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Estimating Population Size and Composition of Dall Sheep in Alaska: Assessment of Previously Used Methods and Experimental Implementation of New Techniques

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SUMMARY

In July 1995 we surveyed Dall sheep (*Ovis dalli*) in the Delta Controlled Use Area (DCUA) using a technique developed in 1994 in Game Management Unit 20A. We divided approximately 1500 km^2 of sheep habitat into 27 sampling units and searched all units at relatively low-intensity with Supercub aircraft. We also searched 9 randomly selected units at higher intensity with a Robinson R-22 helicopter. We used the high-intensity counts to establish a sightability correction factor (SCF) for the low-intensity counts and estimated 1673 sheep $\pm$ 14% (90% CI) in the DCUA. Search intensities expressed in terms of minutes of flight time per km^2 were higher in the DCUA than in Unit 20A for both low- and high-intensity searches. The higher search times were a function of more rugged and topographically complex terrain in the DCUA, and we consider true search intensities in both surveys to have been similar. Calculated sex and age composition ratios in both the DCUA and Unit 20A had wide confidence intervals, probably reflecting natural variation in geographic distribution of various social groupings of sheep. Current age structure in the DCUA suggests that sheep declined in recent years but are now increasing again.

Key words: aerial survey, composition, Dall sheep, *Ovis dalli*, population size.

CONTENTS

Page

BACKGROUND

Numerous survey techniques are employed in Alaska and elsewhere to estimate wildlife populations. Some techniques are inappropriate for Dall sheep (*Ovis dalli*). Sheep are too scattered for aerial photo-direct counts, and rugged mountain habitat makes standard line transect surveys unfeasible. On the other hand, alpine tundra ranges of most Dall sheep are snow-free during summer, and white sheep are highly visible against both vegetated and unvegetated terrain. Many biologists have assumed a high proportion of sheep (approaching 100%) can be seen from the air, and intensive fixed-wing or helicopter surveys have become the standard method for counting Dall sheep. However, mark-recapture analyses using collared sheep have shown actual sightabilities in intensive aerial surveys to be only 70%-80% (Heimer and Watson 1986; Whitten and Eagan 1995).

Use of aerial surveys for monitoring dynamics of sheep populations is compromised by observers' difficulty in classifying sheep into various sex/age classes from the air. Large rams and young lambs are clearly distinguishable, and adult rams can be further divided into subgroups according to horn size. However, young rams (1/4-curl), yearlings, and ewes look alike from an airplane. This forces biologists to compare numbers of lambs or rams to numbers of "ewelike" sheep, and the composition of ewelike animals varies according to yearling recruitment. More accurate composition classifications by ground-based observers are sometimes used to adjust aerial survey data (Whitten 1975; Heimer and Watson 1986), but ground-based surveys usually cover only small areas.

Sheep populations have changed similarly over large portions of the state. For example, sheep declined throughout most of Interior and northern Alaska during the early 1970s, increased through the mid to late 1980s, and declined again in the early 1990s. This pattern generally reflects long-term weather trends, with series of severe winters coinciding with declines of sheep. Thus biologists tend to feel confident about the long-term trends indicated by their sheep population surveys (Heimer and Watson 1986; Harkness 1990). However, accuracy and precision of past sheep population estimates are unknown, and most long-term data sets show some fluctuations in numbers and/or composition which are not consistent with reasonable mortality and recruitment. These aberrations cast doubt on the ability of existing techniques to detect short-term population changes. In areas where surveys are infrequent, detection of even long-term fluctuations may be difficult.

Estimation of moose and caribou populations was in a similar state of confusion until the late 1970s, when application of new and statistically sophisticated techniques improved management (Davis et al. 1979; Gasaway et al. 1986). The purpose of this study is to develop a statistically sound survey method that will similarly improve our understanding and management of sheep.

We tested a new technique in July 1994 in Unit 20A, where recent survey data from small portions of the unit, as well as reports from hunters, suggested sheep had declined dramatically (Eagan 1993, Whitten and Eagan 1995). Some previous sheep surveys in Unit 20A depended on observing sheep at a mineral lick and were considered representative only of sheep in the vicinity of the lick. Other surveys involved high-intensity searches by fixed-wing aircraft and were expensive, time-consuming, and weather-dependent. Most fixed-wing surveys covered only small areas, and the last time most of Unit 20A had been surveyed in a single year was 1973. Our new technique used low-intensity fixed-wing surveys to quickly and inexpensively search all sheep habitat in Unit 20A. We then flew higher intensity searches of some sample units by helicopter to develop a sightability correction factor (SCF) for adjusting the low-intensity counts. Our final estimate was comparable to what we would have counted in a high-intensity helicopter search of the entire area, except that our estimate gave statistical confidence intervals.

We also made more detailed and accurate composition classifications from the helicopter in an attempt to avoid the confusion of basing trends on "ewelike" sheep.

We tested the new technique again in July 1995 in the Delta Controlled Use Area (DCUA). Results of that survey are reported in this Progress Report.

OBJECTIVES

- Review Alaska Department of Fish and Game (ADF&G) and other agency reports on Dall sheep survey techniques.
- Review appropriate literature on other wild sheep, mountain goat, and alpine ungulate survey techniques.
- Review results of previous ADF&G surveys for possible application of statistical analyses to determine confidence intervals or sightability correction factors.
- Develop new or modified techniques for testing during future sheep surveys.

STUDY AREA

During this reporting period, the study area was confined to approximately 1500 km^2 of sheep habitat in the DCUA in the Alaska Range mountains. The DCUA covers parts of Game Management Units 20D and 13B and includes a portion of Unit 20A not covered in the previous year survey.

METHODS

We divided Dall sheep habitat in the study area into 27 sample units of 30-90 km^2 each. Because sheep are usually found on ridges during midsummer, we used drainage bottoms as unit boundaries to reduce the chances of finding sheep on or crossing boundaries during surveys. We surveyed every sample unit at relatively low intensity with fixed-wing aircraft (Piper PA-18 Supercubs with pilot and 1 observer). Observers searched for sheep by following contour lines and flying as many contours as necessary to view all terrain. Actual flight times per km^2 varied with complexity of terrain for different sample units, but we considered overall search intensity uniform. Observers circled over groups of sheep for accurate counts and classified sheep only as adults or lambs. Locations of sheep were marked on 1:63,250 series USGS maps.

We randomly selected 9 sample units to search at higher intensity, using a Robinson R-22 helicopter with pilot and 1 observer. During high-intensity searches, observers circled back over rough or broken terrain and spent as much time in each sample unit as necessary to thoroughly search for all sheep; they counted and mapped sheep as in the low-intensity counts, but classified sheep as lamb, ewe, yearling, or ram. When feasible, observers in high-intensity counts further subdivided rams by horn-curl class. We began high-intensity counts as soon as possible (usually < 30 min) after the low-intensity search of the same sample unit.

We entered data from the low- and high-intensity surveys into the computer program MOOSEPOP to estimate a SCF for the low-intensity counts (Gasaway et al. 1986). MOOSEPOP used the SCF to estimate the sheep population for the entire area covered by the low-intensity survey. The resulting population estimate was the number of sheep we should have seen if the high-intensity survey had covered the entire area. Sightability correction for the high-intensity survey could not be calculated, so we could not estimate a true population size. We also used MOOSEPOP to estimate composition of the sheep population, based only on high-intensity survey data.

RESULTS

Mean search time for the low-intensity survey was 0.93 min/km^2. Mean search time for the high-intensity survey was 1.34 min/km^2. In the 9 sample units counted at both intensities, observers counted 483 sheep during low-intensity searches and 642 during high-intensity searches, with more sheep counted during high-intensity searches in all sample units. SCF calculated from MOOSEPOP for the low-intensity count was 1.30. We counted 1285 sheep in the low-intensity survey of the study area. The estimated total for the DCUA was

1673 sheep ± 14% (90% CI). Again, we stress that this figure is not a true sheep population estimate, but the estimated total that would have been counted if the entire area had been surveyed at high-intensity. The estimated lamb:ewe ratio was 37:100 ± 20.4%, the yearling ewe ratio was 19:100 ± 27.9%, and the ram:ewe ratio was 50:100 ± 45.7% (90% CI).

Due to inclement weather, we were unable to survey our westernmost sample unit, along McGinnis Creek. Few sheep have been found in this area in recent years, and none were seen in the adjacent sample unit during this survey. Consequently, our estimates of sheep in the DCUA should have been little affected.

DISCUSSION

We saw more sheep during high-intensity searches than during low-intensity searches, as in the 1994 Unit 20A survey using the same technique. SCF was similar in both surveys (1.30 in the DCUA vs. 1.36 in Unit 20A). Search intensity per km^2 was higher in the DCUA survey than in the Unit 20A survey for both low-intensity fixed-wing and high-intensity helicopter searches, but the ratio of high-intensity to low-intensity search was similar in both areas (1.44 in the DCUA vs. 1.42 in Unit 20A). In general, the DCUA is more rugged and topographically complex than Unit 20A, and it took more time to cover the same amount of map area in the DCUA. We consider search intensity within each type of search (i.e., low- and high-intensity) uniform across all sample units in both years.

Analysis of last year's Unit 20A survey results suggested our high-intensity search was more efficient than the high-intensity Supercub surveys traditionally used for counting sheep in Alaska (Whitten and Eagan 1995). We feel confident our estimate of 1673 sheep ± 14% in the DCUA also represents as many or more sheep than we could have counted from intensive fixed-wing surveys of the entire survey area. Only 14% of rams in the DCUA were ≤ half-curl in 1995, indicating poor recruitment 2-4 years ago. DCUA sheep probably declined during the early 1990s, although not as severely as in adjacent Unit 20A, where chronic low recruitment led to as few as 3% rams ≤ half-curl (ADF&G, unpubl files) and a population decline of approximately 60% by 1994 (Eagan 1993, Dale 1995). Current age structure in the DCUA includes 18% lambs and 9% yearlings, indicating that sheep are now recovering. Previous intensive fixed-wing surveys (ca. 1.2 min/km^2) of a trend count area within the DCUA indicated 604 adults (i.e., nonlambs) in 1974, 473 in 1975, 450 in 1980, and 614 in 1992 (DuBois 1993). Our low-intensity count of the trend area in 1995 was 472 adults, and the estimated number of adult sheep that would have been counted in a high-intensity helicopter search was 614 (90% CI = 528-700 adults).

Confidence intervals around age and sex ratio estimates were large in the DCUA sheep survey and the Unit 20A survey of 1994, even though we classified roughly 40% of the estimated population in each area. Sheep social behavior leads to sexual segregation of rams and ewes and formation of maternal and nonmaternal bands of ewes (Geist 1971).

Consequently, entire valleys or ridges are often inhabited predominantly by a single type of sheep social group, and composition of sheep in our sample units reflects this natural variation.

During the coming year we intend to survey sheep in Gates of the Arctic National Park in the Brooks Range Mountains. That survey would cover more area than the Unit 20A and DCUA surveys combined. Using the overall data set from these 3 surveys, we plan to run computer simulations to assess the reliability of using sampling/extrapolation techniques, rather than entire area searches at low-intensity, to estimate sheep populations in large areas and/or to reduce the cost of surveys in smaller areas. We also plan to investigate alternative statistical methods for calculating composition ratios with more reasonable confidence intervals.

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