DISTRIBUTION AND ESTIMATED POPULATION OF CARIBOU ON SELAWIK NWR
Towards a caribou inventory plan
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A majority of the western arctic caribou herd (WAH) migrates across Selawik NWR each fall and spring and substantial numbers periodically remain to winter on the refuge. Over the past three years of biological inventory work the refuge staff has cooperated with ADF&G, NPS, and BLM in monitoring the herd by (1) conducting monthly aerial distribution surveys when caribou are present on the refuge and (2) performing aerial radio telemetry flights over the refuge and surrounding areas about three times a year (October-November, January-February, and March-April). Additionally, to obtain an index of intensity of caribou wintering activity on the refuge, we have made some attempts at estimation of the numbers of caribou wintering on the refuge.

Distribution

A knowledge of caribou distribution, both seasonally and annually, is required for understanding the importance of any given land area such as the Selawik NWR to the overall caribou herd. Selawik NWR has caribou monitoring functions legislatively mandated in ANILCA and has a potential caribou-reindeer conflict due to historical domestic reindeer grazing on the southwest corner of the refuge. For these reasons documentation of caribou distribution has been a major winter field activity. With the proper clear weather and sunny lighting conditions caribou trail systems and cratering (feeding) areas are obvious in aerial surveys from altitudes of 1000 to 10,000 feet. If weather permits, frequently a distribution survey and telemetry survey can be combined. Normally telemetry relocations have been contributed to the ADF&G WAH data base, and the refuge staff does no further analysis. The distribution information, however, has been summarized mostly on maps (eg. Fig. 1).

Aerial surveys have shown considerable variability in extent and timing of caribou distribution. In 1984 a majority of the WAH never crossed south of the Kobuk River, but instead wintered in the Brooks Range and on the North Slope. In fall 1985 a majority of the herd crossed the refuge in September and October and a sizeable group remained to winter (Fig 1). This has been the maximum extent of distribution we have observed recently on the refuge, although similar distribution occurred in the 1960's and early 1970's (Hemming 1971, Shea 1976, Davis and Valkenberg 1985). A maximum type of distribution on the refuge may occur every few years, and conversely, a near lack of caribou may occur in some years, hence any monitoring program should be designed to accommodate such variability.

Fig 1. CARIBOU MIGRATION TRAILS AND HEAVY USE WINTER HABITAT

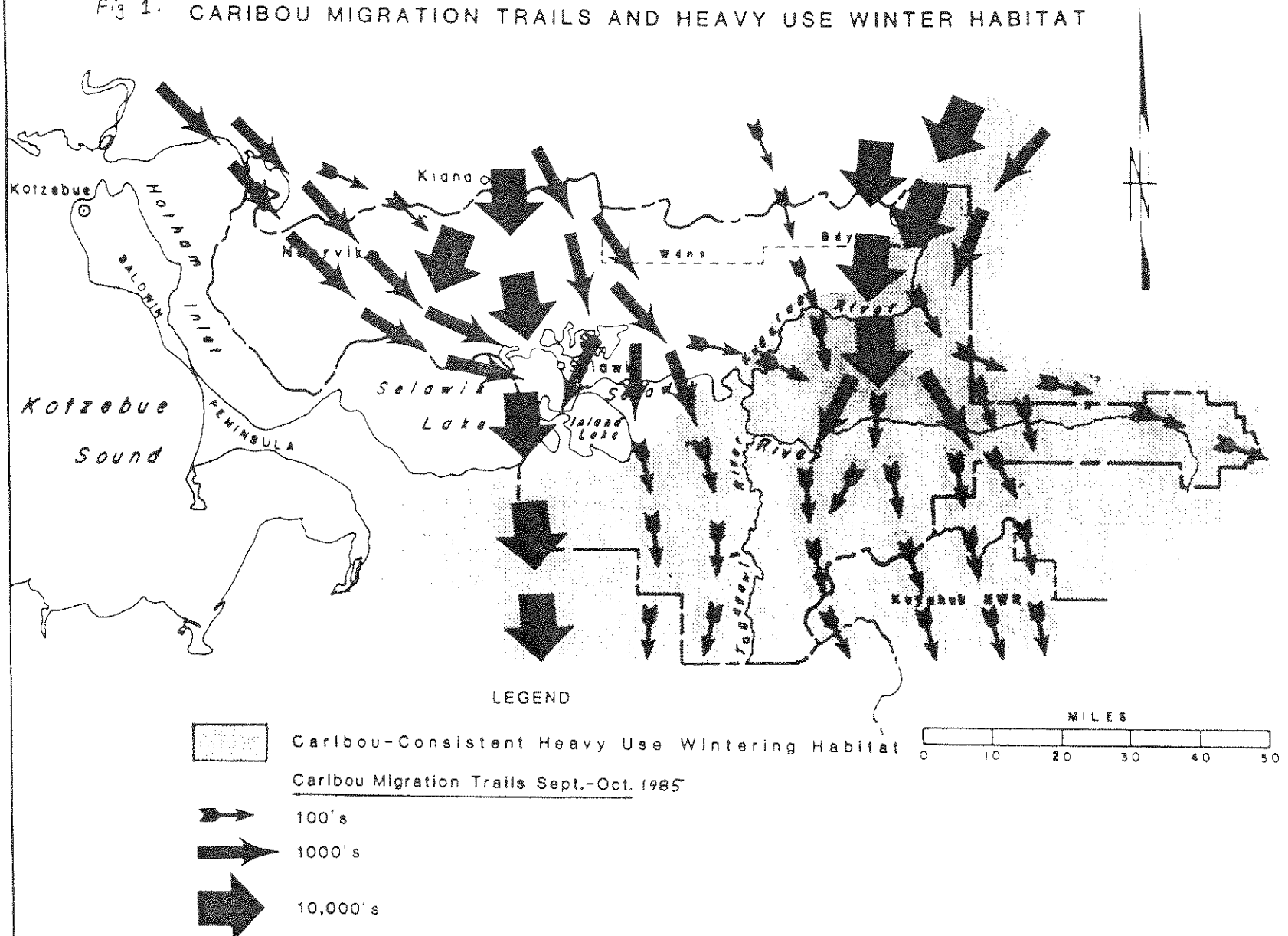
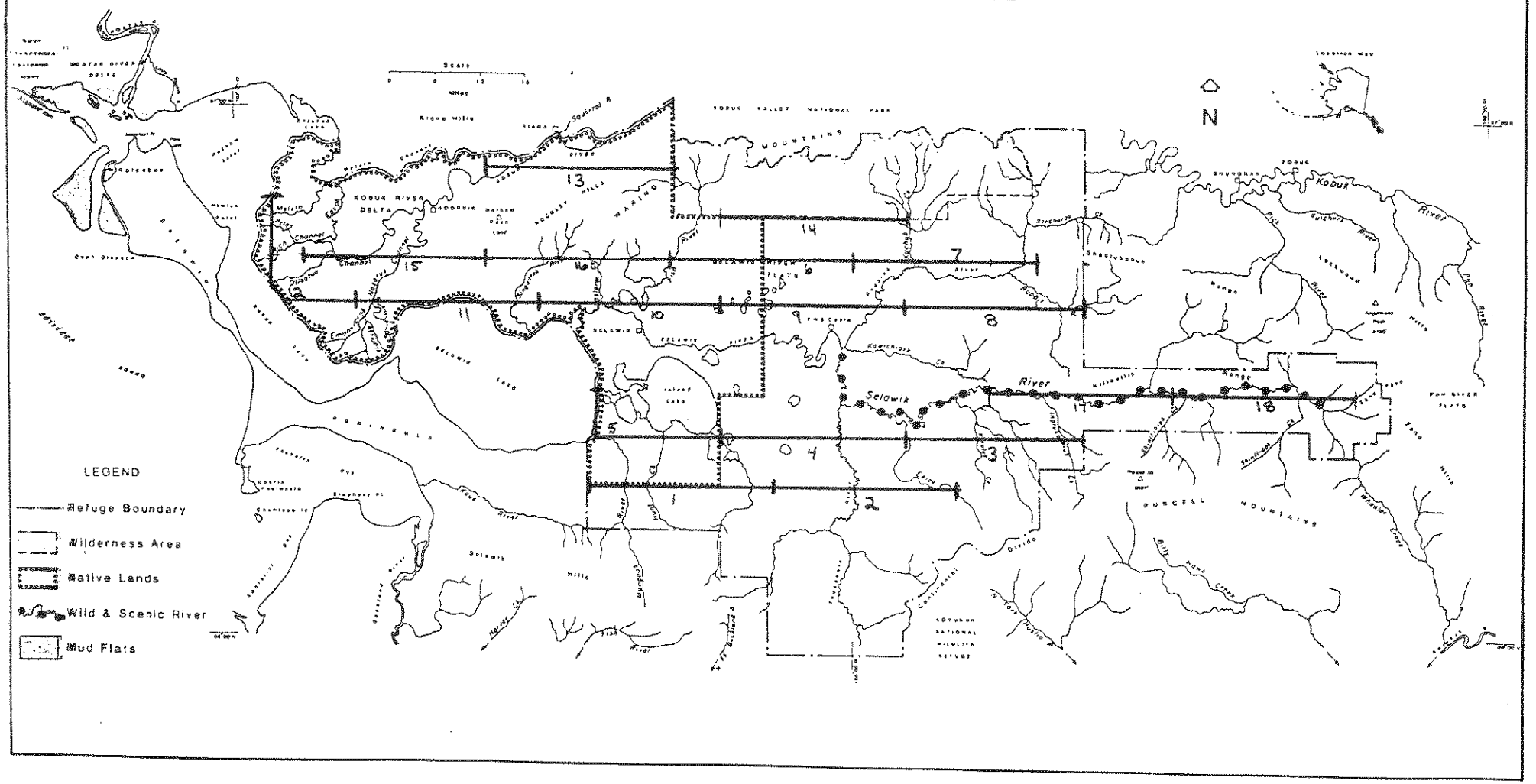


Fig 2.

SELAWIK NATIONAL WILDLIFE REFUGE



Population

To monitor overall herd size the ADF&G has been budgeting for a photo census during the post calving aggregation period at least every two years. Bad weather hampered efforts in 1984 and 1985, but in 1986 an adequate photo sample was obtained and is currently being analyzed. From the refuge management perspective, we are interested in understanding the refuge's importance to the herd, and in monitoring trends in intensity of winter use of the refuge. To obtain such data we made several caribou abundance estimation attempts and evaluated their effectiveness.

Literature. A review of available literature on census methods indicated substantial previous work in aerial survey methods that consisted of stratified random plots or sample areas (Siniff and Skoog 1964, Gasaway in prep- on moose but the method is applicable to caribou) and line or strip transects (Bergerud 1963, Cameron et al. 1984). Siniff and Skoog (1964) sampled most of the Nelchina Basin using 699 random stratified 4 mi2 plots. A total of 10 aircraft that actually surveyed 15% of all occupied habitat during a week long period yielded a population estimate with 95% confidence limits of only 21.% of the estimated 54,452 total caribou. (This was the best success we found in the literature). When using 1/4 and 1/2 mile wide strip transects in Newfoundland and Labrador Bergerud (1963) found that snow and light conditions and survey intensity were the most important factors affecting survey results. Bergerud recommended a sampling intensity of at least 1/3 the area occupied by caribou in densities of > 6 caribou/mi2 if a 10% accuracy is desired. In a North Slope study using 2 mi- wide strip transects flown by helicopter Cameron et al. (1984) found that a sampling intensity of at least 33% coverage was needed to arrive at estimates that were within 20% of the population totals derived by 100% coverage. Fong et al. (1984) determined that transect methods underestimated population size. Observer bias was found to be the greatest source of error in strip transects in the NWT (Heard 1984).

We concluded our literature review with knowledge that 33% sample coverage was required to yield high quality estimates, and that such coverage would exceed our means. However, a goal of determining relative scale in order of magnitude of caribou use (eg 10's, 100's, 10,000's, etc) seemed attainable, and actually fit our needs better.

Methods. A 1:250,000 scale USGS map was used to designate all possible transects prior to random selection. The intersection of each range and township line was numbered and considered to be the possible start of a 24 mile long strip transect. If the start of a randomly drawn transect fell upon a previously drawn transect it's start was shifted to the east to the first undrawn area. A total of 18 transects was drawn in this manner, and are shown in Fig. 2. A transect width of 1/4 mile on each side of the plane was selected based on our knowledge of caribou sightability from previous surveys and from the recommendations of Bergerud (1963). An 80% confidence limit was selected as the desired measure of dispersion based on the recommendations of a statistician (Dr. Lyman McDonald, Univ. of Wyoming, Laramie).

Results. Caribou numbers from each transect were tabulated with density per transect and mean and standard deviation for all transects (Table 1). The transects were considered a simple random sample of caribou density and were extrapolated with the 80% confidence limit. The 1985 and 1986 fall transect surveys yielded estimates of 10,673 and 6,664 caribou with 80% confidence limits of 58% and 65% of the point estimate, respectively (Table 2). In comparison, two more intensive surveys obtained with the Gasaway (in prep) moose census method adapted for caribou resulted in a similar point estimate and similar sized confidence limit in 1984 and a smaller confidence limit as percent of the estimate in 1985. As reported in the literature, our attempts suggested that increasing sampling effort in terms of area covered yielded an increase in estimation accuracy.

Our recommendation for future work is to use the same transects and intensity if order magnitude information is satisfactory. If the need arises for trend detection ability, a much higher sampling intensity using 30-60 transects, plots, or sample areas would be needed. The Gasaway et al. moose census method adapted for caribou offered the best quality estimates and is worth further application.

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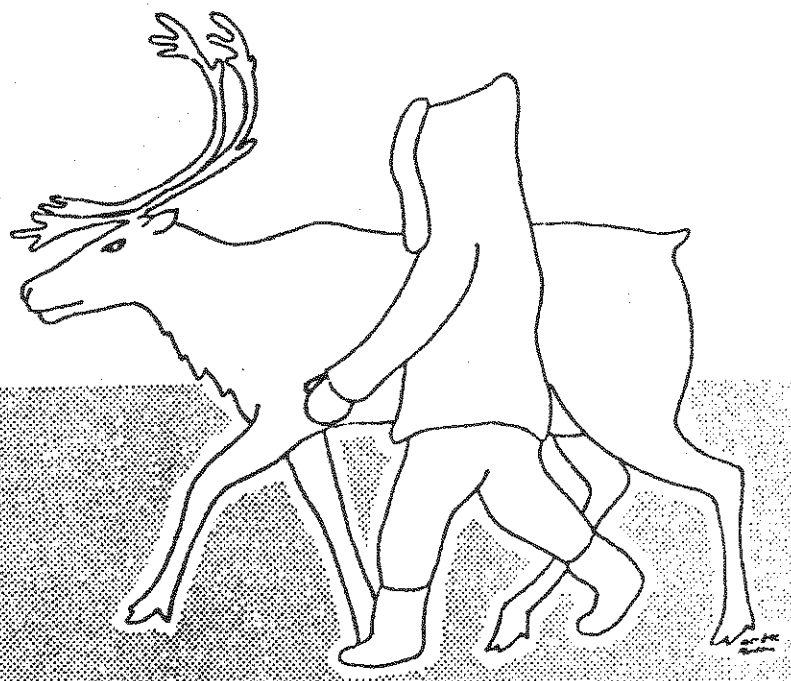
Table 1. Caribou trend survey transects, Selawik NWR, Alaska, November 1986.

Transect	No. of caribou		Density (caribou/km2)	
	1985	1986	1985	1986
1	0	6	0	0.203
2	45	0	1.526	0
3	25	0	0.848	0
4	0	1	0	0.034
5	12	0	0.407	0
6	0	13	0	0.441
7	8	0	0.271	0
8	71	120	2.407	4.068
9	0	33	0	1.119
10	17	0	0.576	0
11	8	0	0.271	0
12	0	11	0	0.373
13	0	0	0	0
14	0	47	0	1.593
15	0	0	0	0
16	38	30	1.288	1.017
17	18	0	0.610	0
18	176	0	5.967	0
Total	418	261	14.171	8.848
Mean	23.3	18.0	0.787	0.492
Standard dev.	42.9	29.8	1.454	1.012
Estimate	10,673	6,664		
80% C.L.	6,196	4,309		

Table 1. Caribou population estimates for Selawik NWR based on random transects (T) and stratified random moose sample units restratified for caribou (M).

Month	Year	Method	Total estimate	80% C.L.	C.L as % estimate	Sample size	Sampling intensity*
December	1984	M	8,496	5,233	61	15	9
October	1985	M	15,303	4,830	32	38	13
November	1985	T	10,673	6,196	58	18	4
November	1986	T	6,664	4,309	65	18	4

* as percent of total refuge covered by sampling method



PROGRAMME ABSTRACTS / RESUMES

2nd NORTH AMERICAN CARIBOU WORKSHOP

2e ATELIER NORD AMERICAIN SUR LE CARIBOU

October 17 – 20 Octobre

1984 – MONTREAL

26. A comparison of caribou census techniques used in Newfoundland

Fong, D.W., E. Mercer, M. McGrath and O. Forsey

Newfoundland Wildlife Division

Key Word: caribou

Abstract: Line transect and random quadrat sampling were used to census caribou populations in insular Newfoundland. Comparisons of these techniques indicated that line transect counts largely underestimated population size.

Résumé: Des transects linéaires et des quadrats d'échantillonage choisis au hazard ont été utilisés pour inventorier les populations de caribou sur l'ile de Terre Neuve. Une comparaison de ces techniques indique que les décomptes le long des transects linéaires ont tendance à grandement sous-estimer les populations.

29. Sampling errors associated with line-transect surveys of caribou

Cameron, Raymond D., Kenneth Whitten, Walter T. Smith and Daniel J. Reed

Alaska Department of Fish and Game

Key Words: caribou, survey, errors

Abstract: Five low-level caribou surveys were conducted by helicopter within a 1640-km² area of the Arctic Coastal Plain of Alaska on 11-14 June 1980-84. Caribou were counted along 12 north-south transects spaced at 3.3-km intervals and extending 41 km inland; numbers of adults and calves within an estimated 1.6 km of each flight line were recorded, and estimates approaching the actual total number of caribou and overall percentage of calves were determined for each survey. Errors incurred at decreasing sampling intensities were projected by recalculating the results obtained with various combinations of transect coverage equivalent to 50% (alternate transects), 33% (every 3rd transect), 25% (every 4th transect), and 17% (every 6th transect) of the study area and comparing the results to the entire data set (i.e., ca. 100% coverage) for a given year. Respective mean (s.d.) errors resulting from extrapolation to total caribou were 12% (8%), 17% (11%), 33% (30%), and 27% (24%); those for calf percentage were 3% (3%), 8% (6%), 11% (12%), and 10% (9%). Culmulatively, two-thirds or more of the possible transect combinations at and above 33% coverage yielded estimates of total caribou and calf percentage that were within 20% and 10%, respectively, of the actual value, whereas half or less of the combinations at 25% and 17% provided data within these limits.

Résumé: Cinq inventaires de caribous par hélicoptère ont été effectués à basse altitude sur une aire de 1640 km² de la plaine cotière arctique de l'Alaska du 11 au 14 juin 1980-1984. Les caribous furent comptés le long de 12 transects orientés nord-sud espacés de 3,3 km et s'étendant sur 41 km à l'intérieur des terres; le nombre d'adultes et de veaux observé à l'intérieur d'une bande d'environ 1,6 km le long de chaque ligne de vol a été enregistré et un estimé voisin du nombre total de caribous et du pourcentage de veaux a été déterminé pour chaque inventaire. L'erreur encourru à des intensités décroissantes d'échantillonage a été établie par le recalcul des données obtenues selon diverses combinaisons de transects équivalent à 50% (tout les 2 transects), á 33% (tout les 3 transects), 25% (tout les 4 transects) et 17% (tout les 6 transects) de l'aire d'étude et comparée aux résultats d'une couverture totale pour une année donnée. L'erreur moyenne relative (s.d.) résultant de l'extrapolation comparé au nombre total de caribous était de 12% (8%), 17% (11%), 33% (30%) et 27% (24%) et pour les pourcentage de veaux était de 3% (3%), 8% (6%), 11% (12%) et 10% (9%). Cumulativement, deux tiers au plus des combinaisons possibles de transects qui ont une couverture de 33% ou plus ont produit des estimés du total de caribou et du pourcentage de veaux qui étaient respectivement à 20% et 10% des valeurs actuelles, tandis que la moitié ou moins des combinaisons à 25% et 17% ont fourni des résultats à l'intérieur de ces limites.

24. Caribou census methods used in the Northwest Territories

Heard, Douglas C.

Government of the Northwest Territories

Key Words: census methods, observer bias, aerial photography

Abstract: Four methods have been used to estimate caribou numbers in the NWT; 1) range-wide and 2) calving ground transect strip surveys where caribou are counted visually and aerial photographic surveys of 3) calving grounds and 4) post-calving aggregations. The biggest drawback of visual surveys is the high variability of observer bias. Bias in counting caribou on aerial photographs can be minimized. Although not without its problems, aerial photography will probably be the technique of the future in the Northwest Territories.

Résumé: Quatre méthodes ont été utilisées pour estimer le nombre de caribou dans les T.N-O. Dénombrement visuel 1) par couverture totale et 2) le long de transects à travers les aires de mise-bas; dénombrement sur des photographies aériennes 3) des aires de mise-bas et 4) des agrégations post-vêlages. Le principal inconvénient des inventaires visuels est la forte variabilité dans le biais des observateurs. Ce même biais peut être minimisé en comptant les caribous sur des photographies aériennes. Bien qu'elle ne soit pas sans problèmes pour les fins de dénombrements de caribous la photographie aérienne sera probablement la technique de l'avenir dans les T.N-O.

J. Wildl. Manage 27(3)

AERIAL WINTER CENSUS OF CARIBOU

ARTHUR T. BERGERUD, Wildlife Division, Department of Mines, Agriculture and Resources, St. John's, Newfoundland

Abstract: During 1957–61, 400 hours of flying time were spent in censusing caribou (*Rangifer tarandus*) in Newfoundland and Labrador. The standard strip census method was used with two rear-seat observers, each scanning a ¼-mile strip. In northern Labrador, the strip was increased to ½ mile. Caribou were reported by rear-seat observers through an intercommunication system to the front-seat navigator, who plotted the animals on large-scale maps or aerial photographs. An estimation was made of the caribou missed by the rear-seat observer by comparing the results of three observers scanning the same strip. Herd structure and distribution were affected by snow cover. Shallow snow depths resulted in low, uniform densities and large herd areas. Densities and heterogeneity were increased when soft snow levels were higher. One herd of 2,000 animals received 88 percent aerial coverage over a 2-day period. Statistics for caribou per square mile were determined at various sampling intensities, using three systematically spaced transect patterns and a random flight design, and compared with figures secured with 88 percent aerial coverage in the systematic design and 79 percent aerial coverage in the random design.

This paper describes and discusses some refinements of caribou census techniques evolved over a 5-year period in Newfoundland. Because of the vast distances involved, caribou censusing depends largely on the use of aircraft. There are few studies (Banfield et al. 1955, Watson and Scott 1956) devoted to improving the technique or testing the accuracy of aerial counts.

Approximately 400 hours of flying time were used in winter aerial surveys during 1957–61. The caribou on insular Newfoundland were censused in 1957, 1959, and 1961, those in southern Labrador in 1958 and 1960, and in northern Labrador and Quebec in 1958. Surveys in 1959 and 1961 exceeded 50 percent coverage of the area occupied by some of the herds and were of particular value in improving the design.

This investigation has been part of a life-history study of the Newfoundland caribou sponsored jointly by the Canadian Federal Wildlife Service and the Newfoundland Provincial Wildlife Division. The Provincial Game Department of Quebec assisted in the 1958 census of Labrador.

Appreciation is acknowledged to these observers: Douglas H. Pimlott, Harry W. Walters, Donald R. Miller, Raymond McGrath, Jacques Normandin, Olendo Gillingham, Ronald G. Hounsell, John S. Tener, William J. Carberry, Stephen T. Hall, Frank S. Manuel, and William A. Andersen. Robert W. McNeily and Ronald G. Hounsell spent considerable time obtaining the information presented in Table 8. Stuart S. Peters assisted in reviewing the manuscript.

DESCRIPTION OF HABITAT

Tree cover on the ranges inhabited by the three races of caribou varies from a closed-crown boreal forest, interspersed with extensive open bogs on the better sites, to lichen- or heath-dominated barrens on the poorer sites and above tree line. Large sections of the range in Newfoundland and northern Labrador are within the woodland and forest–tundra forest zones described by Hare (1959) and are characterized by lichen woodland. The dominant tree species in these open woodlands in Newfoundland are the black spruce (*Picea mariana*) and the deciduous larch (*Larix laricina*). Black spruce dominates in Labrador. Hare (1959) places most of southern Labrador in a zonal subdivision of the boreal forest termed southeastern poor forests.

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AERIAL CENSUSING OF CARIBOU USING STRATIFIED RANDOM SAMPLING[1]

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Abstract: This paper describes an aerial census of the Nelchina herd of Alaska caribou (*Rangifer tarandus*), located in south-central Alaska. The census was taken February 23–27, 1962, by the method of stratified random sampling. The areas currently utilized by the herd were divided into *strata* on the basis of population densities, and each stratum was gridded into 4-square-mile sampling units. The number of units allocated for sampling each stratum was proportional to the estimated population therein, thus permitting greater sampling effort in those strata with high caribou densities—a procedure known as *optimum allocation*. The initial allocation was adjusted so that at least 15 percent of the area in each stratum was sampled. The relation of the strata means and variances was examined to establish a reference which may be used for the allocation of sampling effort in future surveys. The population estimate for the areas sampled by this technique was found to be 54,452 ± 11,867, with 95 percent confidence limits. A direct count was made in a few areas where stratified sampling could not be used. A conservative final population estimate for the Nelchina herd was 71,000 animals.

Effective management of game populations depends on reliable census information, but accurate censusing is difficult. In Alaska, because of the vast, remote areas involved and the rugged nature of the terrain, the enumeration of big-game populations is done almost entirely by aerial observations. Aircraft have been used in census work for some years, but not always effectively.

Banfield et al. (1955), Bowman (1955), Buechner et al. (1951), Grzimek and Grzimek (1960), Petrides (1953), and Watson and Scott (1956) have contributed to the development of aerial census techniques. These past studies generally have employed transect sampling, in which the air-

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