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A STANDARDIZED TECHNIQUE FOR HELICOPTER SURVEYS OF BIGHORN SHEEP

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Abstract: Helicopter surveys are used commonly to provide population indices and to determine the distribution of bighorn sheep (*Ovis canadensis*) in Idaho. Surveys, however often differ in methodology, creating problems in comparisons and interpretation of data. We present a methodology that standardizes helicopter survey techniques and data collection procedures, and uses a sightability model to correct for visibility bias inherent in helicopter surveys for bighorns. Our technique provides estimates of total population and herd composition with known levels of precision. We present survey data for 4 populations of California bighorn sheep (*Ovis canadensis californiana*). The model calculated 90% CIs of ±18% for population number and parameter estimates.

Accurate and precise estimates of populations of ungulates have been elusive goals for wildlife biologists (Caughley 1974, 1977, LeResche and Rausch 1974, Pollack and Kendall 1987, Samuel et al. 1987) and specifically for mountain sheep (Bodie et al. 1990, McDonald et al. 1990, , Neal et al. 1994). Highly variable population trend and herd composition data collected during mountain sheep aerial surveys can create difficulty in assessing population performance (Bleich et al. 1990, Bodie et al. 1995, Neal et al. 1994).

In the past, Idaho Department of Fish and Game (IDFG) wildlife managers and biologists conducted independent aerial trend surveys with little coordination between individuals. Population trend survey methods and data collection techniques were based on the survey supervisor's past experience in conducting aerial surveys for other large ungulates, primarily mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*). The literature provided little assistance in designing bighorn trend surveys.

IDFG and U. S. Bureau of Land Management (BLM) biologists and managers were concerned that aerial trend surveys of California bighorn sheep were not providing sufficient information to intensively manage a sensitive and limited wildlife resource. Increased demand for bighorn harvest and livestock grazing opportunities, wilderness designation for portions of the California bighorn range, a proposed U. S. Air Force tactical electronic bombing range adjacent to a major California bighorn range, and a subsonic and supersonic Military Operating Area over most of the California bighorn habitat in Idaho created a need for more accurate population estimates.

The IDFG and BLM funded a research project, Federal Aid in Wildlife Restoration, Project W-160-R-19, to determine the variables affecting visibility bias during California bighorn sheep helicopter surveys (Bodie et al. 1995). Our objective was to use the results of these and other studies to develop a standardized method for bighorn surveys that would provide cost efficient, reliable estimates of population numbers and performance, and detect a change in population of ± 20%.

METHODS

We conducted a literature review of studies of population estimation techniques and evaluated these for relevancy to Idaho conditions and the needs of our California bighorn management program. A method was selected and implemented in 1992 for California bighorn populations in Idaho. The selected method was then used to estimate population numbers and herd composition parameters of 4 California bighorn populations in southwestern Idaho.

Standardized Survey Methods

Surveys were flown in June since average group sizes were large, most lambing was completed, and ewes and lambs had already formed nursery groups reducing the potential to disrupt lambing activities (Bodie et al. 1995). Rams used open flats and slopes at the upper edge of canyons where green-up was occurring and sightability was high. Ewes and lambs ran less, were in or near escape cover, and the lambs were out of the lying-in-seclusion phase and moving with the ewes. Sightability in the escape cover habitats was low and since ewes and lambs ran less, avoidance of the survey was minimized resulting in relatively precise estimates (Bodie et al. 1995).

Most bighorn habitats in Idaho are characterized by steep, rugged terrain, with limited human access. These factors preclude the use of ground or fixed-wing aircraft surveys. Helicopter survey was selected because it provides a time and cost- efficient survey tool, while allowing a more intensive observation of the survey area than possible during fixed-wing surveys (Bleich et al. 1990).

Sample Design

The survey area was divided into sampling subunits (6 to 12 km^2). Results from previous surveys provided information on how sheep responded to the helicopter. This information was used to design survey routes that moved sheep into habitats with higher visibility. Bighorns react to helicopter disturbance by moving large distances during and after helicopter surveys (Bleich et al. 1990, Bodie et al. 1995). Large movements during surveys and our inability to predict subunit densities violate two of the assumptions of random or stratified random sampling (Bodie et al. 1995) and suggest that these sampling designs are not suitable for bighorn surveys. Our procedure was, therefore, to survey all sampling subunits. The helicopter crew was instructed to include marginal areas with widely scattered groups of sheep since the population estimate was only valid for the area surveyed.

Survey Procedures

Flight paths were designed to consider the reaction of sheep to helicopter caused disturbance. In some cases bighorns could be "pushed" to the edge of bighorn habitat where observability was higher.

A Bell Jet Ranger III helicopter with two trained and experienced observers was flown at 35 to 45 km/hr at 30 to 60 m agl on 100 m vertically separated contours, systematically over the entire survey area. The doors nearest the observers were removed to increase visibility. A survey segment was started at drainage bottom and progressed up slope until a plateau or ridge top was reached. Survey segments were small, <1 km in length. Larger segments allowed these highly mobile animals to move greater distances creating difficulty in determining if a group had been counted. Survey segments used borders that were readily identified from the canyon bottoms and from the plateau. Plateaus were flown at 200 m intervals to a minimum of 1,000 m from the canyon rims. Survey flights were not conducted when wind speed exceeded 25 km/hr or rain decreased visibility.

Data were recorded on a standard survey form using the instructions given in Appendix A and the locations mapped. The latitude and longitude were recorded from a ship-board Global Positioning Service (GPS) receiver.

The bighorn classification system described by Geist (1971) was modified to reflect differences in horn growth patterns of local bighorn populations, difficulties in identification of sheep by the helicopter crew, harvest regulations for rams, and because the June surveys occur during the middle of the yearly growth period. Sheep were classified as ewes, lambs, legal, and sub-legal rams.

Sightability Model

Two techniques have been described to correct for visibility bias encountered during helicopter surveys of bighorn sheep, mark-recapture (Neal et al. 1994) and sightability correction (Bodie et al. 1995). We selected the sightability correction method to avoid the expense of marking animals and the expense and disturbance associated with multiple helicopter surveys. The computer program AERIAL SURVEY (Unsworth et al. 1991) modified for bighorn sightability (Bodie et al. 1995) was used to estimate population parameters (Steinhorst and Samuel 1989) for all survey areas.

RESULTS AND DISCUSSION

Population surveys were conducted during June 1992 and June 1993 for 4 California bighorn populations in southwestern Idaho (Table 1.). The sightability model reduced the ram:ewe ratio and increased the lamb:ewe ratio estimate for all surveys, because rams, and ewes without lambs, tended to use habitats of higher visibility than ewes with lambs (Bodie et al. 1995). During 1993, lamb survival was about 50% of that observed in 1992. The higher percentage of ewes without lambs observed in 1993 resulted in lower observed ram:ewe ratios for the Little Jacks Creek and Owyhee River populations, since ewes without lambs are more likely to be in habitats with high visibility. Severe conditions during the 1992-93 winter (snow depths >140% of normal) were probably responsible for the decreased lamb survival observed in 1993. The number of sheep observed during 1993 increased by 29% for the Little Jacks population and by 6% for the Owyhee population over 1992 data. The model estimated that the Little Jacks Creek population was not different

Table 1. A comparison of observed and estimated bighorn sheep population parameters from helicopter sightability surveys of 4 populations in southwestern Idaho, 90% CI in parenthesis, 1992-93.

		Observed [a]			Estimated [a]		
Survey location	Year	Rams per 100 ewes	Lambs per 100 ewes	Total	Rams per 100 ewes	Lambs per 100 ewes	Total
Little Jacks Creek	1992	87.9A	52.0A	194	69.4A	55.8A	308A (±51)
	1993	62.1B	22.9B	251	57.1A	23.6B	341A (±63)
Owyhee River	1992	50.9A	44.1A	628	45.4A	46.7A	1041A (±205)
	1993	44.8A	19.9B	669	40.5A	21.5B	858B (±141)
Bruneau/Jarbidge	1993	107.8	15.7	114	91.9	16.7	165 (±37)
Big Jacks Creek	1993	54.3	41.3	90	53.1	41.9	114 (±33)

[a] Estimates for populations within columns followed by different letters are different (Bonferroni method; $z < 0.033$). Ratios by populations within columns followed by different letters are different (Tukey type test for multiple proportions; $G < 0.05$, Zar 1984).

between years ($z > 0.033$) but the Owyhee population was ($z < 0.033$), (Table. 1).

A typical evaluation of the differences between 1992 and 1993 survey data (not corrected for visibility bias) could include the following. The severe winter probably caused some additional mortality for rams in the Little Jacks Creek population and possibly, to a lesser extent, in the Owyhee population. Lamb survival decreased in both units. Total ram numbers and total animals observed increased between 1992 and 1993. These data give conflicting information to the manager trying to set harvest levels. However, the sightability model estimates for the same comparisons indicate that ram:ewe ratios and estimates of ram numbers were not different between years for both populations, and lamb:ewe ratios decreased between years. The Little Jacks Creek population was not different while the Owyhee population decreased between 1992 and 1993.

MANAGEMENT AND RESEARCH IMPLICATIONS

Standardized survey methods that correct for visibility bias provide the IDFG with estimates of California bighorn numbers and population parameters with known levels of precision. The lack of sightability estimates for bighorns in timbered habitats precludes the use of the model to correct Rocky Mountain bighorn (*O. c. canadensis*) survey data for visibility bias. A better understanding of bighorn response to helicopter disturbance, factors affecting sightability, and importance of standardizing survey techniques can improve data gathered from trend surveys of Rocky Mountain bighorn populations.

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