on Dall sheep. The mean of all pixel-level snow duration values was computed within each mountain unit. Cloudy pixels were counted as snow-covered if days before and after were snow-covered.



Figure 3. The average (a) May temperature, (b) total winter precipitation, and (c) snow disappearance date (SDD) over the entire study period, 2000–2015 (van de Kerk et al., 2018).

In addition to the three snow cover variables (SDD, SLE, and SCD), for each mountain unit, the distance to the center of the Dall sheep range, mean latitude, mean longitude, and mean elevation were estimated from the Global Multi-resolution Terrain Elevation Data 2010 produced by the United States Geological Survey. Monthly gridded climate products from the Scenarios Network for Alaska + Arctic Planning (SNAP) were used to estimate average annual temperature, average May temperature, total annual precipitation, and total winter (October–April) precipitation. Annual average lamb-to-ewe ratios were calculated for each mountain unit for 2000–2015. The number of surveys per mountain unit for each year was used as a weighting factor in the models to account for the different number of surveys aggregated per data point (van de Kerk et al., 2018).

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

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Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Painter, T.H., K. Rittger, C. McKenzie, P. Slaughter, R.E. Davis, and J. Dozier. 2009. Retrieval of subpixel snow covered area, grain size, and albedo from MODIS. *Remote Sens. Environ.* **113** 868–79 https://doi.org/10.1016/j.rse.2009.01.001

van de Kerk, M., D. Verbyla, A.W. Nolin, K.J. Sivy, and L.R. Prugh. 2018. Range-wide variation in the effect of spring snow phenology on Dall sheep population dynamics. Environ. Res. Lett(*13*),7. https://doi.org/10.1088/1748-9326/aace64

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