STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

Bill Sheffield, Governor

Box 686
Kotzebue, AK 99752-0686

April 17, 1985

Mr. C. Mack Shaver
Superintendent
National Park Service
P.O. Box 287
Kotzebue, Ak 99752-0287

Dear Mack,

Here is the final copy of the Noatak moose survey report. It is not a polished, finished product, as Kate Cannon and I agreed upon earlier, but rather a technical reference document which will serve as a guide to future late winter moose surveys in this region. I was extremely pleased that our agencies cooperated to accomplish what otherwise could not have been done. I look forward to future cooperative efforts whether small or large, formal or informal.

I have also forwarded a copy to Kate in Utah. Thanks again.

Sincerely,

David James

David James
Alaska Dept. of F & G

Enclosure

Northwest Areas
National Park Service
[illegible] 19 '85

Init.	Date
Supt.	
Ch Rgr.	
Admin.	
Maint.	
FILE	

What was the habitat differences between the high and low density areas?

11-K2LH

MOOSE DEMOGRAPHY AERIAL SURVEY

OF THE MIDDLE NOATAK RIVER VALLEY, LATE WINTER, 1985

David D. James, Alaska Department of Fish and Game, Kotzebue

Kate Cannon, National Park Service, Kotzebue

INTRODUCTION

The use of the moose demography aerial survey technique (Gasaway, et.al., Alaska Department of Fish and Game, Fairbanks) in several Game Management Units in Alaska has generally resulted in information of quality superior to that which has resulted from previously used techniques. Game Management Unit 23 is one of the areas where the moose demography aerial survey technique (MDAST) has not previously been attempted. The impetus to initiate the MDAST in Unit 23 resulted from the need of both sponsoring agencies (ADF&G and NPS) to better understand the status and trend of moose populations impacted by increased human activity including subsistence and recreational hunting, non consumptive uses, and other activities.

STUDY AREA

The area surveyed is a portion of the middle Noatak River drainage (Figure 1). It includes the northwest corner of the Noatak National Preserve, and a 50-60 square mile area in the vicinity of Deadlock Mountain, just outside of and adjacent to the Preserve boundary.

The survey area also roughly corresponds to the "Middle Noatak moose survey area" in which the ADF&G has conducted moose surveys for the past several years (data on file, ADF&G Kotzebue). The "Middle Noatak River" nomenclature will be retained and used to refer to the present MDAST survey as well. The size of the survey area is 2,115 square miles. It includes the Kelly and Kugururok River drainages north of the Noatak River and several smaller tributaries south of the Noatak River that drain the Maiyumerak Mountains.

The Middle Noatak River survey area was chosen for several reasons. First, the uncertainties associated with attempting a first-time effort, and limited time and budgets (no special funding was available) required a relatively uncomplicated survey environment. Most of the Middle Noatak River survey area is open tundra or tundra-shrub with relatively restricted areas of spruce forest, hence moose are relatively easy to see compared to areas of extensive spruce forests. Second, the middle Noatak River is one of the more heavily used moose hunting areas in Unit 23, hence the potential for hunting impacts is of some concern. Third, there is currently concern that the impact of moose on their browse may be at or near a detrimental level. Therefore, the Middle Noatak River seemed to be both an area where difficulties in conducting a MDAST would be minimized and where better resource information would be useful for management purposes.

SURVEY PREPARATION

The survey area was plotted on a USGS 1:250,000 topographical map.

The area was divided into 172 sample units (SU) which averaged 12.3 square miles each. All area measurements were accomplished with a polar planimeter. Maps of the preferred scale, 1:63,360, are not available for much of the survey area, so only 1:250,000 scale maps were used. Use of 1:63,360 maps facilitates location and identification of landmarks and improves accuracy in determining the size of SU's, so they should be used whenever possible. About 2 working days were required to prepare the map. An additional working day was required to redraw a completely new map at the conclusion of the fieldwork because the use of the original map during the aerial surveys rendered it unsuitable for measurement of SU sizes. Duplication of effort might be avoided in the future if photocopies of the original map are used during the aerial survey.

WEATHER AND ENVIRONMENTAL CONDITIONS

Skies were clear during all 5 days of the project. Winds were calm to light and variable on March 15-17. Winds were variable, north to northeast at 10-25 m.p.h. (estimated) on the 18th & 19th. The temperature was relatively constant at 0o F +/- 10o. Snow cover was

100% and was deeper than it had been in several years. The deepest snow we observed relative to an adult moose was about 6-8" below the abdomen. Most of the area had less snow, but even open tundra areas were covered with about 12" of snow. The previous snowfall had occurred less that 1 week before the survey began. Bright light of approximately medium intensity resulted in dark shadows in spruce stands which were especially noticeable by late afternoon.

STRATIFICATION FLIGHTS

The stratification flights were conducted in a Cessna 185 provided by the National Park Service. Ray Bane (NPS) was the pilot, Kate Cannon (NPS) was the backseat observer/recorder, and David James (ADF&G) was the navigator in the right front seat. Flights of 6.4 and 6.1 hours were made on March 15 and 16, respectively.

Considerable difficulty was encountered the first day because of frost build up on the inside of the windows, hampering visibility. No problem was experienced the on the second day because of a combination of full-on interior heat, strong cross-ventilation, and slightly warmer ambient temperatures.

Having only 1 instead of 2 observers in the back seat probably compromised our ability to accurately estimate relative moose density. The navigator found it impossible to do an adequate job of map-reading while simultaneously trying to count moose. The original plan was that the navigator could do both of the above, thereby compensating for the lack of a second back seat observer. It did not work very well. Two backseat observers should be used whenever possible.

The primary criterion for classifying a SU as high, medium, low or none was the number of moose seen. Additional consideration was given to habitat type and to moose tracks in snow.

High Density Units:

As few as 9 observed moose were used to classify a sample unit (e.g., SU #1) as high density when, because of numerous tracks and bedding sites and extensive willow thickets interspersed with spruce stands, it was apparent that a substantial number of additional moose were present but unseen. In the case of SU # 1, 45 moose were counted when it was later surveyed. The adjacent SU #2 was also classified as high density primarily on the basis of its overall similarity to SU #1. Later, 34 moose were counted in SU #2, and 41 moose were seen in SU #18, another high density SU containing similar habitat. SU #20 had many similarities to the above 3 SU's, but when surveyed, contained 136 moose. That was considerably more than 1, 2, and 18, and it alone contributed a great deal of variation to the final estimate. A fifth stratum of super-high density would have been appropriate. In the future, a little more effort expended during the stratification flight would probably make it possible to differentiate between high and super-high densities in SU's.

SU's #94, #118 and #139 were also classified as high density. Very few trees are present in #94, and there are none in #118, and #139. The number of moose counted during subsequent surveys were 33, 51, and 21, respectively. SU's #118, and #139 share a common boundary and we suspect that some moose shifted from #139 to #118 during the 2 days which elapsed between the stratification flight and the survey flight. The less time between stratification and survey the better, but obviously not all SU's can be surveyed within 24 hours. Also, seasonal movements of moose normally begin in March in Unit 23. The only practical way to minimize the above problem, therefore, would be to conduct the entire project before March. At any rate, the average number of moose in #118, and #139 together was 36, which suggests consistency in the stratification criteria even though different habitat types (#1, #2, #18, vs. #94, #118, #139) were encountered.

SU #5 was originally classified as low density although when it was surveyed 44 moose were counted. SU #5 was inadvertently missed during the stratification flight and consequently was classified on the basis of its being adjacent to other SU's which were observed during stratification and classified as low density. Furthermore, it was assumed that #5 contained habitat similar to the adjacent low density SU's. A portion of #5, however, contained some unique, treeless habitat consisting of several lakes with steep banks and adjacent ravines supporting extensive willow thickets. We justified placing SU #5 in the high density stratum after it had been surveyed with the following reasoning: first, #5 was not actually observed during stratification but was classified on the basis of assumed habitat only. Second, we believe that 12-20 moose would have been observed during the stratification flight had we flown over, because the moose in #5 were highly visible even from distances of 1 mile or more, so it would have been classified as high density.

The above problem demonstrated the importance of determining relative density on the basis of actual observation during the stratification flights. As an alternative, if an SU that has not been observed during stratification must later be surveyed, then the survey should be immediately preceded by a brief "stratifaction" flight to check the accuracy of the original classification. This would be valid only if the observer had also participated in the stratification flight and was therefore familiar with the classification criteria.

It should be pointed out that had #5 not been shifted from the low to the high stratum, the resultant population estimate would have been meaningless because of a confidence limit of +143%. Although 4 other SU's were also classified without actually having been flown over, we believe the probability is low that they included an unsuspected pocket of anomalous habitat, as #5 did. The other SU's were located in relatively high, steep mountainous areas which constitute a very different environment than the relatively flat, open, lake-interspersed area of SU #5.

Medium density units:

Five of 30 SU's classified as medium density were later surveyed. SU's #29, #30 and #33 were reasonably consistent at 33, 18, and 22 moose, respectively. SU #16 was substantially higher at 48. This, we believe, was another case in which a little more time (3-4 hours) spent during stratification flights might have resulted in a substantial improvement in accuracy of the density classification. The last SU surveyed in the medium density stratum was #8 in which 60 moose were counted. SU #8 was clearly mis-classified. The majority of the moose were located in 1 of 3 converging canyons separated by mountains. The canyon with most of the moose was not flown over, during stratification whereas the remainder of the SU was observed. Once again, an assumption about homogeneity of moose distribution, even within only a 12 square mile area, proved erroneous.

Low Density Units:

The low density stratum contained 78 SU's; #3, #4, #26, #39 and #50 were surveyed. The number of moose varied from 0 to 7. The variation within the low stratum was much less than in the high or medium density strata.

Forty three SU's were classified as having no moose. Many of those SU's, however, appeared to be suitable for moose during other seasons of the year. Subsequently, we learned that the standard practice in other areas of Alaska has been to exclude only those SU's which have no potential as moose habitat during any time of the year, such as glaciers and very steep mountains. We recommend following that practice in the future.

STRATIFICATION RECOMMENDATIONS

The proclivity of moose to form dense aggregations in late winter, such as the 9.7 moose/square mile in SU #20, demonstrated the necessity to execute a thorough stratification survey. Overlooking aggregations during the stratificaion process can result in unacceptable variation in the final estimate.

We believe that 3-4 hours of additional flight time during the stratification survey would have prevented much of the mis-calculation of relative moose densities which occurred in this project. This would have required part of a third day's flight in the C-185. The extra time required to complete an extended stratification survey could be at least partially offset by initiating the enumeration surveys of randomly selected SU's before the stratification was complete. This presumes the availability of enough pilot/observer teams are available.

SAMPLE UNIT SURVEYS

The sample unit surveys were conducted on March 17, 18 and 19. One Supercub (PA-18) team (J.Walker/Pilot, D. James/Observer) surveyed on all 3 days. On the 19th NPS provided a second Supercub team (M. Shaver/Pilot, K. Cannon/Observer). Eighteens SU's were surveyed in the order in which they were drawn from a random number table. 8 high, 5 medium, and 5 low density SU's were surveyed. Weather, time, and funding were all considerations which prevented surveys of additional SU's.

Some of the SU's along the Noatak river were surveyed on the 17th; winds were calm to light and variable. Winds and accompanying turbulence had increased, however, on the 18th and 19th when surveys were attempted in the mountainous areas north of the Noatak, making it necessary to discontinue the survey in the mountains and survey additional SU's nearer the Noatak River instead. As a result, the northern part of the Middle Noatak River Survey Area was under-represented in the final results. Therefore, the biological validity of the final estimate is somewhat conjectural, although all SU's were surveyed in the order in which their respective accession numbers were drawn from a random numbers table to ensure statistical validity.

In the future, a better course of action might be to survey the mountainous areas first because strong winds and other inclement weather normally restrict access to the mountains before they do the lower, more open terrain of the Noatak valley.

Moose densities in SU's: The moose densities observed in the 18 SU's surveyed ranged from 0-9.7 moose per square mile. These values are shown in Figure 2. Considerable variation occurred within the high and medium strata.

The density of moose in the high density SU's that were surveyed varied from 1.6-9.7 moose/square mile, for an average of 3.9. Much of the variability was contributed by SU #139 (low) and SU #20 (high). Explanations for these occurrences and possible ways to avoid them in the future were discussed previously, under "Stratification Flights". Excluding SU #20, the average of the 7 remaining SU's was about 3.

The SU's in the medium density stratum ranged from 1.3-5.3 moose/square mile and averaged 2.8. As previously discussed, we believe that it is possible in future stratification flights to prevent mis-classification such as that which occurred when #8 and #16 were included in the medium density stratum. Had that been done in this study, a more representative average of about 2 might have been found, the average of the remaining three SU's and the medium stratum.

The low density SU's sampled varied from 0-0.5 moose/square mile and averaged 0.2. The exclusion of SU #5 and its placement into the high density stratum was already discussed.

If the above supposition that 3 moose/square mile and 2 moose/square mile was really representative of the high and low density strata, respectively, then one might conclude there was not much real difference between the 2 strata. A simple visual examination of Figure 2 suggests the same. In fact, under the conditions which existed during this survey, a more appropriate stratification might have been to include all the medium SU's and all but #20 of the high SU's into a "medium" stratum. The low stratum could have remained the same, and SU #20 would have been representative of the "high" density stratum.

Speculation aside, the data in Figure 2 show that most moose densities in the surveyed SU's ranged from 1.5-4.0 moose per mile.

Search Time A wide variety of search times resulted in a range of 1.7-8.4 minutes/square mile which reflected different types of habitat. The lowest search times resulted from SU's consisting mostly or entirely of open tundra interspersed with varying amounts of low shrub thickets. Longer search times were needed to search SU's containing a significant spruce forest component.

One of the major limitations on the results of this survey was the fact that we made no attempt to determine a sightability correction factor (SCF). All searches were considered "standard intensity", despite the variation in search time described above. In the future, if funding and/or personnel do not permit a complete determination of the SCF it might be desirable to establish a SCF for SU's that contain a significant amount of spruce forest. We almost certainly did not see all moose in the SU's with spruce stands. We are forced to conclude that the estimated population is an underestimate, and also that the variations, hence confidence limits, are inherently less reliable than they would have been had the SCF process been incorporated into the survey.

POPULATION ESTIMATE

The estimated population of moose in the 2,115 square mile Middle

Noatak Moose Survey Area was 2,227 +/- 26% at the 90% confidence level or 1,660-2,795 moose. This estimate was derived using the HP-97 program described in the survey manual (Gasaway, et.al,) The population estimate equated to a density of between .0.8 -1.3 moose/square mile, including areas not inhabited by moose.

Improved precision should be a goal of future estimates of moose populations in GMU 23. The estimate generated from this study resulted in a difference of 1,135 moose between the 90% upper and lower confidence limits. Management utility would be enhanced by a decrease in the difference between the upper and lower figures. For example, a very conservative management scheme might base allowable harvest on the lower confidence limit of 1,660. Had the lower level of precision been +/- 15%, the lower limit would have been close to 1900, allowing a commensurate increase in the estimate of allowable harvest.

The usefulness of the present estimate should not be underrated, however. The previous estimate of the number of moose in the entire Noatak River drainage was 1,900 (Quimby and James, 1985). That estimate was admittedly a subjective one, but nevertheless was based on the best biological information available. It is our understanding that the pattern of subjective estimates of moose population being substantially lower than the estimates resulting from the MDAST is one that has occurred in several other regions of Alaska, and seems to be the rule rather than the exception.

MOOSE CALF ESTIMATE

The estimated number of calves (short-yearlings) in the survey area was 388 +/- 34% or 255-521 at the 90% level of confidence. This confidence limit was proportionately greater than the limit on the total population estimate. This apparently reflected the inadequacy of stratification based on relative numbers of moose in order to estimate number of calves. Presumably, stratification based on relative numbers of calves would be more appropriate. In the future, the number of calves as well as the number of moose should be recorded during stratification flights. This might allow a subsequent re-adjustment of the strata specifically to estimate calf numbers.

The HP-97 "Sex and Age Ratio" program was used to estimate the calf/adult moose ratio. Adult moose in this case means all moose except calves (short-yearlings). The figure derived was 0.22. +/-12% for a 90% confidence interval of .0.20-0.25. Hence, the number of short-yearlings constituted 20-25% of the number of adult moose. This is equivalent to 17-20% calves in the total population. A precision level of +/- 12 is probably adequate for management purposes, i.e. to indicate relative recruitment of first year moose to the population.

The above estimates are comparable to the ratios derived from the actual

number (601) of moose counted. Adults and calves numbered 491 and 110 respectively. These figures calculate to a calf/adult ratio of 0.22 and a calf percentage of herd of 18%.

SUMMARY

1. The estimated number of moose in the 2,115 square mile Middle Noatak River Moose Survey Area during March, 1985 was 2,227 +/- 26% (1660-2795, 90% C.I.)

2. The estimated number of calf moose was 388 +/- 34% (255-521, 90% C.I.) and the estimated calf/adult ratio was 0.22 +/- 12% (0.20 - 0.25, 90% C.I.)

3. Proper identification and classification of relative members of moose during stratification flights is extremely critical during late winter surveys because of dense aggregations.

4. It may not be possible to estimate the number of calves within an acceptable level of precision if the stratification is based on relative numbers of all moose instead of relative numbers of calves.

5. The estimated number of moose for a small portion of the Noatak drainage (1660-2795) suggested that the previous, subjective estimate (1,900) of moose in the entire Noatak drainage was extremely conservative.

6. The estimated density of moose within the survey area was 0.8-1.3 moose/square mile.

7. Estimated densities of moose within the high, medium, and low

strata were 3.9, 2.8, and .26 moose/square mile, respectively.

FIGURE 1. Middle Noatak River Moose Survey Area, 2,115 mi^2.

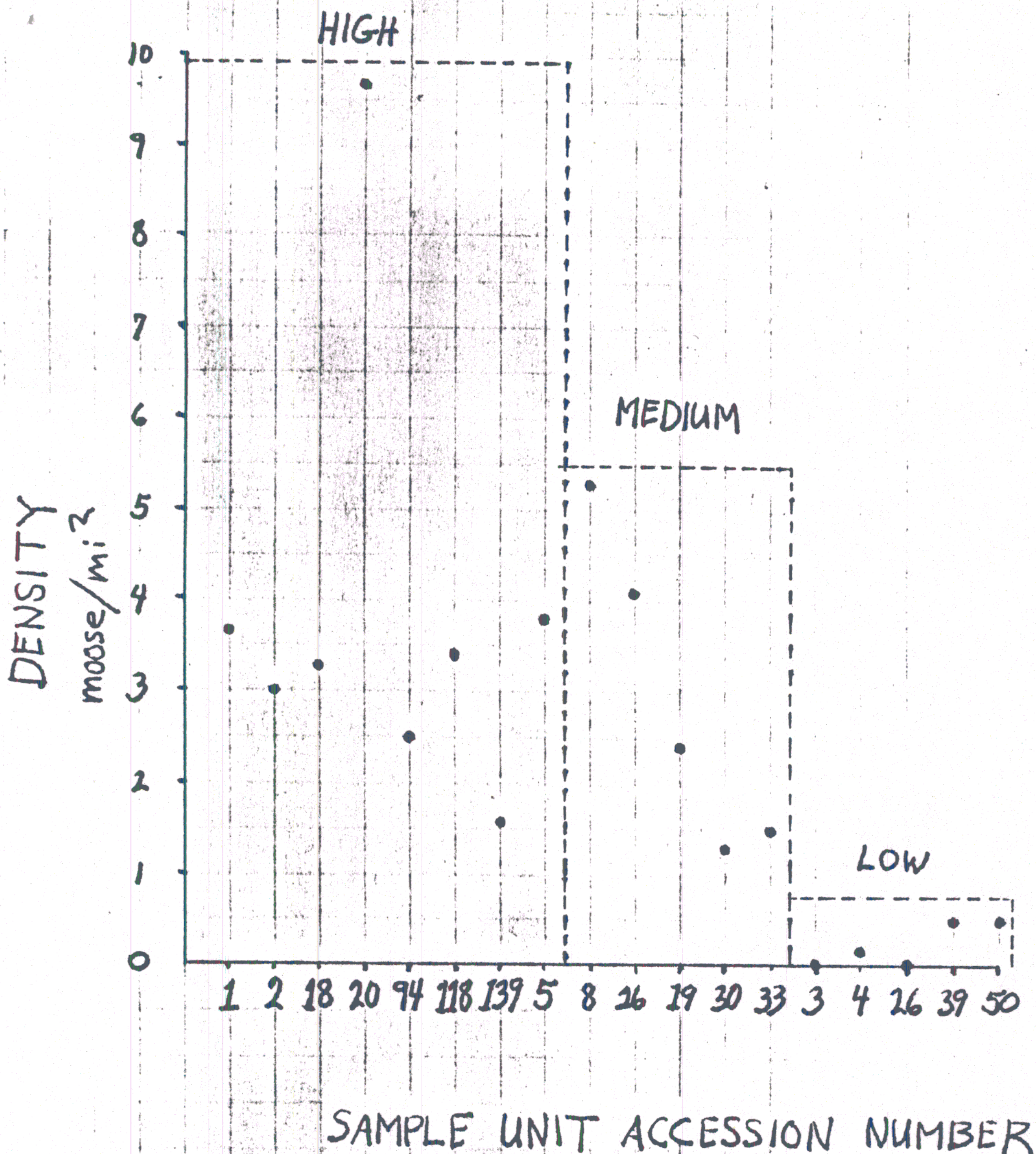

FIGURE 2. Moose densities in sample units surveyed in the Middle Noatak River survey area, 1985.

Appendix A.

Form 4. Daily tally of count data by stratum for moose population estimation survey.

Survey Area Middle Noatak River

Game Management Unit(s) 23 Subunit(s) NA

Stratum "0" Stratum Area 561 mi^2 Total SUs In Stratum 43

SU no.	Date searched	No. moose in SU	SU area (mi^2)	Search effort (min/mi^2)	SU density ($moose/mi^2$)	No. moose in SCF searches Std. Int.

Appendix A.

Form 4. Daily tally of count data by stratum for moose population estimation survey.

Survey Area Middle Noatak River

Game Management Unit(s) 23 Subunit(s) NA

Stratum High Stratum Area 277 mi^2 Total SUs In Stratum 21

SU no.	Date searched	No. moose in SU	SU area (mi^2)	Search effort (min/mi^2)	SU density ($moose/mi^2$)	No. moose in SCF searches Std.	Int.
1	3/17/85	45	12.3	6.8	3.66		
2	3/18/85	34	11.4	7.0	2.98		
18	3/18/85	41	12.3	7.1	3.33		
20	3/17/85	136	14.0	8.4	9.71		
94	3/18/85	33	13.3	2.6	2.48		
118	3/18/85	51	15.1	3.1	3.38		
139	3/18/85	21	13.2	2.1	1.59		
5	3/19/85	44	11.6	3.9	3.79		

Appendix A.

Form 4. Daily tally of count data by stratum for moose population estimation survey.

Survey Area Middle Noatak River

Game Management Unit(s) 23 Subunit(s) NA

Stratum Medium Stratum Area 325 mi^2 Total SUs In Stratum 30

SU no.	Date searched	No. moose in SU	SU area (mi^2)	Search effort (min/mi^2)	SU density ($moose/mi^2$)	No. moose in SCF searches Std.	Int.
8	3/19/85	60	11.4	4.0	5.26		
16	3/19/85	48	11.6	4.7	4.14		
19	3/17/85	33	13.5	4.7	2.44		
30	3/19/85	18	14.2	2.7	1.27		
33	3/19/85	22	14.9	2.8	1.48		

Appendix A.

Form 4. Daily tally of count data by stratum for moose population estimation survey.

Survey Area Middle Noatak River

Game Management Unit(s) 23 Subunit(s) NA

Stratum Low Stratum Area 952 mi^2 Total SUs In Stratum 78

SU no.	Date searched	No. moose in SU	SU area (mi^2)	Search effort (min/mi^2)	SU density ($moose/mi^2$)	No. moose in SCF searches Std.	No. moose in SCF searches Int.
3	3/19/85	0	10.2	2.8	0		
4	3/19/85	2	11.9	2.9	0.19		
26	3/19/85	0	10.9	1.7	0		
39	3/19/85	6	12.3	4.0	0.49		
50	3/19/85	7	13.3	5.0	0.53		

Appendix B.

Form 8. Summary information of sample unit (SU) sex and age class data.

Survey Area Middle Noatak River Date March 15-19, 1985

Game Management Unit(s) 23 Subunit(s) NA

Stratum High Stratum Area 277 mi^2 Total SUs in stratum 21

SCF_o "1" $V(SCF_o)$ "0" v_s "0" SCF_c "1"

SU no.	SU area (mi^2)	Bulls: No. of yearlings	Bulls: No. of adults	Total no.	No. of ~~cows~~ "adults"	No. of calves
1	12.3			45	37	8
2	11.4			34	29	5
18	12.3			41	36	5
20	14.0			136	109	27
94	13.3			33	26	7
118	15.1			51	45	6
139	13.2			21	19	2
5	11.6			44	34	10
				405	335	70

Appendix B.

Form 8. Summary information of sample unit (SU) sex and age class data.

Survey Area Middle Noatak River Date March 15-17, 1985

Game Management Unit(s) 23 Subunit(s) NA

Stratum Medium Stratum Area 325 mi^2 Total SUs in stratum 30

SCF_o "1" $V(SCF_o)$ "0" v_s "0" SCF_c "1"

SU no.	SU area (mi^2)	Bulls: No. of yearlings	Bulls: No. of adults	Total no.	No. of ~~cows~~ "adults"	No. of calves
8	11.4			60	46	14
16	11.6			48	37	11
19	13.5			33	28	5
30	14.2			18	15	3
33	14.9			22	17	5
				181	143	38

Appendix B.

Form 8. Summary information of sample unit (SU) sex and age class data.

Survey Area Middle Noatak River Date March 15-19, 1985

Game Management Unit(s) 23 Subunit(s) NA

Stratum Low Stratum Area 952 mi^2 Total SUs in stratum 78

SCF_o "1" $V(SCF_o)$ "0" ν_s "0" SCF_c "1"

SU no.	SU area (mi^2)	Bulls: No. of yearlings	Bulls: No. of adults	Total no.	No. of ~~cows~~ adults	No. of calves
3	10.2			0	0	0
4	11.9			2	2	0
26	10.9			0	0	0
39	12.3			6	5	1
50	13.3			7	6	1
				15	13	2
				+405	+335	+70
				+181	+143	+38
				601 total moose	491 adults	110 calves

18% calves in population

.22 calf/adult ratio

Appendix C.

Form 5. Moose population estimation survey--data summary.

Survey Area Middle Noatak River

Game Management Unit(s) 23 Subunit(s) NA

Date of Survey March 15 – 19, 1985 Survey Supervisor D. James

DATA SUMMARY FOR STRATUM

STRATUM POPULATION ESTIMATE	Low stratum	Medium stratum	High stratum
A_i = area (mi^2)	952	325	277
N_i = total SUs	78	30	21
n_i = no. SUs searched	5	5	8
d_i = obs. density	0.26	2.76	3.92
$\hat{T}_i$ = est. no. moose (uncorrected)	244	897	1,087
$V(\hat{T}_i)$ = variance of $\hat{T}_i$	11,348	48,643	41,475

DATA SUMMARY FOR SURVEY AREA

SURVEY AREA INFORMATION

Total area (mi^2) = 2,114

Total No. SUs = 172

Total No. SUs searched = 18

OBSERVED POPULATION ESTIMATE

$\hat{T}_o$ = obs. pop. est. (uncorrected) = 2,227

$V(\hat{T}_o)$ = variance obs. est. = 101,466

ν_o = degrees of freedom = 12

SCF_o = obs. sight. correction factor = not done

$V(SCF_o)$ = variance of SCF_o = ↓

n_o = no. SCF plots searched = ↓

ν_s = degrees freedom of SCF_o = ↓

EXPANDED POPULATION ESTIMATE

SCF_c = sight. correction constant = not done

$\hat{T}_e$ = expand. pop. est. (T_o X SCF_c) = ↓

$V(\hat{T}_e)$ = variance of $\hat{T}_e$ = ↓

ν_e = degrees of freedom = ↓

TOTAL POPULATION ESTIMATE

$\hat{T}$ = total pop. est. ($\hat{T}_e$ x SCF_c) = 2,227

d = density = 1.05

90% CI as % of $\hat{T}$ = 26

CL_u = upper confidence limit = 2,795

CL_ℓ = lower confidence limit = 1,660

SCF = sight. correct. factor (SCF_o X SCF_c) = NA with SU #5 shifted to High density stratum

1.00 ***
0.000000 ***
0. ***

277.0 ***
21. ***

1 45.0 ***
12.3 ***
2 34.0 ***
11.4 ***
18 41.0 ***
12.3 ***
20 136.0 ***
14.0 ***
94 33.0 ***
13.3 ***
118 51.0 ***
15.1 ***
139 21.0 ***
13.2 ***
44.0 ***
5 11.6 ***

8. ***
3.924418605 ***
1087.1 ***
41474.622 ***

325.0 ***
30. ***

8 60.0 ***
11.4 ***
16 48.0 ***
11.6 ***
19 33.0 ***
13.5 ***
30 18.0 ***
14.2 ***
33 22.0 ***
14.9 ***

5. ***
2.759146341 ***
896.7 ***
46643.180 ***

952.0 ***
78. ***

3 0.0 ***
10.2 ***
4 2.0 ***
11.9 ***
26 0.0 ***
10.9 ***
39 6.0 ***
12.3 ***
50 7.0 ***
13.3 ***

5. ***
0.255972696 ***
243.7 ***
11348.424 ***

2227.5 ***
101466.23 ***
12. ***

2227. ***
101466. ***
12. ***

[illegible] ***
2227 ***
90% confidence 101466. ***

1,660-2795 more in Middle Nantahala River survey area

90.
1660 ***
2795 ***
25.56 ***

95.
1533. ***
2922. ***
31.2 ***

Appendix D.

HP-97 Program for population estimate (altered).

est. # calves

0. ***
0. ***

1.00 ***
0.000000 ***
0. ***

277.0 ***
21. ***

6.0 ***
12.3 ***
5.0 ***
11.4 ***
5.0 ***
12.3 ***
27.0 ***
14.0 ***
7.0 ***
26.0 ***
6.0 ***
15.1 ***
2.0 ***
13.2 ***
10.0 ***
11.6 ***

8. ***
0.603968939 ***
167.3 ***
1955.078 ***

325.0 ***
30. ***

14.0 ***
11.4 ***
11.0 ***
11.6 ***
5.0 ***
13.5 ***
3.0 ***
14.2 ***
5.0 ***
14.9 ***

est. calves

5. ***
0.579268293 ***
186.3 ***
3105.768 ***

952.0 ***
78. ***

0.0 ***
10.2 ***
0.0 ***
11.9 ***
0.0 ***
10.9 ***
1.0 ***
12.3 ***
1.0 ***
13.3 ***

5. ***
0.034129693 ***
32.5 ***
327.089 ***

388.1 ***
5387.93 ***
10. ***

388. ***
5388. ***
10. ***

1.00 ***
388. ***
5388. ***

90.
255. ***
521. ***
34.3 ***

95.
225. ***
552. ***
42.1 ***

Appendix E.

HP-97 Program for calf estimation.

```
Calf ratio

8.   ***
37.   ***
12.3 ***

5.   ***
29.   ***
11.4 ***

5.   ***
36.   ***
12.3 ***

27.   ***
103.   ***
14.0 ***

7.   ***
26.   ***
13.3 ***

6.   ***
45.   ***
15.1 ***

2.   ***
19.   ***
13.2 ***

10.   ***
34.   ***
11.6 ***

area ——> 277.0 ***
# SU's ——> 21. ***
dens.(num) 0.678294574 ***
est # num (num) ——> 187.9 ***
2039.439 ***
3.246124031 ***
899.2 ***
25589.151 ***
6923.016 ***
```

```
Calf ratio

14.   ***
46.   ***
11.4 ***

11.   ***
37.   ***
11.6 ***

5.   ***
28.   ***
13.5 ***

3.   ***
15.   ***
14.2 ***

5.   ***
17.   ***
14.9 ***

325.0 ***
30. ***
0.579268293 ***
188.3 ***
3105.768 ***
2.179878049 ***
708.5 ***
27631.170 ***
8953.121 ***

0.   ***
0.   ***
10.2 ***

0.   ***
2.   ***
11.9 ***

0.   ***
0.   ***
10.9 ***

1.   ***
5.   ***
12.3 ***

1.   ***
6.   ***
13.3 ***
```

```
Calf ratio

952.0 ***
78. ***
0.034129693 ***
32.5 ***
327.089 ***
0.221843003 ***
211.2 ***
7976.815 ***
1522.260 ***

calves ——> 409. ***
5472. ***
10. ***
adults ——> 1619. ***
61157. ***
12. ***
ΣCov. ——> 17398. ***

est. ratio ——> 0.224672441 ***
0.000224750 ***
10. ***

CI l
CI u   90.%
0.197497980 ***
0.251846902 ***
12.1 ***
```

Appendix F.

HP-97 Program for calf/adult ratio estimation.

unaltered strata, as is

1.00 ***
0.000000 ***
1. ***

265.0 ***
20. ***

45.0 ***
12.0 ***
34.0 ***
11.0 ***
41.0 ***
12.0 ***
136.0 ***
14.0 ***
33.0 ***
13.0 ***
51.0 ***
15.0 ***
21.0 ***
13.0 ***

7. ***
4.011111111 ***
1062.9 ***
52325.701 ***

325.0 ***
30. ***

60.0 ***
11.0 ***
48.0 ***
12.0 ***
33.0 ***
14.0 ***
18.0 ***
14.0 ***
22.0 ***
15.0 ***

5. ***
2.742424242 ***
891.3 ***
48722.923 ***

363.0 ***
79. ***

0.0 ***
10.0 ***
2.0 ***
12.0 ***
44.0 ***
12.0 ***
0.0 ***
11.0 ***
6.0 ***
12.0 ***
7.0 ***
13.0 ***

6. ***
0.842857143 ***
811.7 ***
294576.748 ***

2765.9 ***
395625.37 ***
9. ***

2766. ***
395625. ***
1. ***

1.00 ***
2766. ***
395625. ***

50.%
-1206. ***
6737. ***
143.6 ***

95.%
-5226. ***
10758. ***
288.9 ***

Appendix G.

HP-97 Program for population estimate(unaltered).

Appendix H. High, medium, low, and "O" density strata in the Middle Noatak River Moose Survey Area, March 15-16, 1985.

High

1
2
17
18
20
21
27
29
38
63
72
78
84
94
104
114
118
119
139
140

Medium

7
8
16
19
30
31
33
34
37
41
42
54
55
69
85
90
93
108
112
115
120
125
134
146
149
152
156
170
171
173

Low

3
4
5 [a]
6
9
14
15
22
23
24
25
26
28
32
35
36
39
40
43
44
45
46
49
50
51
52
53
56
57
60
61
62
64
65
68
70
71
73
74
75
76
77
83
91
92
95
98
99
100
102
105
109
110
111
113
117
121
122
124
126
127
133
135
136
137
138
143
150
151
154
155
158
162
164
165
166
167
168
169

"O"

10
11
12
13
47
48
58
59
66
67
80
81
82
86
87
88
89
96
97
101
103
106
107
116
123
128
129
130
131
132
141
142
144
145
147
148
153
157
159
160
161
163
172

a #5 was subsequently transferred to the high stratum