Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration

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

1 July 1994 - 31 December 1994

Kenneth R. Whitten
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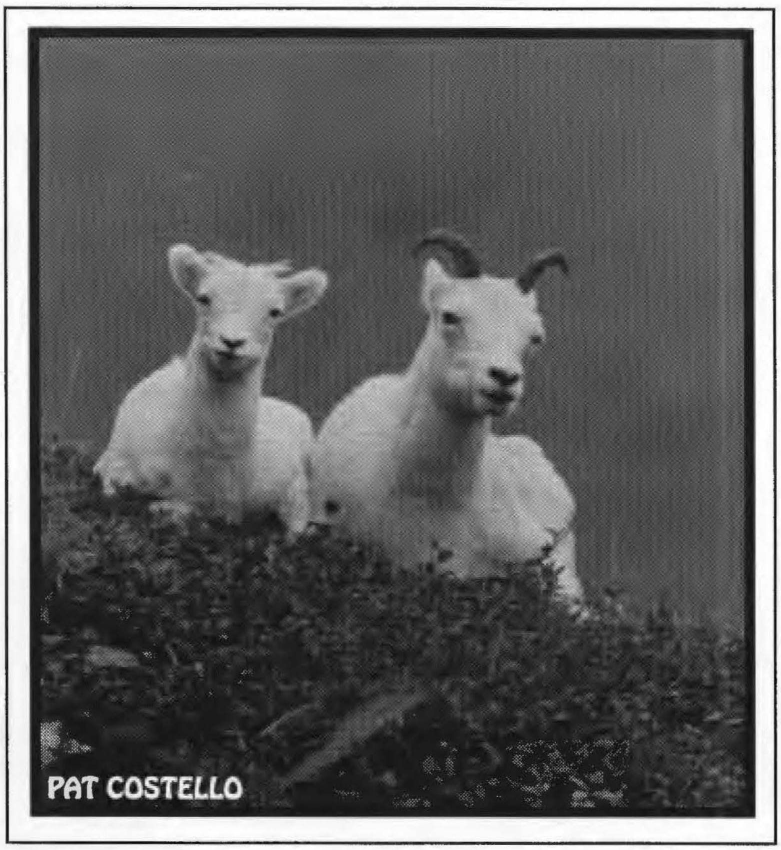

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BACKGROUND

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. Thus 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; F. J. Mauer, U.S. Fish and Wildl. Serv., pers. commun.).

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, but young rams (1/4-curl), yearlings, and ewes tend to 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 irregularly according to variations in 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 can 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 understanding and 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, suggest sheep have declined dramatically (Eagan 1993). A major decline of caribou in the same area has prompted a controversial wolf-control effort. We need an accurate assessment of sheep population status as baseline information for determining factors limiting sheep population growth. We can also use data on sheep numbers to predict future opportunities for harvesting rams.

Many previous sheep surveys in Unit 20A involved high-intensity searches using fixed-wing aircraft. These searches were expensive, time-consuming and weather-dependent. Other surveys depended on observing sheep at a mineral lick and were considered representative only of sheep in the vicinity of the lick. Surveys were usually representative of only small areas, and the last time most of Unit 20A was surveyed in a single year was 1973. Our new technique used low-intensity aerial surveys to quickly and inexpensively search all sheep habitat in Unit 20A. We then flew higher intensity searches of some sample units to develop a sightability correction factor (SCF) for adjusting the low-intensity counts. Our final estimate is comparable to what we would have counted in a high-intensity search of the entire area, except that our estimate also gives statistical confidence intervals.

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 the Alaska Range mountains in Game Management Unit 20A, which covers approximately 3000 km^2 of sheep habitat.

METHODS

We divided known Dall sheep habitat in the study area into 50 sample units of 50-75 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 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 get a good look at 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 only as necessary to obtain 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 17 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 they felt necessary to thoroughly search for all sheep; they counted and mapped sheep as in the low-intensity counts, but classified sheep as lamb, ewelike (including yearlings and some small rams), and adult ram. When feasible, observers in the 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 sightability correction factor (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 0.74 min/km^2. Mean search time for the high-intensity survey was 1.05 min/km^2. In the 17 sample units counted at both intensities, observers counted 570 sheep during low-intensity searches and 786 during high-intensity searches, yielding a SCF of 1.38 for the low-intensity count. Observers counted more sheep during high-intensity searches in 15/17 sample units. We counted 1425 sheep in the low-intensity survey of the entire study area. The estimated total for the entire area was 1942 sheep ±17% (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:"ewelike" ratio was 50:100 ±11.4% and the ram:"ewelike" ratio was 42:100 ±30.9% (90% CI).

DISCUSSION

We assumed we would see more sheep during high-intensity searches than during low-intensity searches, and we did. We spent more time looking for sheep in the high-intensity searches. However, we also felt that sightability of sheep was higher from the helicopter because of its greater forward and sideways visibility, slower flying speed, and higher maneuverability compared with the Supercubs. Increased maneuverability of the helicopter enabled us to fly more closely to terrain and make sharper turns, allowing us a constant view of terrain. Fixed-wing aircraft must frequently make climbing or descending turns over valleys to set up safe approaches for counting sheep in narrow side canyons or on cliffsides, which takes time away from actively searching for sheep.

Heimer and Watson (1982) concluded that Supercubs were better survey aircraft than helicopters. Their argument was based partly on cost-effectiveness; turbine helicopters cost 3-4 times as much per hour as Supercubs, requiring that turbine helicopter surveys locate many more sheep per hour to be cost-effective. Because they saw more sheep per hour from a less expensive Supercub, Heimer and Watson (1982) concluded that helicopters were undesirable for surveying sheep. We have reexamined the original data upon which Heimer and Watson (1982) based their conclusion. They compared 2 fixed-wing surveys and 1 helicopter count of the same area, but the surveys were weeks apart so there was no way to know if the same number of sheep were available for all 3 counts. Also, rams were not classified by horn-curl in the most efficient count (in terms of both sheep/hr and dollars/sheep), whereas they were in the other counts. Therefore, the so-called less efficient surveys expended an unknown amount of extra time in circling and classifying rams. Finally, the helicopter survey tallied the highest absolute number of sheep, but covered more area. Because of these discrepancies, we question the conclusion by Heimer and Watson (1982) that helicopters are not suitable for surveying sheep. Researchers in Wrangell/St. Elias National Park and Preserve also compared aircraft types and concluded, as we did, that helicopters were superior vehicles for counting sheep (Strickland et al. 1992*a*).

Recent studies suggest a point of diminishing returns beyond which increased fixed-wing search intensity ceases to result in more sheep seen. Strickland et al. (1992*b*) reported observers in Supercubs saw 22% more sheep when searching at 1.2 min/km^2 than at 0.4 min/km^2, but increasing search intensity to 2.3 min/km^2 did not result in more sheep seen. McDonald et al. (1990) counted 16% more sheep at 2.5 min/km^2 than at 1.0 min/km^2. Thus, the point of diminishing returns for Supercub surveys appears to be about 1.2 min/km^2. Based on our own experiences, the point of diminishing returns probably occurs sooner over relatively open habitat and later over complex broken terrain.

Researchers have occasionally used collared sheep to determine mark-recapture SCF for intensive fixed-wing surveys. Heimer and Watson (1986) reported seeing 48/63 collared sheep (76%; SCF = 1.31) in a Supercub survey of 1.3 min/km^2. Heimer and Watson (1986) also reported seeing 83% of the collared sheep in another Supercub survey of 0.9 min/km^2. However, when we examined original data files from that survey, it was unclear how many collared sheep were actually present in the population and which collars were found by radiotracking only (i.e., not truly "recaptured" in the visual count). Sightability may have been as low as 71% (60/85 versus 68/82; SCF = 1.41 and 1.21, respectively). The ADF&G files show another survey with similar confusion over the number of collars available, and sightability between 62% and 78% (57/92 versus 57/73; SCF = 1.61 and 1.28, respectively). Mauer and Whitten (FWS, unpubl. files) found 24/28 radiocollared sheep (86%; SCF = 1.17) in a Supercub survey of 2.7 min/km^2; however, 3 of the 24 collars were not detected visually, even though the sheep wearing them were definitely seen and counted (based on other collared sheep in the same groups). Thus, apparent efficiency (based on collars actually recorded) would have been only 75% (SCF = 1.33). Collectively, these surveys indicate that efficiency for intensive fixed-wing surveys is about 70%-80% (SCF = 1.25-1.43), but may be slightly higher if observers are seeing some sheep whose collars they don't detect.

We don't know what proportion of sheep were counted in our high-intensity helicopter searches. However, our lower (Supercub) search intensity was intermediate between the low-intensity searches of McDonald et al. (1990) and Strickland et al.

(1992*b*), in which 16% and 22% more sheep were found by increasing intensity to the point of diminishing returns. Yet we saw 38% more sheep in our high-intensity helicopter searches. This suggests our high-intensity search was more efficient than high-intensity Supercub surveys.

The R-22 piston helicopter we used cost about 1.5 times as much per hour as a Supercub (compared with 3-4 times for a turbine helicopter). Because we flew more intensively with the R-22, we actually spent about twice as much per km^2 to survey at high-intensity with the helicopter than to search at low-intensity by Supercub. At the intensities flown, we did find more sheep/dollar in our Supercub counts. However, the cheaper cost of a Supercub would be false economy when finding as many sheep as possible is important. Doubling Supercub search intensity would have put us at the point of diminishing returns for fixed-wing surveys. That would have equalized cost with the high-intensity helicopter survey, but apparently would not have located as many sheep. Increasing Supercub intensity anymore would only further reduce cost-efficiency.

Bleich et al. (1994) cautioned that intensive surveying with helicopters can drive sheep out of count areas before they are seen or cause sheep to flee far enough and fast enough they are counted in more than 1 sample unit. Heimer and Watson (1982) also cautioned that sheep may try to evade helicopters. We were aware of these possibilities and delineated sample units so that boundaries were natural barriers to sheep movement (at least on a time frame of minutes to a few hours). We took special note of sheep near boundaries of sample units and tried to sort out any problems with groups moving across boundaries between fixed-wing and helicopter counts of the same area. Potential errors were further reduced by having fixed-wing aircraft observers count adjacent units sequentially. Because Dall sheep are conspicuous, in contrast to the cryptically colored desert bighorns studied by Bleich et al. (1994), we could usually confirm that sheep counted in 1 area were still there when we continued to the next area.

We feel confident our estimate of 1942 sheep ±17% represents as many or more sheep than we could have counted from intensive fixed-wing surveys of all of Unit 20A. McNay (1990) reported up to 5000 sheep in Unit 20A in 1989, basing his estimate on an assumption of continuous growth since 3576 sheep were supposedly counted in a unitwide survey in 1977 (W. E. Heimer, ADF&G, unpubl. files). However, Heimer's count was actually a composite from Supercub surveys flown mostly in 1973 but with some areas counted in 1970 or 1975 (ADF&G files). The search intensity for Heimer's count was 0.76 min/km^2, almost identical to our low-intensity survey. Presumably, sheep declined during the mid-1970s, so the basis for McNay's extrapolations was unrealistic. It is clear, however, that sheep in Unit 20A are now far less abundant than they have been in the past, although magnitude of the recent decline is uncertain.

Chronic low recruitment was a factor in the recent decline (Eagan 1993). The lamb:"ewelike" ratio we observed in 1994 (50:100 ±11%) suggests recruitment may now be improving. The ram:"ewelike" ratio in 1994 had a large confidence interval (±31%), making it difficult to compare with previous counts. Large statistical variation in ram:"ewelike" ratios may result because rams and ewes are segregated geographically, requiring a high proportion of sample units be counted to reduce sampling variance.

Some recent experiments in Dall sheep population estimation used double counting techniques in which 2 aircraft surveyed the same areas (McDonald et al. 1990, Strickland et al. 1992*a,b*). Groups seen by only 1 aircraft or by both were compared statistically and a total number of sheep was estimated, taking into account SCF for both planes. Accounting for sheep movement and joining or fragmenting of groups between flights was difficult and somewhat subjective. These double count surveys yielded population estimates with confidence intervals ranging from ±19% (80% CI) to ±24% (95% CI). The method we employed required no subjective decisions and yielded a CI of ±17% at the 90% level. We intend to examine our data further to see what effect reducing the number of units sampled by helicopter would have on the overall estimate and confidence limits. We also plan to investigate how well we could estimate numbers using randomly selected samples of survey units for low-intensity, fixed-wing counts. We plan to continue experimenting with this technique during summer 1995 in the Delta Controlled Use Area and/or Tok Management Area.

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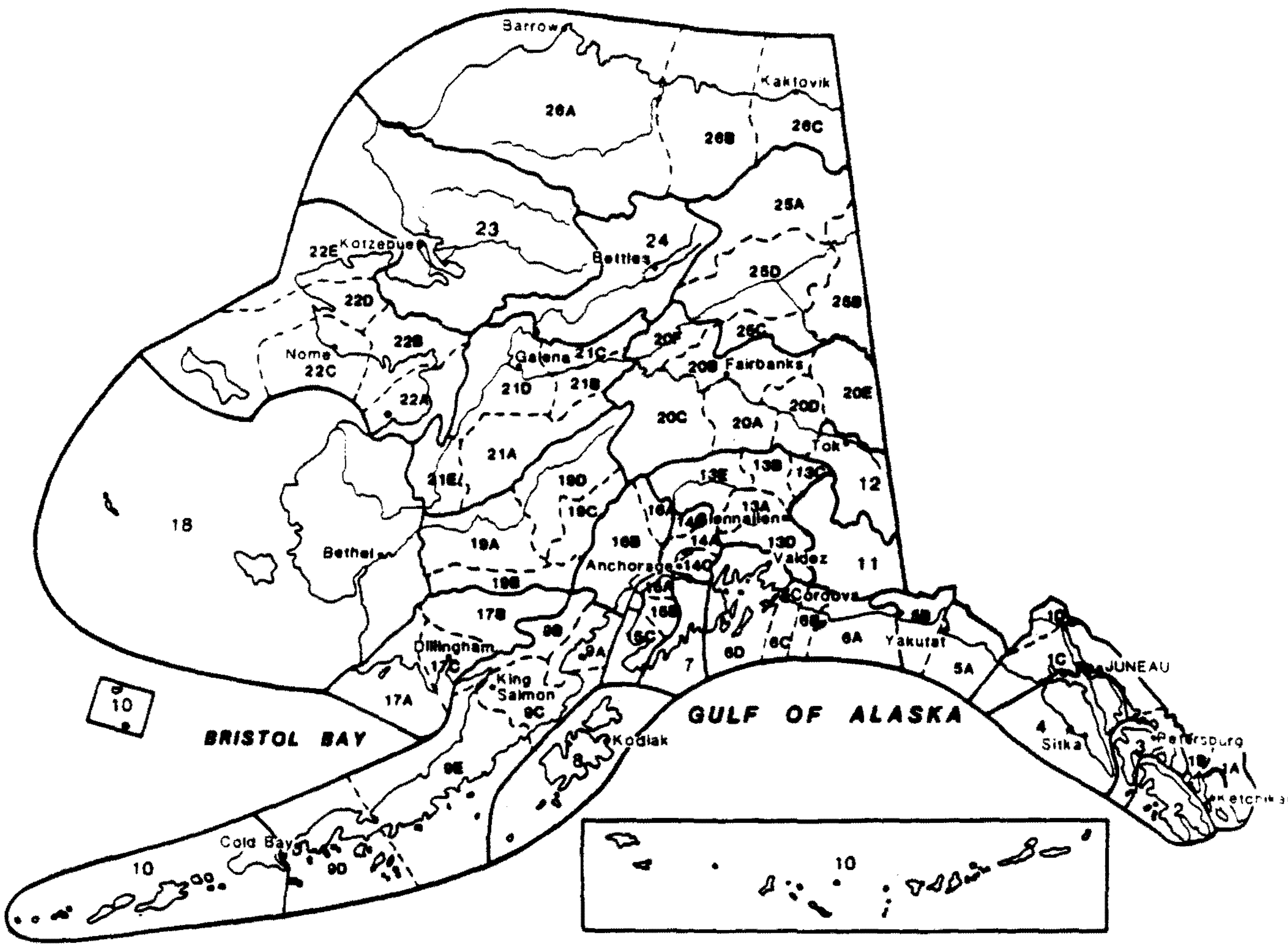
Alaska's Game Management Units



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