Effects of snow cover on Dall sheep recruitment

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INTRODUCTION

Dall sheep

- Endemic to alpine areas throughout the ABoVE domain
- Often face extreme weather conditions such as heavy snowfall
- Recent population declines have been attributed to harsh spring weather and snow conditions[1]
- Exact mechanisms driving the declines are not known

Objective

- Weather conditions during the lambing season are expected to strongly impact Dall sheep recruitment
- We investigated the effect of spring snow cover on the relative number of lambs in the population

METHODS

Sheep data

- Aerial annual sheep counts from 2000-2015
- Dall sheep ranges divided into 28 units (Fig. 1)
- Used the ratio of lambs per ewe as an index of lamb recruitment

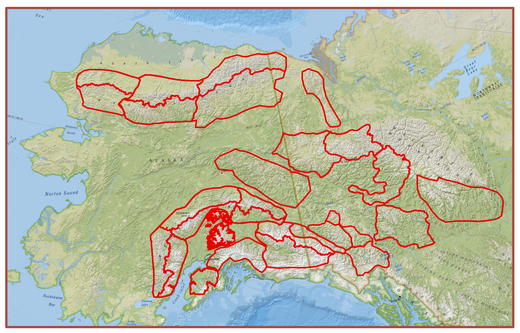


Figure 1: the 28 units we delineated

Climate data

- Estimated last day of spring snow and snowline elevation on May 15th, which coincides with the peak of lambing season, from the MODIS daily snow cover fraction product
- Classified mountain ranges into three climate groups based on May temperature and winter precipitation

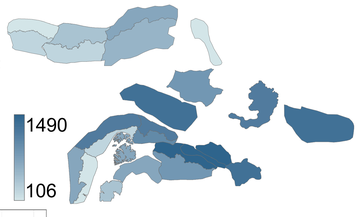
[1] Alaska Department of Fish and Game. 2014. Trends in Alaska sheep populations, hunting, and harvests. Division of Wildlife Conservation, Wildlife Management Report ADFG/DWC/WMR-2014-3, Juneau.

Data analysis

- Linear mixed models with a random effect of unit and weighted by the number of surveys to examine the effect of spring snow variables on lamb:ewe ratios
- Additive and interactive models with the snow variables as well as latitude, elevation, climate group and year
- Ranked models based on the Akaike Information Criterion (AIC)

RESULTS

Figure 2 (right): the average snowline elevation on May 15th in each of the units



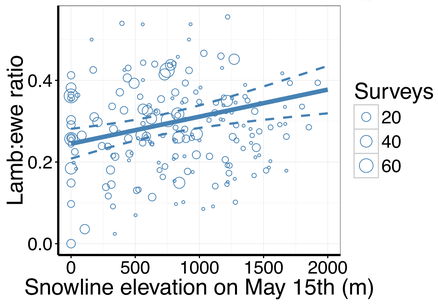


Figure 3 (left): effect of May 15th snowline elevation on recruitment

Figure 4 (left): the average last day of spring snow in each of the units

Figure 5 (right): effect of last day of spring snow on recruitment

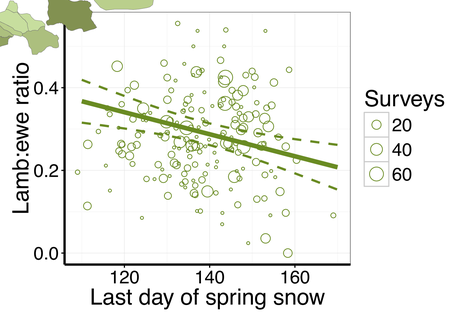


Table 1. The number of parameters (k), ΔAIC, and weight of the models with a weight ≥0.1 (total = 47 models)

Model	k	ΔAIC	Weight
LastSnowDay * Latitude	6	0.00	0.41
LastSnowDay * Latitude + Elevation	7	2.00	0.15
LastSnowDay * Latitude + Year	7	2.04	0.15
LastSnowDay * Latitude + ClimateGroup	8	3.00	0.09
LastSnowDay * ClimateGroup	8	3.48	0.07
LastSnowDay * ClimateGroup + Elevation	9	4.98	0.03
LastSnowDay * ClimateGroup + Latitude	9	5.52	0.03
LastSnowDay * ClimateGroup + Year	9	5.62	0.02
May15Snowline * Year + ClimateGroup	8	7.19	0.01
May15Snowline * Year + Latitude	7	8.22	0.01
May15Snowline * Latitude	6	8.49	0.01

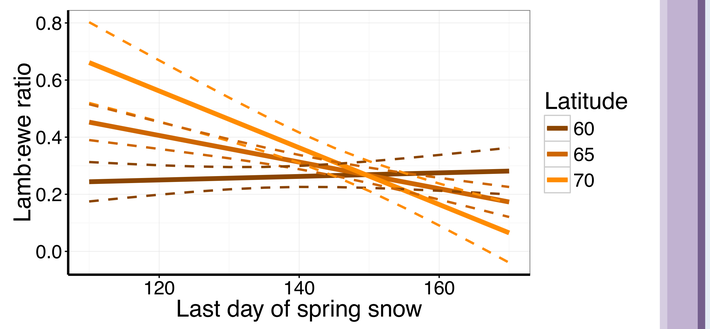


Figure 6: relation between the last day of spring snow, latitude, and recruitment as predicted by the highest ranked model

CONCLUSIONS

- Recruitment (lamb:ewe ratios) increased with snowline elevation on May 15th and decreased with later spring snow cover
- The last day of spring snow and latitude were the best predictors for lamb recruitment; the effect of the last day of spring snow was strongest at high latitudes, and weaker at lower latitudes
- Results highlight strong effects of spring snow on population dynamics of this iconic northern species