PELLET - GROUP COUNT EVALUATION FOR CENSUS AND HABITAT USE OF ALASKAN MOOSE.

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Abstract: The pellet-group count census technique was tested over a four-year period at the Kenai Moose Research Center (MRC) with known numbers of Alaskan moose (*Alces aloes gigas*) enclosed in a 2.59km^2 area. Pellet groups were randomly distributed in each of seven vegetation types and there were significant differences ($P > 0.01$) between densities of pellet groups by vegetation type. On this basis the number of pellet groups per type was summed to obtain a stratified estimate of the number of pellet groups in the enclosure and the pellet groups/moose/day. Pellet groups/moose/day from 20.7 to 28.7 calculated from known moose days in the enclosure were considered high. Using a range from 10 to 25 pellet groups/moose/day, a range of calculated estimates of moose

numbers was made. During only one of four winters did the actual moose numbers fall into the calculated range. Actual moose number was lower than the low extreme of the calculated range for every winter but one. Some improvements and refinements of our technique may improve accuracy and avoid overestimations of more numbers; however, in general it is doubtful whether we could greatly improve our accuracy due to the many variables confronting this procedure. Pellet group counts indicated some validity in population trend assessment. The distribution of pellet groups, in broadly classified vegetation types, corresponded to reported and observed habitat use.

Pellet group count census techniques, first described by Bennett et al. (1940), have been used for various species of big game. Neff (1968:612) extensively reviewed this subject and concluded ".....pellet-group counts are not a panacea or a short cut to big game population data. However, it does appear that the method is valid, and that it can be made to yield reliable data under field conditions."

Timmermann (1974) reviewed pellet group count procedures for moose and found that good information on moose (*Alces* sp.) deposition rates was lacking. He also discussed the potential of differential deposition in rates as reported by DesMeules (1968) and Smith (1964). Timmermann (1974) concluded that it remains to be proven that pellet group counts provide reliable population estimates, although they do provide a good basis for comparative relative densities between areas and from year to year on a single area.

Knowledge of the appropriate model is necessary for eatimating reliable confidence intervals in estimated animal numbers (Bowden et al. 1969). Although a real distribution of pellet groups is quite variable most observers have found that they tend to be aggregated. Loveless (1967) found that mule deer (*Odocoileus hemionus*) pellet groups on north facing slopes were randomly distributed while those occurring on south and west facing slopes were contagiously distributed. Bowden et al. (1969) compared the distribution of mule deer pellet groups with four mathematical distributions. The Poisson distribution, which would represent a random placement of pellet groups, did not fit their data. All three contagious distributional models (negative binomial, Thomas, and Neyman Type A) fit the data.

The Kenai Moose Research Center (MRC), with known numbers of moose enclosed in four 2.59 km^2 (1 mi^2) pens, provides an opportunity to test the application of the pellet group counting technique with Alaskan moose (*Alces alces gigas*). The MRC is located in the glacislly scoured Kensi Lowlands and contains a representative pattern of both burned (1947 Kenai Burn) and remnant vegetation types. Regrowth in the burn is a mixture of paper birch (*Betula papyrifera*), white spruce (*Picea glauca*) and black spruce (*P. mariana*), willow (*Salix* sp.) and aspen (*Populus tremuloides*); remnant mature stands are mixed birch-white spruce-aspen with black spruce in the wetter sites. Topography of the area is rolling and, with the interspersion of regrowth snd remnant stands, there appears to be little influence of slope or aspect on vegetational use by moose.

STUDY AREA AND METHODS

One-hundred-sixty (159 in winter 1970-71) 2.4 x 7.3m (17.8m^2) permanent browse utilization plots in Pen 1 were used for pellet group count plots. Plots were randomly located in each of seven vegetative types (Tables 1 and 2) representing 204.3 ha of the 241.1 ha in Pen 1. The sample plots constitute 0.14 percent (0.139 in 1970-71) of the area utilized. The nonsampled area of 36.8 hectares (91 acres) consisted of black spruce-(*Ledum*), grass, sedge and water areas which were not considered winter use areas based upon winter feeding preferance of 3 tame moose on natural forage (LeResche and Davis 1973).

Plots were cleared of pellets in May, 1970 and were first counted and cleared again on June 2-4, 1971. Fecal deposits in each plot were classified as winter (pelletized) or summer (not pelletized). Based on observations of the MRC trapped moose, the period of pelletized fecal groups was established as beginning about November 1 and continuing until about June 1. No plots were counted or cleared in spring 1972. On May 10, 11, 14 and 18, 1973 the 160 plots in Pen 1 were again counted and cleared. Separation of past year from present year groups was attempted on the basis of leaf and duff cover over pellet groups, deterioration of pellet groups and color and texture of these groups. The leaf cover use was enhanced by the fact that leaves fall during early October in this area, prior to pelletization of moose fecal droppings (November 1). On May 6, 7, and 8, 1974 the plots were counted and cleared with only winter-summer separation made as the plots had been cleared the previous May.

Moose days were calculated for the four winter periods in Pen 1 based upon the 210-day (November 1 to June 1) pellet forming period and known numbers of moose present, for either the entire period or parts thereof (Table 3). We considered this an accurate appraisal of moose numbers in Pen 1 as moose were trapped and observed throughout this period. The winters of 1972-73 and 1973-74 had 196 and 191 potential moose days, respectively, since the plots for each period were counted prior to June 1, when pellet formation generally ceased.

Daily moose defecation rates were determined at MRC by backtracking moose in fresh snow (Franzmann et al. 1976).

RESULTS AND DISCUSSION

A Poisson distribution was tested with the pellet group data from each vegetation type and against the pooled count each year. In all cases, except for the pooled count in 1971, the Poisson distribution fit the observed distribution (Tables 1 and 2), indicating a random placement of pellet groups. The mean number of pellet groups per type was then compared by analysis of variance using a $\sqrt{x + 1/2}$ transformation of the data. In all four years, the hypothesis of no difference among habitat types was rejected ($P > 0.01$). On this basis, we summed the number of pellet groups per type to obtain a stratified estimate of the total number of groups deposited in the enclosure. In each of the four years, this estimate was uniformly higher than the value obtained by pooling the data.

Table 1. Pellet-groups deposited by vegetative type per 17.9m² plot, hectare and type with chi-square values for Poisson distribution during winters Kenai Moose Research Center, Alaska 1970-74.

Vegetative Type	Hectares	Probability of larger X^2 for Poisson Distribution	Pellet Groups Per Plot			Hectare	Type	% of Total
			X	S^2	N			
1970-71								
Dense Mature Hardwoods	21.1	>0.25	0.45	0.576	20	251.6	5309	7.3
Thin Mature Hardwoods	18.7	>0.25	0.68	0.673	19	379.5	7096	9.8
Spruce Birch Regrowth	36.2	>0.25	0.33	0.319	24	82.7	2995	4.1
Spruce Regrowth	16.1	>0.25	0.20	0.168	20	250.8	4038	5.6
Dense Birch Spruce Regrowth	45.7	0.22	1.28	1.877	25	718.1	32815	45.3
Medium Birch Spruce Regrowth	38.4	>0.25	0.73	0.845	26	409.7	15734	21.8
Thin Birch Spruce Regrowth	28.1	>0.25	0.28	0.293	25	156.0	4383	6.1
Pooled Total	204.3	>0.01	0.58	0.802	159	324.7	66326	-
Stratified Total							72370	100.00
1971-72								
Dense Mature Hardwoods	21.1	>0.25	0.30	0.221	20	167.8	3541	4.4
Thin Mature Hardwoods	18.7	>0.25	0.75	0.145	20	418.6	7827	9.7
Spruce Birch Regrowth	36.2	>0.25	0.50	0.435	24	125.3	4537	5.6
Spruce Regrowth	16.1	>0.25	0.20	0.274	20	250.8	4038	5.0
Dense Birch Spruce Regrowth	45.7	>0.25	1.20	1.000	25	673.2	30764	38.0
Medium Birch Spruce Regrowth	38.4	>0.25	0.88	0.586	26	493.9	18967	23.4
Thin Birch Spruce Regrowth	28.1	>0.25	0.72	0.543	25	401.1	11271	13.9
Pooled Total	204.3	>0.25	0.68	0.686	160	380.7	77767	-
Stratified Total							80945	100.0

Table 2. Pellet-groups deposited by vegetative type per 17.9m^2 plot, hectare and type with chi-square values for Poisson distribution during wintera Kenai Moose Research Center, Alaska 1970-74.

Vegetative Type	Hectares	Probability of larger X^2 for Poisson Distribution	Pellet Groups Per Plot			Hectare	Type	% of Total
			$\bar{x}$	s^2	N			
1972-73								
Dense Mature Hardwoods	21.1	>0.25	0.30	0.221	20	167.8	3541	5.5
Thin Mature Hardwoods	18.7	>0.25	0.70	1.063	20	390.6	7305	11.4
Spruce Birch Regrowth	36.2	>0.25	0.17	0.145	24	42.6	1543	2.4
Spruce Regrowth	16.1	>0.25	0.20	0.274	20	250.8	4038	6.3
Dense Birch-Spruce Regrowth	45.7	0.14	0.92	0.910	25	516.1	23586	36.8
Medium Birch-Spruce Regrowth	38.4	>0.25	0.77	0.825	26	432.2	16596	25.9
Thin Birch Spruce Regrowth	28.1	>0.25	0.48	0.343	25	267.4	7514	11.7
Pooled Total	204.3	>0.25	0.52	0.603	160	291.1	59472	-
Stratified Total							64123	100.0
1973-74								
Dense Mature Hardwoods	21.1	>0.25	0.35	0.555	20	196.2	4139	9.8
Thin Mature Hardwoods	18.7	>0.25	0.20	0.168	20	111.6	2087	4.9
Spruce Birch Regrowth	36.2	>0.25	0.13	0.114	24	32.6	1180	2.8
Spruce Regrowth	16.1		0	0	20	0	0	0.0
Dense Birch-Spruce Regrowth	45.7	>0.25	0.68	0.727	25	381.5	17433	41.1
Medium Birch-Spruce Regrowth	38.4	>0.25	0.35	0.395	26	196.4	7543	17.8
Thin Birch-Spruce Regrowth	28.1	>0.25	0.64	0.407	25	356.5	10019	23.6
Pooled Total	204.3	>0.25	0.35	0.392	160	195.9	40018	-
Stratified Total							42401	100.0

From stratified total winter pellet groups (Tables 1 and 2) and total moose days (Table 3), pellet groups/moose/day were calculated (Table 4). In winter 1970-71, 3,575 moose days resulted in 72,370 pellet groups for a calculated 20.2 pellet groups/moose/day. In winter 1971-72, 3,082 moose days produced 80,945 pellet groups or 26.3 pellet groups/moose/day.

During winter 1972-73, 2,303 moose days produced 64,123 pellet groups or 27.8 pellet groups/moose/day and in winter 1973-74, 1,475 moose days produced 42,401 pellet groups or 28.7 pellet groups/moose/day.

These calculated defecation rate estimates are high in relation to most reported rates. Franzmann et al. (1976) reported significant differences ($P > 0.01$) between adult male (19.6/day) and adult female (14.6/day) moose deposition rates. The combined (male and female) deposition rate was 17.6/day (range = 10 to 25). Timmerman (1974) reviewed the reported average daily deposition rates for moose and the variability was from 9.6 to 32.2 deposits/day/moose with most estimates between 11 and 16. Due to the reported variability in moose deposition rates we decided to utilize a range of deposition rates (10 to 25/day) to assess our estimates of moose in the MRC enclosure.

Using the range of deposition rates and the stratified total pellet groups (Tables 1 and 2) with pellet group days (Table 4) we estimated number of enclosed moose each year of pellet group counts (Table 4). During winter of 1970-71 the calculated range of moose numbers was 13.8 to 34.5, when the actual mean number of moose was 17.1. During winter

Table 3. Moose days in Pen 1 Kenai Moose Research Center

Alaska during winters 1970 to 1974. *

Moose Number	Winter 1970-71	Winter 1971-72	Winter 1972-73	Winter 1973-74
3	210	210	196	-
Calf of 3	135	61	-	-
6	210	135	-	-
Calf of 6	-	61	-	-
670	210	210	196	-
10	210	210	196	191
Calf of 10	135	61	61	191
35	210	210	196	191
40	210	210	166	-
Calf of 40	135	61	-	-
41	115	-	-	-
4170	115	-	-	-
43	210	210	97	191
53	210	210	-	-
55	210	-	-	-
58	210	210	196	191
61	210	210	-	-
64	210	210	196	-
65	-	-	67	-
6171A	-	61	-	-
69	210	210	196	191
6171B	-	61	-	-
R70-8	210	210	196	191
Calf of R70-8	-	61	-	138
76	-	-	196	-
Calf of 76	-	-	112	-
93	-	-	14	-
96	-	-	22	-
TOTAL	3575	3082	2303	1475

* Based on 210-day pellet-forming winter period (November 1 to June 1)

Table 4. Pooled and stratified total pellet-groups in Pen 1, Kenai Moose Research Center, Alaska with calculated pellet-groups/moose/day and calculated and actual moose numbers during winters 1970-74.

Winter	% Pen in Plots	Total Pellet-groups		Moose Days	Pellet-groups per moose/day	Pellet group Days	Range of Moose Numbers	
		Pooled	Stratified				Calculated[2]	Actual
1970-71	0.139	66326	72370	3575	20.2	210	13.8 to 34.5	17.1
1971-72	0.140	77767	80945	3082	26.3	210	15.4 to 38.5	14.7
1972-73	0.140	59472	64123	2303	27.8	196	12.2 to 30.5	11.8
1973-74	0.140	40018	42401	1475	28.7	191	8.1 to 20.2	7.7

1 Based on 210-day pellet-forming winter period (November 1 to June 1).

2 Based on range of 10 to 25 pellet-groups/moose/day.

of 1971-72 the calculated range of moose numbers was 15.4 to 38.5, when the actual mean number was 14.7. During the 1972-73 196 pellet-group day period, the calculated range of moose numbers was 12.2 to 30.5 and the actual mean moose number was 11.8. During the 1973-74 191 pellet group day period the calculated range of moose numbers was 8.1 to 20.2 and the actual mean moose number was 7.7. Actual moose numbers fell into the calculated range of moose numbers during winter 1970-71 only. Each other winter period the actual moose number was lower than the extreme low end of the calculated range. We would expect the actual moose numbers to fall near the center of the range of calculated values assuming the procedure was accurate.

Refinement of the procedure may improve estimations. One potential error source was that we estimated initiation of pellet formation of moose in the fall by observation. This variability could have been eliminated by clearing plots in the fall after pelletization was well under way or after leaf fall. The variability of deposition rates associated with age classes (calves, yearlings and adults) should be better defined as well as, the potential individual variability over time associated with altered feeding habits.

The separation of winter 1971-72 and 1972-73 pellet groups was apparently successful based upon the calculated pellet groups/moose/day of 26.3 and 27.8 respectively. Any great difference in these figures would have indicated that our criteria for separation were not valid. Aging summer fecal deposits resulted in a total of 11 deposits in 1971 and 22 in 1972 which we believed invalidated our summer ageing technique since there were more moose in Pen 1 the summer of 1971 than in 1972. Possibly, the older summer fecal deposits had deteriorated.

Winter habitat selection by moose, as indicated by pellet groups per vegetative type (Table 1 and 2), demonstrates an affinity for birch regrowth (combined dense, medium and thin birch-spruce regrowth) areas. During all four winters 73.2 to 82.5 percent of pellet groups were in these areas. Spruce regrowth areas (combined spruce-birch regrowth and spruce regrowth) for the four winters continued 2.8 to 10.6 percent of the pellet groups. Mature hardwood areas (combined dense and thin mature hardwoods) contained from 14.1 to 17.1 percent.

Summer habitat selection by moose, as indicated by fecal deposits per vegetative type was perhaps not useful since ageing of summer deposits was not valid and spruce - *(Ledum)*, grass, sedge and water areas, which were observed to receive increased summer use, were not sampled. However, it should be noted that in all four years no summer fecal deposits were counted in thin mature hardwoods and only five were counted in dense mature hardwoods.

Neff (1968:612) stated "A major problem requiring future research attention concerns the use of pellet group distribution pattern as an index to habitat preferences."

Anderson et al. (1972) could find no significant correlations between indices of mule deer numbers and mean yield or utilization of selected deer browse. We believe the winter habitat selection by moose at the MRC as reflected by pellet group distribution corresponded to observed and expected use. LeResche and Davis (1973) reported tame moose on normal range at the MRC consumed 72 percent birch stems in February-May and 21 percent of the remaining material was lowbush cranberry (*Vacinium vitis-idaea*). Birch-spruce regrowth (73.2 to 82.5 percent of pellet groups) provided the birch for winter browsing. Thin mature hardwood areas contained the greatest proportion of ground cover lowbush cranberry (Oldemeyer and Seemel 1976) and the relative substantial use of these areas, reflected by pellet group distribution, was likely related to its use and importance to moose. However, an undetermined proportion of hardwood use by moose in winter may relate to protection, resting, and relief from snow and may partially account for pellet group distribution. The relative nonuse of hardwoods by moose in summer, based on pellet group distribution, was reasonable in this context as LeResche and Davis (1973) reported that lowbush cranberry at the MRC was taken in trace amounts during the summer. With foliage present on birch in summer, protection and resting areas were more numerous in the regrowth, and mature timber was not necessarily required. Spruce regrowth areas received the least moose use based on pellet group distribution, and this was expected since moose do not browse spruce and these areas contain low densities of birch. The percent of use found (2.8 to 10.6) may relate to these areas being used for protection in addition to the presence of some browse. We found the distribution of pellet groups, in broadly classified vegetation types, corresponded to reported and observed habitat use by moose at the MRC.

We believe the MRC provided an ideal testing situation to evaluate pellet group technique in estimating moose numbers. The tendancy to overestimate known moose numbers utilizing pellet counts, moose days and a range of pellet group daily deposition rates was disturbing. If we consider accurate execution of the technique as outlined, we must conclude that winter pellet group count were not precise estimators of moose numbers at the MRC.

It is possible for some refinement in our technique, but it is doubtful whether we could greatly improve our accuracy due to the many variables confronting this procedure. Annual population trend assessment may be benefited by utilizing pellet group counts in that from winters 1971-72 through 1973-74 the actual population declined as did the range of calculated estimates. The downward trend from 1970-71 to 1971-72, however, was not detected.

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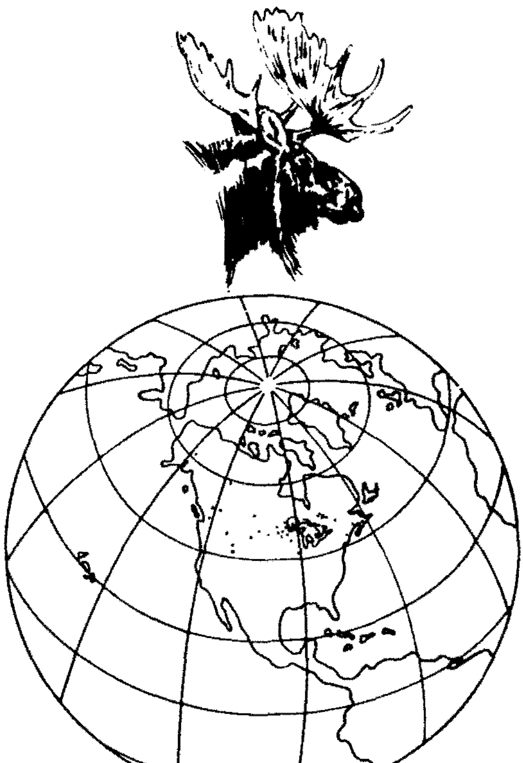

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53 DELEGATES TO THE 1976 CONFERENCE ATTENDED FROM MOST PARTS OF THE MOOSE RANGE OF NORTH AMERICA.