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SEWARD PENINSULA MOOSE

POPULATION IDENTITY STUDY

By
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(Includes limited data through September 1982)

SUMMARY

In April 1981, 40 adult moose (22 cows, 18 bulls) were instrumented with radio collars on 2 drainages in the central Seward Peninsula (Game Management Unit 22D). In April 1982, 9 bulls and 1 cow were instrumented to replace radios that were lost during the year from equipment malfunctions, death of the animal, or from moose that slipped their collars. Blood samples were taken from both years and analyzed for hematological and serological values described by Franzmann et al. (1976). Packed cell volume (PCV), hemoglobin (Hb), total serum protein (TSP), calcium (Ca), and phosphorus (P) were compared with 17 other populations of Alaskan moose. Samples from 1981 indicated moose were in "average" condition. Calcium ranked 5th, PCV and Hb ranked 6th, and P and TSP both ranked 14th. However, hematological values from the 1982 samples ranked 12th for PCV and Hb, indicating that moose were in poorer condition. Hair collected from 38 moose in April 1981 was analyzed for 15 trace elements (Franzmann et al. 1976). Franzmann and Schwartz (1983) reported 6 of these elements showed some relationship to condition. Three of 6 trace elements indicate Unit 22 moose are in "poor" condition, and 3 elements indicate "average" condition. Hematological and hair element data raise enough questions about condition of Unit 22 moose to warrant further investigation.

The reproductive success of each instrumented cow was monitored during 2 calving seasons. Preliminary indications are that most calf mortality occurs during the summer, and a calf has a high probability of living to 1 year of age if it survives through November. Mean yearling recruitment during 3 "reproductive seasons" was calculated to be 71 yrlgs/100 cows. Moose older than 4 years appear to have a higher reproductive success than 2- or 3-year-old moose.

Moose movements fell into 2 general categories, sedentary and highly migratory. Moose classified as sedentary moved an average of 8.2 km (5.1 mi) between observations and highly migratory moose moved an average of 17.3 km (10.8 mi) between observations. The maximum distance any moose traveled from the point of capture was 97 km (60 mi), and the mean distance moose moved from the point of capture was 44 km (27 mi). Seasonal fidelity to the same winter range was high. All but 3 moose returned to the drainage where they were captured, and 38% (12 moose) returned to within 1.6 km (1 mi) of where they were captured. Some moose may be dispersing to new areas because 3 animals did not return to their "parent" winter range.

Key words: *Alces alces*, moose, population identity, Seward Peninsula.

CONTENTS

BACKGROUND

Moose (Alces alces) were virtually absent from the Seward Peninsula (Game Management Unit 22) 30 years ago. An aerial survey conducted by the Department in spring 1960 revealed only 13 moose, all in the eastern portion of the peninsula. Aerial surveys in subsequent years documented a rapid increase in moose in the late 1960's and their expansion into all areas containing winter habitat. By the mid-1970's, population growth rate declined, and numbers stabilized in some areas. Unit 22 now supports a moose population in excess of 2,500 animals (Grauvogel 1981). Winter browse is limited primarily to narrow stands of willows (Salix spp.) along major drainages. Density of moose on the winter range is high, especially in the central portion of the Seward Peninsula (Subunits 22B and 22D). These areas also supported an exceptionally dense population of snowshoe hares (Lepus americanus) from 1978 through winter 1980. High hare and moose densities may have adversely affected the quality and/or quantity of the winter range because of overbrowsing. Range factors in Unit 22 are at present poorly understood. However, aerial surveys in the spring have shown that moose calf survival to 10 months of age has declined from a high of 30% in the early 1970's to a recent 5-year average of 20%. This decline may have several causes, but I believe 1 contributing factor is increased competition as moose numbers approach range carrying capacity. To effectively manage the population and achieve the desired density of moose for existing range conditions, information is needed on the fidelity of moose to their wintering range, the size of annual home ranges, timing of seasonal movements, the extent of migration or immigration into new areas, and age-specific reproductive history.

Average annual harvests have increased from 56 moose in the late 1960's to 267 animals during the most recent 5-year period. Nearly one-half of the harvest was reported from Subunit 22D, an area traversed by a gravel road that provides easy access from Nome. Demand for moose by recreational and subsistence hunters living within Unit 22 is high, and the number of nonlocal hunters has steadily increased. Furthermore, mineral exploration has intensified in the area during the last 3 years, and major developments are likely to occur in the near future. Information on population identities and magnitude of seasonal movements is necessary to manage the resource for optimum sustained harvests, to effectively allocate harvest among user groups, and to avoid or mitigate problems associated with mineral development.

OBJECTIVES

To determine population identities and seasonal movement patterns of moose on the central Seward Peninsula.

STUDY AREA

Two drainages within Subunit 22D were selected for moose collaring work. The Kuzitrin drainage encompasses all of the eastern portion of 22D, and the Agiapuk drainage is located near the western edge of the Subunit (Fig. 1). These 2 rivers form a drainage basin of approximately 12,395 km^2 (4,800 mi^2) ranging in elevation from sea level to 1,541 m (4,700 ft). The basin is bounded on the south and east by 2 geologically young mountain ranges, the Kigluaik and Bendeleben Mountains. Each contains precipitous slopes, numerous rocky outcrops, and relatively sparse vegetation, except at low elevations. The mountains on the northern side of the basin are lower in elevation (maximum height 941 m [2,870 ft]), and the relief is predominately rolling hills with gentle slopes. Both rivers terminate in Imuruk Basin, a lake whose waters flow into the Bering Sea 56 km (35 mi) to the west.

The vegetation of the region is primarily wet tundra at lower elevations, but it usually grades into dry tundra as the land slopes upward and has higher relief. Willows commonly grow along all rivers and into the headwaters of all tributaries. Along the lower portions of the major rivers, willows attain heights of 3-4½ m (10-15 ft), and the stands commonly extend as far as 400 m from either side of the main water course. Willows generally become less abundant upstream. Willows growing in the upper tributaries and alpine areas average 1-3 m in height, and growth is typically limited to a few meters on either side of streams. However, extensive stands of "shrub" willows occur on hillsides where sufficient moisture is present.

The absence of trees is a striking characteristic of the region. Spruce (*Picea* spp.) is found only in a few scattered locations in the extreme eastern portion of the Subunit. Aspen (*Populus tremuloides*) is present only in a few isolated stands along the major rivers. The lack of trees and the predominant tundra vegetation result in extensive open habitat.

METHODS

Forty adult moose (18 bulls and 22 cows) were captured on the Kuzitrin and Agiapuk drainages and fitted with visual and radio collars during 14-16 April 1981. Ten moose (9 bulls, 1 cow) were collared 27 April 1982 to replace radio collars that were lost during the year from equipment malfunctions, moose that died, or from moose that slipped their collars. Grauvogel (1982) described the capture methods, drug dosages, field procedures, and specifications of visual and radio collars. Up to 40 ml of blood was collected from the jugular vein in sterile evacuated containers, and the samples were analyzed for blood chemistry values as outlined by Franzmann et al. (1976). A tuft of hair was plucked from the right or left shoulder and sent to Cleveland Clinic Foundation, Cleveland, Ohio for analysis of trace elements (Franzmann et al. 1975).

Instrumented moose were located approximately once a month using fixed-wing aircraft. Depending on weather conditions, staff support, and aircraft availability, 1 of 3 types of aircraft was used: Piper PA-12, Cessna 206, or Cessna 185. When an instrumented animal was located, its position was plotted on U. S. Geological Survey maps having a scale of 1 inch to the mile (1:63,360). Group size and composition, activity (lying or standing), vegetation type (alpine willow, lowland willow, or tundra), and any unusual conditions were recorded on a separate data sheet. Upon returning from the field, the location of each moose was plotted on individual maps (scale 1:63,360). Data points were connected sequentially with straight lines, providing a pictorial history of the movements of each moose.

RESULTS AND DISCUSSION

Capture methods and equipment, body condition and size, and age of instrumented moose were presented by Grauvogel (1982), and these subjects will be reviewed again when the final completion report is published.

Blood Parameters

A number of investigators have used chemical analysis of blood to assess the physiological condition of animal populations (Rosen and Bischoff 1952; Kitts et al. 1956; McEwan 1968; Anderson et al. 1970; Franzmann 1971, 1972; LeResche et al. 1974; Pedersen and Pedersen 1975; Seal 1977; Bahnak et al. 1979; Franzmann et al. 1980). Franzmann et al. (1976) applied the technique to moose and established baseline values for comparing Alaskan moose populations using hematological and serological criteria.

Franzmann and Schwartz (1983) summarized the results of serological work on moose in Alaska from 1969 through 1981. Samples of moose blood from the Seward Peninsula were included in this study and were ranked with other Alaskan moose populations for comparison. However, raw values for individual moose and a discussion of the Seward Peninsula moose population were not included.

Samples from Unit 22 moose were analyzed for up to 23 different parameters; however, Franzmann and Schwartz (1983) found that packed cell volume (PCV), hemoglobin (Hb), total serum protein (TSP), calcium (Ca), and phosphorus (P) were the best 5 indicators of relative physical condition in moose populations. These parameters are less subject to variability from the stress and excitement of capture and have been shown to be consistent indicators of population condition when samples are taken in late winter/early spring. The 5 blood values obtained from each moose captured in Unit 22 are listed in Table 1. Franzmann and Schwartz (1983) reported PCV, Hb, TSP, Ca, and P values from 18 "populations" of Alaskan moose (Table 2, some samples were taken from the same moose population, but in different years) and then ranked these populations numerically in each of the 5 groups according to the blood parameter values (Table 3). Three populations were used as baseline indicators of condition: 1) The Copper River Delta moose population represented an expanding, highly productive population, 2) The Moose Research Center (MRC) population represented the lower end of the scale due to its high density, summer confinement, and low productivity, and 3) A 1977 sample from GMU 15 was taken from a group of postparturient cows in extremely poor condition.

GMU 22 moose blood parameters ranked 6th for PCV and Hb, and 5th for Ca (Table 3). However, the other 2 values were much lower; P ranked 14th and TSP ranked near the bottom at 16th. Using the baseline populations for comparison, GMU 22 moose would appear to be in average condition, although 2 of 5 values indicate possible stress. Franzmann and Schwartz (1983) pointed out that the blood values should not be strictly interpreted according to ranking; rather, the values provide an assessment of relative condition on a scale from good to poor. If values consistently fall on 1 end of the scale or the other, we can assume the moose population in question approaches this physical condition. Blood values are only one of many possible indicators of condition; therefore, additional work should be conducted to collaborate or refute any such findings.

Franzmann et al. (1976) concluded that PCV and Hb were the 2 blood values that best represented condition in Alaskan moose. Because these 2 parameters, as well as Ca, are in the middle-to-high range for GMU 22 moose, we can assume the population was in relatively good physical condition at the time of capture. However, because 2 of the 5 values are at the low end of the spectrum, this conclusion should be viewed with caution. Grauvogel (1980) pointed out that the density of GMU 22 moose on their winter range often exceeded 8 animals/km^2 (20/mi^2), and the winter range has supported such a density for a number of years. Some deterioration in winter range condition has occurred or is likely to occur in the future. Because blood data from GMU 22 were taken from only 1 point in time (1981), it would be advisable to take additional blood samples in the future.

A small contribution toward this end was made in spring 1982 when blood was collected from 5 bulls. Mean PCV and Hb values were 39% and 15 g/dl, respectively. When these values are compared with the Alaskan moose populations in Table 3, they rank 12th, or near the low extreme. Mean PCV from the 1982 sample (39%) was significantly lower ($\underline{P} < 0.02$, $\underline{t}$-test) than the 1981 value (43%). Mean Hb concentration from the 1982 sample (15 g/dl) was also significantly lower ($\underline{P} < 0.01$, $\underline{t}$-test) than the 1981 value (17 g/dl). The winter of 1981-82 on the Seward Peninsula was more severe than previous years because of a midwinter thaw and associated rain which resulted in a thick ice crust. Such conditions made it more difficult for moose to travel (animals were breaking through the snow crust and suffering abrasive injuries) and may have impeded efficient foraging. The differences in the mean values of the 1981 and 1982 samples are large enough to warrant further blood collection whenever practical.

Hair Mineral Analysis

Hair mineral element analysis has also been investigated as a possible indicator of condition in moose (Franzmann et al. 1976, 1977; Flynn et al. 1977; Franzmann 1977). The "state of the art" was best summarized by Franzmann and Schwartz (1983) who pointed out that mineral metabolism studies of moose have given the wildlife manager 1 more tool with which to understand the dynamics of populations. They analyzed hair for 16 trace elements and found that 6 elements (zinc [Zn], copper [Cu], cobalt [Co], iron [Fe], potassium [K], and lead [Pb]) showed some relationship to general physical condition. Their data indicated that moose in better condition showed a greater intake of these elements, but variability between populations was considerable. Hair analysis did not provide conclusive evidence about moose condition, but in combination with other procedures, it did provide supportive assessment information.

Hair collected in April 1981 from 38 moose in Unit 22 was analyzed for 15 trace elements (Table 4). Table 5 presents the values for Zn, Cu, Co, Fe, K, and Pb obtained by Franzmann and Schwartz (1983) for each condition class (see Franzmann et al. [1976] for explanation of classes), and I've included the values obtained from Unit 22 moose for comparison. Element values are ranked numerically only for condition classes 4 through 9. Body condition classes from Unit 22 moose ranged from a low of 5 to a high of 8 (Grauvogel 1982). Three of the elements from Unit 22 moose (Zn, Co, and K) fall below condition class 4. On the other hand, Fe falls between condition classes 8 and 9, and Cu and Pb rank between classes 5 and 6. Thus, if Franzmann's element table is used as a measure of condition, 3 of 6 elements indicate that Unit 22 moose are in poor condition and 3 elements indicate average condition.

Franzmann's work is still preliminary, and the baseline values established for each element by condition class may not be applicable to trace element values obtained from Unit 22 moose. Thus, any conclusions made from these comparisons may be erroneous. Still, the preliminary indication is that 3 of the 6 trace elements are below normal. This information, together with the hematological data presented above, raises enough questions about present and future condition of the Unit 22 moose population to warrant further work.

Reproductive History

Blood (1974) indicated that reproductive success of moose is related to nutritional status, and Pimlott (1959) and Markren (1969) indicated that physiological status of moose is in part a function of the existing range conditions and winter severity. Blood data from Seward Peninsula moose indicate that the population falls in the normal range with respect to general condition. Relative body size is also an indicator of physical condition (Franzmann et al. 1976). Grauvogel (1982) compared body measurements of 6 populations of Alaskan moose and found moose from the Seward Peninsula to be as large as any in the State.

Because moose from the study area have a relatively large body size and the population as a whole exhibits good physical condition, high productivity would be expected. To ascertain the reproductive success of Unit 22 moose, cows were monitored to determine initial calving success and survival of calves to 1 year of age. Grauvogel (1982) noted that fecundity in the GMU 22 population is high. When 22 cows were palpated in April 1981, all were found to be pregnant. Department of Fish and Game aerial surveys conducted in March and April have shown that recruitment to short yearlings has averaged about 20% of the total population (Grauvogel 1981). High yearling recruitment was also substantiated since 64% of the cows captured during instrumentation were accompanied by 1 or more short yearlings (Grauvogel 1982).

Table 6 presents the reproductive history of each collared moose from April 1981 through September 1982 (18 months). The status of each cow with respect to offspring is depicted sequentially by month. For example, if a cow produced 2 calves in June, lost 1 in August and the other in October, the sequence would be shown as 2 calves-1 calf-alone. Solid lines between months indicate no change in condition. Question marks were used during the calving period (May, Jun, Jul) if cows were not sighted, or when a known reduction in the number of offspring occurred, and the status of the cow during 1 or more intervening months was unknown. The values in the April 1981 and May 1982 columns indicate the number of yearlings produced by each cow. Total recruitment is the sum of yearlings produced in 1981 and 1982 plus the number of 1982 calves alive as of September.

Table 6 also provides a summary of the reproductive success of all cows instrumented in Unit 22. During May and June 1981, 22 cows produced 26 calves (118 calves/100 cows), but by November 1981, only 17 calves remained alive (77 calves/100 cows). One year later during May and June, 20 cows produced 24 calves (120 calves/100 cows); by September, only 14 calves remained alive (70 calves/100 cows). Calf mortality from May through September was 35% (9/22) in 1981 and 42% (10/24) in 1982. Actual mortality was probably higher because 6 cows (Nos. 1, 10, 15, 17, 18, 19) were never sighted with any offspring during the May-July period, but they probably gave birth and lost their calves between observations.

During the winter period between September 1981 and May 1982, only 2 of 17 calves died, resulting in the recruitment of 15 yearlings (68 yrlgs/100 cows). The previous year's recruitment (April 1981 at the time of capture) was 19 yearlings, or 87 yrlgs/100 cows. Because most calf mortality occurs prior to September, yearling recruitment for the 1982-83 season is expected to be 60-70 yrlgs/100 cows. Assuming this projection is correct, the mean yearling recruitment for the 3 reproductive seasons will be approximately 71 yrlgs/100 cows. This figure agrees with the November 1981 composition count of 70 calves/100 cows ($\underline{N}$ = 368) conducted by Department personnel (Grauvogel 1983). Because the collared moose sample is small and the associated 95% confidence interval for calf mortality is wide (16-54%), agreement of the 2 values may be coincidental. After obtaining additional reproductive data, I plan to compare the Kuzitrin and Agiapuk populations to determine whether calf mortality observations can be used to predict trends in yearling recruitment. Preliminary indications are that most calf mortality occurs during the summer, and that a calf has a high probability of living to 1 year of age if it survives through November.

Markgren (1969) reported cow moose from Sweden are most productive between 5 and 11 years of age. The reproductive success of Unit 22 cows appears to be positively correlated with age (Fig. 2). When the reproductive success of 2 and 3-year-old moose was compared with all older age classes combined (4-10+), the difference was significant ($T_1 = 2.55$, $\underline{P} < 0.01$, Mann-Whitney U-test). However, because of the small number of data points/age class, this hypothesis should be collaborated with additional work. If the assumption is valid, a significant increase in reproductive success would be expected when 3-year-old moose attain the age of 4 or 5. As more information becomes available, reproductive success by age class will be reexamined.

Movements

Moose from the Kuzitrin and Agiapuk drainages exhibited similar movement patterns. During April, moose remained on winter ranges near their points of capture. In fact, 1 week after capture, moose had moved an average distance of less than 1.6 km (1 mi). This finding was expected because snow depth changed little and temperatures averaged below freezing. In April, the broad river valleys probably provided the most favorable food and cover, and moving long distances at that time appeared to be of little advantage. By late May, however, temperatures were generally above freezing during the day, and the snow cover began to take on a patchy character except for steep north-facing slopes where it was usually continuous. Warming temperatures and the emergence of willows previously covered by snow appeared to stimulate moose to move from their winter ranges. Movements were predominantly north or east (300° through 90° magnetic) and usually toward higher terrain. Only 20% of the moose moved in a southerly direction, and only 11% moved south more than 16 km (10 mi). Fig. 3 illustrates dispersal routes from winter to summer ranges and the maximum distance traveled by each instrumented animal during an annual cycle. Typically, moose followed an erratic course when traveling to and from their winter ranges; however, for graphic purposes, the routes are shown as straight lines.

Six weeks after collaring, moose had moved an average distance of 30 km (19 mi), but there were some notable exceptions. Nine animals (38%) moved a straight-line distance of 47 km (29 mi) or more. Collared moose No. 11 (a 16-year-old cow) covered 97 km (60 mi), crossing at least 3 major river drainages to the northern tip of the Seward Peninsula where she gave birth to a new calf. Summaries of movement data collected for each cow and bull are shown in Tables 7 and 8, respectively. These data were compiled from 18 months of observations of all collared animals except Nos. 51-58. The latter were first instrumented in April 1982, and data only span a 5-month period.

Moose movements fell into 2 general categories: 1) sedentary animals that remained in the vicinity of their winter range and whose seasonal migration was predominately to a different elevation or vegetation type; and 2) highly migratory animals whose seasonal movements covered large distances. LeResche (1974) and Ballard and Taylor (1980) described similar movement patterns from other populations of Alaskan moose. A few animals exhibited movements intermediate between sedentary and highly migratory; however, I've classified moose as sedentary if they moved less than 21 km (13 mi) from their point of capture during an annual cycle, and highly migratory if they moved over 30 km (19 mi). Using this criterion, 13 of 40 moose were sedentary (33%), 3 were intermediate (7%), and 24 were highly migratory (60%). The mean distance moved between sightings was 8 km (5 mi) for sedentary moose, 11 km (7 mi) for intermediate moose, and 22 km (14 mi) for migratory moose. Both bulls and cows exhibited sedentary and migratory movement behavior and distances traveled were similar. The mean distance cows moved between observations was 17 km (11 mi) vs. 16 km (10 mi) for bulls. The maximum distance a moose moved during 1 year (from the point of capture) ranged from as little as 3 km (2 mi) to 97 km (60 mi), and the mean was 44 km (27 mi) for cows and 41 km (25 mi) for bulls.

Perhaps the most interesting finding to date has been the lack of fidelity to a particular drainage. After leaving their winter range, 45% of the moose collared in the Agiapuk drainage and 35% of those collared in the Kuzitrin drainage moved to other river systems. Eighteen collared moose (9 bulls and 9 cows, 45% of the sample) moved completely out of the Kuzitrin basin and crossed the continental divide to spend part of the year (usually summer and fall) in a different drainage basin. However, most moose eventually returned to their "parent" drainage to winter (see Fig. 3 for schematic of routes and Table 7 and 8 for distances traveled).

Overall, seasonal fidelity to the same winter range was high. Of the 32 moose for which there are movement data through 1 entire year, all but 3 returned to the winter range where they were captured. Twenty-two moose (69%) returned to within 6 km (4 mi) of their point of capture, and 12 (38%) of these returned to within 2 km (1 mi) (Tables 7, 8).

Collared moose Nos. 2, 10, and 15 (all cows) migrated from Subunit 22D to 22E during June 1981 and remained in that area through the winter of 1981-82. Pulliainen (1974) concluded moose often dispersed to new habitats where unutilized forage was available. Although Subunit 22E has a relatively low moose population density, summer forage does not appear to be significantly better in 22E than in 22D. Winter browse is certainly less abundant in Subunit 22E than in 22D, but it may be superior in nutrient value because it has not been as extensively browsed. It appears that moose on the Seward Peninsula may occasionally disperse, either permanently or temporarily, to take advantage of more favorable habitats. Movement data obtained during the remainder of this study should provide more information on home ranges and dispersal.

RECOMMENDATIONS

1. Movements of radio-collared moose should be monitored 1 more year to provide additional information on timing and magnitude of seasonal movements, adult mortality, fecundity, survival rates of calves, and varations in home range sizes.

2. If possible, blood samples should be collected from 5 or more moose during April or May 1983. Blood chemistry should be compared with earlier values to determine if Unit 22 moose are (becoming?) physiologically stressed during late winter.

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LITERATURE CITED

Anderson, A. E., D. E. Medin, and D. C. Bowden. 1970. Erythrocytes and leukocytes in a Colorado mule deer population. J. Wildl. Manage. 34(2):389-406.

Bahnak, B. R., J. C. Holland, L. J. Vernie, and J. J. Ozoga. 1979. Seasonal and nutritional effects on serum nitrogen constituents in white-tailed deer. J. Wildl. Manage. 43(2):454-460.

Ballard, W. B., and K. P. Taylor. 1980. Upper Susitna valley moose population study. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-9, W-17-10, and W-17-11, Job 1.20R. Juneau. 101pp.

Blood, D. A. 1974. Variation in reproduction and productivity of an enclosed herd of moose (Alces alces). Proc. Int. Congr. Game Bio. 11:59-66.

Flynn, A., A. W. Franzmann, P. D. Arneson, and J. L. Oldemeyer. 1977. Indications of copper deficiency in a subpopulation of Alaskan moose. J. Nutr. 107 (7):1182-1189.

Franzmann, A. W. 1971. Application of physiologic values to bighorn sheep management. Trans. 1st North Am. Wild Sheep Conf., Fort Collins, Colo. 1:87-91.

__________. 1972. Environmental sources of variation of bighorn sheep physiologic values. J. Wildl. Manage. 36(3):924-932.

__________. 1977. Condition assessment of Alaskan moose. Proc. North Am. Moose Conf. Workshop. 13:119-127.

Franzmann, A. W., and C. C. Schwartz. 1983. Moose productivity and physiology. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-9, W-17-10, W-17-11, W-21-1, and W-21-2, Job 1.21R. Juneau. 131pp.

Franzmann, A. W., A. Flynn, and P. D. Arneson. 1975. Levels of some mineral elements in Alaskan moose hair. J. Wildl. Manage. 39(2):374-378.

__________, __________, and __________. 1977. Alaskan moose hair element values and variability. Comp. Biochem. Physiol. 57(3):299-306.

Franzmann, A. W., R. E. LeResche, P. D. Arneson, and J. L. Davis. 1976. Moose productivity and physiology. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Final Rep. Proj. W-17-2, W-17-3, W-17-4, W-17-5, W-17-6, and W-17-7, Job 1.1R. Juneau. 87pp.

Franzmann, A. W., W. B. Ballard, C. C. Schwartz, and T. Spraker. 1980. Neonatal Alaskan moose calf physiologic and morphometric measurements and variability. Proc. North Am. Moose Conf. Workshop. 16:106-123.

Grauvogel, C. A. 1980. Seward Peninsula moose survey-inventory progress report. Pages 98-108 in R. A. Hinman, ed. Annual Report of Survey-Inventory Activities. Part II, Vol. XI. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-17-12, Job 2.0, 13.0, 1.0, and 22.0. Juneau. 122pp.

__________. 1981. Seward Peninsula moose survey-inventory progress report. Pages 159-166 in R. A. Hinman, ed. Annual Report of Survey-Inventory Activities. Part II, Vol. XII. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-19-1 and W-19-2, Job 3.0, 1.0, and 12.0. Juneau. 224pp.

__________. 1982. Seward Peninsula moose population identity study. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-21-2, Job 1.29R. 17pp.

__________. 1983. Seward Peninsula moose survey-inventory progress report. Pages 125-131 in J. A. Barnett, ed. Annual Report of Survey-Inventory Activities. Part III, Vol. XIII. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-1, Job 1.0. Juneau. 150pp.

Kitts, W. D., P. J. Bandy, A. J. Wood, and L. McT. Cowan. 1956. Effect of age and the plane of nutrition on the blood chemistry of the Colombian black-tailed deer (Odocoileus hemionus) - A. Packed-cell volume, sedimentation rate, and hemoglobin. Can. J. Zool. 34:477-484.

LeResche, R. E. 1974. Moose migrations in North America. Naturaliste Can. 101:393-415.

LeResche, R. E., U. S. Seal, P. D. Karns, and A. W. Franzmann. 1974. A review of blood chemistry of moose and other cervidae, with emphasis on nutritional assessment. Naturaliste Can. 101:263-290.

Markgren, G. 1969. Reproduction of moose in Sweden. Viltrevy 6(3):127-285.

McEwan, E. H. 1968. Hematological studies of barren-ground caribou. Can. J. Zool. 46(5):1031-1026.

Pedersen, R. J., and A. A. Pedersen. 1975. Blood chemistry and hematology of elk. J. Wildl. Manage. 39(3):617-620.

Pimlott, D. H. 1959. Reproduction and productivity of Newfoundland moose. J. Wildl. Manage. 23(4):381-401.

Pulliainen, E. 1974. Seasonal movements of moose in Europe. Naturaliste Can. 101:379-392.

Rosen, M. D., and A. L. Bischoff. 1952. The relation of hematology to condition of California deer. Trans. North Am. Wildl. Conf. 17:482-496.

Seal, U. S. 1977. Assessment of habitat condition by measurement of biochemical and endocrine indicators of the nutritional, reproductive, and disease status of free-ranging animal populations. Pages 305-329 in Proc. Natl. Symp. on Classification, Inventory, and Anal. of Fish and Wildl. Habitat. U.S. Fish and Wildl. Serv. Biol. Serv. Publ. 78/76. 604pp.

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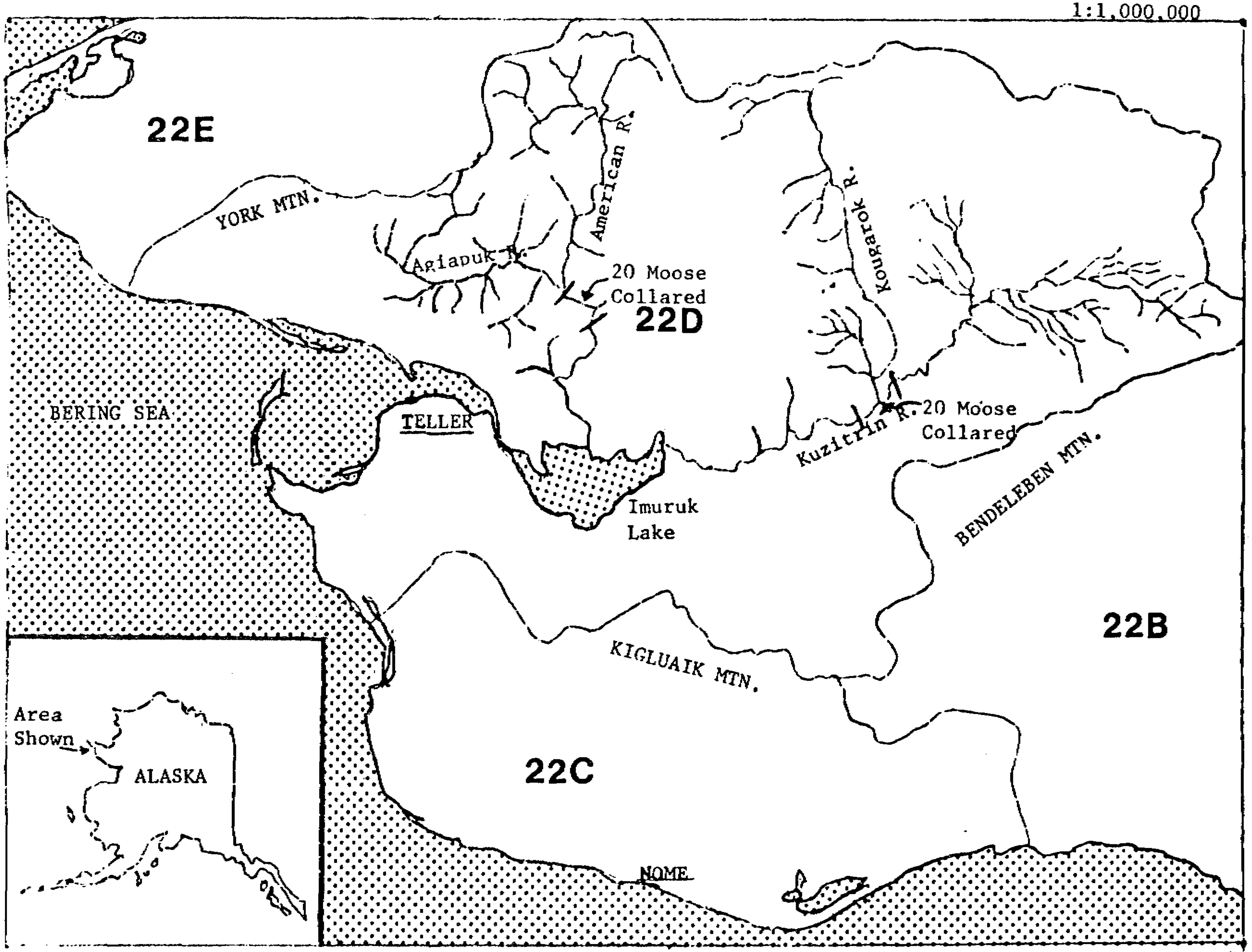

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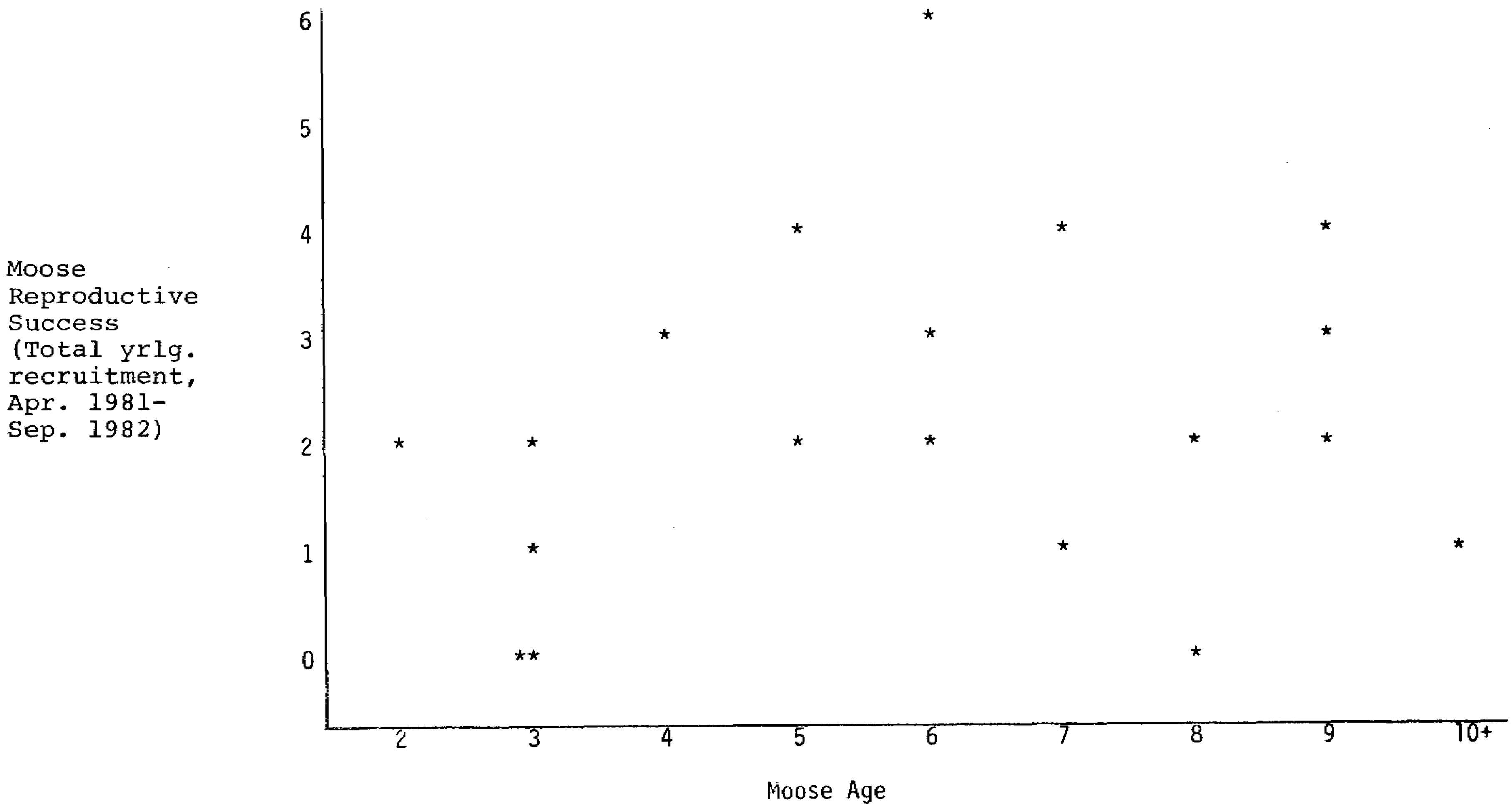
SCALE

Fig. 1. Seward Peninsula, showing Unit 22 study area.



*Each asterisk represents data from 1 moose.

Fig. 2. Reproductive success of Unit 22 moose with respect to age.

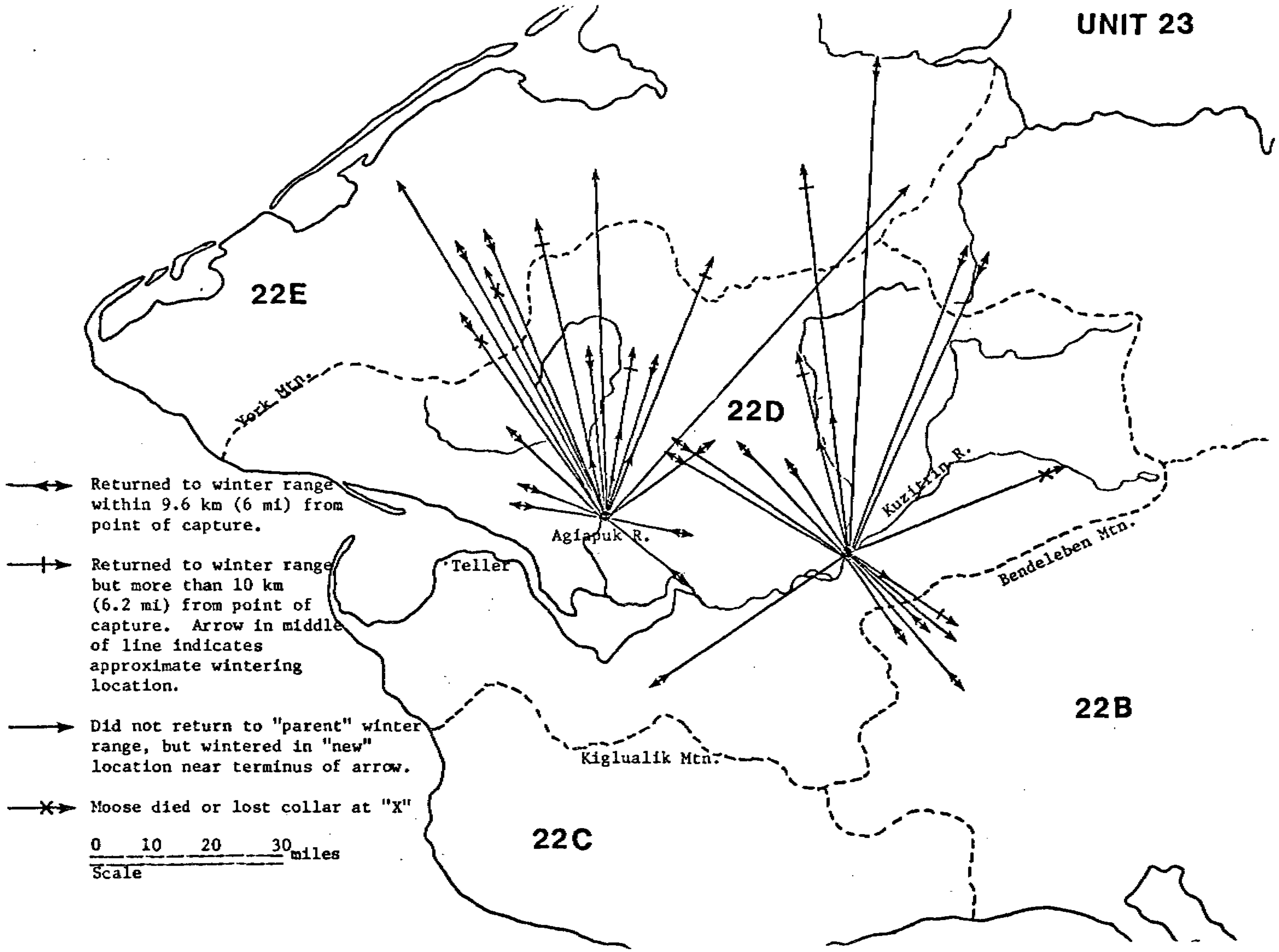


Fig. 3. Annual movements of Unit 22 moose from their winter range.

Table 1. Condition-related blood values for Unit 22 Moose during late winter 1981.

Visual Collar No.	Radio Serial No.	Sex	Age (yr)	PCV (%)	Hb (g/dl)	TSP (g/dl)	P (mg/dl)	CA (mg/dl)
1	8143	F	6	43.5	17.0	6.5	3.5	11.2
2	8126	F	9	45.0	18.6	6.2	4.3	10.4
3	8113	F	8	48.0	18.8	6.3	3.4	10.2
4	8130	F	7	39.5	15.0	6.3	2.4	11.2
5	8137	F	5	41.5	17.2	5.8	4.2	9.3
6	8115	F	6	36.5	17.0	6.0	3.9	11.6
7	8138	F	3	44.5	17.7	6.3	4.3	10.4
8	8104	F	3	50.0	18.2	6.7	4.5	12.1
9	8123	F	9	45.0	18.6	6.2	4.8	11.5
10	8128	F	4	38.5	16.0	6.2	3.0	11.7
11	8106	F	16	40.0	17.0	5.6	4.0	10.1
12	8124	F	7	48.0	18.3	5.9	3.7	10.7
13	8119	F	3	40.0	18.5	5.9	4.5	11.2
14	8112	F	14	44.0	17.2	5.9	3.1	11.0
15	8132	F	2	42.5	18.0	5.6	3.9	10.9
16	8110	F	5	38.0	16.8	6.0	4.3	10.1
17	8140	F	12	42.5	17.8	6.7	3.4	10.8
18	8136	F	3	34.0	17.0	6.1	5.0	9.7
19	8111	F	8	46.0	17.8	6.4	4.1	10.4
20	8118	F	6	39.5	14.6	6.5	4.0	10.9
22	8129	M	4	45.0	18.5	6.1	3.2	11.3
23	8117	M	7	50.0	18.0	6.9	5.8	11.2
24	8116	M	3	42.0	16.8	6.0	5.4	10.9
25	8139	M	3	43.0	18.0	5.8	3.7	11.8
26	8142	M	11	43.5	17.0	7.5	3.9	12.7
27	8141	M	4	40.0	17.0	5.9	4.7	10.0
29	8135	F	9	37.0	16.0	5.4	2.6	10.8
30	8109	M	Unk	44.0	16.8	6.2	3.4	12.0
31	8131	M	5	46.5	17.2	6.9	3.4	11.5
32	8122	M	3	40.0	12.6	6.0	4.5	10.6
35	8121	M	2	47.0	19.5	5.8	4.4	10.8
36	8133	M	6	45.0	18.5	6.1	3.4	10.5
37	8125	M	3	39.0	16.8	6.0	3.1	10.1
38	8108	M	4	41.0	17.0	5.8	3.9	10.9
40	8120	M	8	45.0	17.8	6.6	4.2	10.5
42	8114	F	Unk	46.5	18.8	6.9	3.9	12.3
$\bar{X}$ (all ages combined [N = 36])				42.7	17.3	6.2	3.9	10.9
± SD				3.9	1.3	0.4	0.7	.7
$\bar{X}$ (37+ mo. [N = 25])				42.6	17.3	6.3	3.9	10.8
± SD				4.0	1.1	0.5	0.7	0.9

Table 2. Condition-related blood parameters from 18 Alaskan moose populations during late winter/early spring season.[a]

Population	PCV (%)			HB (g/dl)			TSP (g/dl)			P (mg/dl)			Ca (mg/dl)		
	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N
Moose Res. Center (inside)	41.0	5.0	37	16.8	2.1	38	6.9	0.6	42	4.3	1.6	42	9.8	1.3	42
Moose Res. Center (outside)	41.8	5.2	38	16.5	1.9	39	6.8	0.6	52	3.8	1.1	52	10.0	0.7	52
GMU 1,[b] 1978	36.6	6.1	14	14.2	2.3	14	6.4	0.4	14	5.0	0.9	14	9.8	0.5	14
GMU 5, 1978	40.4	3.4	36	16.6	1.4	36	7.5	0.3	35	3.7	1.0	35	11.0	0.5	35
GMU 6, 1974	53.5	3.8	32	19.9	0.3	32	7.3	0.5	30	5.3	0.6	30	10.5	0.7	30
GMU 9, 1977	39.0	5.4	56	16.4	1.3	54	7.8	0.4	57	4.4	0.6	57	10.8	0.4	57
GMU 13, 1975	49.2	3.8	55	19.7	0.7	55	7.4	0.4	53	5.6	0.9	53	10.8	0.8	53
GMU 13, 1977							7.2	0.5	29	4.4	0.9	29	11.4	0.8	29
GMU 13, 1979	40.9	3.6	10	16.8	1.6	10	5.6	0.6	12	4.8	0.8	12	9.4	1.0	12
GMU 13, 1980	43.0	5.2	23	17.8	1.2	23	6.8	0.5	27	5.1	1.3	27	10.2	0.5	27
GMU 13, 1981	43.8	4.3	9	17.8	1.7	9	6.7	0.5	7	5.2	1.2	7	10.5	0.6	7
GMU 14, 1974	35.8	10.2	21	13.5	3.0	20	6.8	0.4	30	4.7	1.3	30	10.3	0.7	30
GMU 15, 1970							6.7	0.5	24	4.4	0.9	24	11.1	0.6	24
GMU 15, 1971							6.6	0.4	40	3.5	0.9	40	10.2	0.4	40
GMU 15, 1975	46.4	3.0	25	18.9	1.3	25	6.9	0.7	24	4.8	1.1	24	9.9	0.9	24
GMU 15, 1977	36.5	4.4	12	13.2	2.3	12	6.2	0.3	13	3.9	1.4	13	10.5	1.1	13
GMU 20, 1975							6.9	0.5	12	4.7	1.1	19	8.9	0.6	12
GMU 22, 1981	42.6	4.0	25	17.3	1.1	25	6.3	0.5	25	3.9	0.7	25	10.8	0.9	26
All pop. combined	43.6	6.9	406	17.3	2.6	406	6.9	0.6	544	4.6	1.3	544	10.4	1.0	544

[a] After Franzmann and Schwartz (1983).
[b] GMU = Game Management Unit.

Table 3. Rank of Alaskan moose populations based on condition-related blood parameters.[a]

Rank	PCV (%)	Hb (g/dl)	TSP (g/dl)	P (mg/dl)	Ca (mg/dl)
1	GMU 6[b] (1974)[c]	GMU 6 (1974)	GMU 13 (1975)	GMU 13 (1975)	GMU 13 (1977)
2	GMU 13 (1975)	GMU 13 (1975)	GMU 5 (1978)	GMU 6 (1974)	GMU 15 (1970)
3	GMU 15 (1975)	GMU 15 (1975)	GMU 13 (1975)	GMU 13 (1981)	GMU 5 (1978)
4	GMU 13 (1981)[d]	GMU 13 (1981)	GMU 6 (1974)	GMU 13 (1980)	GMU 13 (1975)
5	GMU 13 (1980)	GMU 13 (1980)	GMU 13 (1977)	GMU 1 (1978)	GMU 22 (1981)[e]
6	GMU 22 (1981)[e]	GMU 22 (1981)[e]	GMU 15 (1975)	GMU 15 (1975)	GMU 9 (1977)
7	MRC (outside)	GMU 13 (1979)	MRC (inside)	GMU 13 (1979)	GMU 6 (1974)
8	MRC (inside)	MRC (inside)	GMU 20 (1975)	GMU 20 (1975)	GMU 13 (1981)
9	GMU 13 (1979)	GMU 5 (1978)	MRC (inside)	GMU 14 (1974)	GMU 15 (1977)
10	GMU 5 (1978)	MRC (outside)	GMU 13 (1980)	GMU 9 (1977)	GMU 14 (1974)
11	GMU 9 (1977)	GMU 9 (1977)	GMU 14 (1974)	GMU 15 (1970)	GMU 15 (1971)
12	GMU 1 (1978)	GMU 1 (1978)	GMU 13 (1981)	GMU 13 (1977)	GMU 13 (1980)
13	GMU 15 (1977)	GMU 14 (1974)	GMU 15 (1970)	MRC (inside)	MRC (outside)
14	GMU 14 (1974)	GMU 15 (1977)	GMU 15 (1971)	GMU 22 (1981)[e]	GMU 15 (1975)
15			GMU 1 (1978)	GMU 15 (1977)	MRC (inside)
16			GMU 22 (1981)[e]	MRC (outside)	GMU 1 (1978)
17			GMU 15 (1977)	GMU 5 (1978)	GMU 13 (1979)
18			GMU 13 (1978)	GMU 15 (1971)	GMU 20 (1975)

[a] Table per Franzmann and Schwartz (1983).
[b] GMU = Game Management Unit.
[c] Year of collection.
[d] Double line represents combined populations' mean value.
[e] Shows Unit 22 ranking with other Alaskan populations.

Table 4. Mineral element levels (ppm) in hair from Unit 22 moose, April 1981.

Radio Serial No.	Zn	Cu	K	Co	Fe	Pb	Ca	Mg	Na	Cd	Mn	Cr	Mo	Se	Al
8104	75.1	3.2	583.0	0.4	63.1	7.6	308.0	57.0	808.0	1.3	1.3	0.3	0.4	1.8	2.6
8105	80.6	6.3	427.0	0.4	52.6	4.3	281.0	68.0	593.0	1.4	1.6	0.3	0.4	1.3	1.8
8106	47.5	2.9	509.0	0.4	73.5	8.8	316.0	71.0	962.0	1.5	1.2	0.6	0.6	1.2	1.6
8107	59.6	7.2	368.0	0.4	74.3	7.2	408.0	60.5	671.0	0.2	1.2	0.4	0.6	1.6	4.4
8108	46.3	8.5	477.0	0.6	50.8	2.0	272.0	67.0	715.5	0.8	2.0	0.4	0.4	1.2	2.8
8109	83.2	8.6	762.0	0.6	56.5	2.4	463.0	42.0	762.0	0.6	2.3	0.3	0.8	1.2	1.2
8110	78.8	5.5	580.5	0.5	61.2	3.3	429.0	78.5	639.0	0.3	0.6	0.8	0.7	0.8	1.8
8111	92.7	7.3	440.5	0.6	39.9	4.9	381.5	48.0	792.5	0.8	2.0	0.3	0.6	1.3	1.7
8112	72.2	7.8	609.5	0.5	60.8	4.2	183.0	56.0	347.5	0.6	1.3	0.6	1.2	1.9	1.6
8113	64.6	8.2	438.0	0.3	53.3	7.2	250.0	80.0	738.5	0.6	1.2	0.3	0.5	0.2	1.3
8114	68.3	2.4	704.5	0.5	52.4	9.6	365.5	53.5	1029.5	0.4	0.3	0.8	0.4	1.6	1.9
8115	62.2	6.9	398.5	0.7	60.9	8.8	430.5	63.0	726.0	0.5	1.0	0.2	0.4	0.4	1.4
8116	80.6	11.3	482.0	0.3	73.6	2.3	291.5	49.5	465.5	0.2	2.0	0.9	0.4	1.3	6.2
8117	73.8	3.9	468.0	0.3	32.5	3.9	249.5	59.0	611.0	0.6	1.0	0.6	1.0	1.8	1.2
8118	76.3	9.4	465.0	0.3	78.4	4.3	346.5	58.5	526.5	0.3	1.0	0.6	0.5	1.6	1.6
8119	82.2	2.3	603.0	0.4	62.5	4.0	364.5	74.5	1016.0	0.7	1.1	0.6	0.2	1.2	4.8
8120	83.6	5.8	443.6	0.4	48.5	7.6	327.5	60.5	443.5	0.8	1.2	.5	0.8	0.8	2.6
8121	90.9	3.5	783.5	0.3	65.2	1.1	287.5	68.0	548.5	0.8	1.6	0.6	0.8	0.6	1.4
8122	57.3	5.3	439.5	0.8	73.0	3.5	416.5	63.0	1026.0	0.6	1.3	0.7	0.6	1.0	1.6
8123	68.0	5.0	482.5	0.6	107.9	2.6	429.5	42.0	692.0	0.6	1.2	1.2	0.4	0.4	1.3
8124	47.9	5.6	429.0	0.2	80.7	9.3	399.0	59.0	684.5	0.6	2.3	0.3	0.4	2.8	1.8
8125	48.1	6.9	652.0	0.2	69.3	4.0	439.5	68.0	711.5	0.6	2.0	0.8	0.4	2.2	1.6
8126	96.7	10.0	568.0	0.2	96.7	3.3	502.0	36.0	612.0	0.6	2.6	0.4	1.0	2.6	2.0
8127	21.3	3.8	537.0	0.2	48.3	3.3	372.0	93.5	908.0	0.6	2.2	0.8	1.2	2.2	2.2
8128	93.8	8.6	489.0	0.1	34.8	1.4	268.5	73.0	537.5	0.3	2.0	0.9	0.6	1.6	5.8
8129	68.5	7.5	392.0	0.3	83.2	8.6	329.5	92.0	451.0	1.0	2.1	0.6	0.8	1.6	5.3
8130	54.0	7.3	421.0	0.3	90.9	4.5	262.5	83.0	596.0	0.8	0.8	0.8	0.8	1.8	3.5
8131	61.7	2.2	360.0	0.3	46.6	2.8	306.5	87.5	1008.5	1.2	1.4	0.6	1.2	2.0	1.9
8132	30.6	6.6	602.5	0.2	55.4	7.5	314.5	46.0	949.0	0.6	1.3	0.5	1.2	2.3	2.2
8133	83.4	3.8	490.5	0.3	46.6	10.5	338.0	55.5	562.0	0.2	1.5	1.0	0.6	0.5	1.6
8134	72.6	8.0	400.0	0.3	74.8	7.2	308.5	69.0	581.0	0.8	2.2	0.6	1.2	0.4	2.8
8135	68.9	7.5	473.5	0.3	81.5	7.3	275.0	82.0	508.5	0.2	3.0	0.2	0.8	0.6	2.5
8136	39.6	9.6	480.5	0.2	73.2	3.8	311.0	61.5	396.5	0.2	2.8	0.3	0.8	0.2	1.5
8137	51.5	10.1	475.0	0.3	70.1	8.2	393.5	46.5	1002.5	0.4	2.6	0.8	1.2	1.8	1.6
8138	65.4	14.3	347.5	0.3	49.7	8.8	262.0	53.5	445.5	0.5	1.8	0.5	1.0	1.3	3.3
8139	63.3	11.2	458.0	0.2	53.8	2.3	367.5	45.5	512.5	0.5	1.3	0.5	0.6	0.6	1.5
8140	68.2	9.6	726.5	0.3	57.4	3.0	357.5	90.0	1163.5	0.6	2.0	0.3	1.2	1.6	2.4
8141	65.4	8.0	538.0	0.4	63.2	4.5	293.0	72.0	926.0	0.3	1.1	0.8	0.8	1.1	2.1
Mean	67.0	6.9	508.0	0.37	64.0	5.3	340	64.0	707.0	0.62	1.62	0.57	0.72	1.33	2.38
±SD	17.2	2.8	110.0	0.16	17.0	2.7	70	15.0	228.0	0.33	0.63	0.24	0.30	0.67	1.30

Table 5. Comparison of Unit 22 moose hair mineral element levels with mineral element levels (ppm) in Alaska moose hair by condition class.[a]

Condition class	Zinc			Copper			Cobalt			Iron			Potassium			Lead		
	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N
4	77	19	14	5.3	2.6	14	0.8	0.7	14	48	12	14	618	373	14	1.7	2.4	14
5	82	22	79	4.8	3.1	79	0.7	0.6	79	52	18	79	685	359	79	4.3	3.6	79
6	82	23	215	7.1	5.1	215	0.8	0.9	215	50	18	215	884	636	215	5.9	5.5	215
7	83	24	235	8.0	4.2	235	1.1	1.0	235	53	20	235	1079	740	235	6.4	5.2	235
8	84	24	109	10.6	4.4	109	1.2	1.0	109	55	23	109	1235	734	109	6.8	5.3	109
9	94	25	12	10.4	3.9	12	1.3	1.0	12	66	46	12	1157	1063	12	5.5	4.6	12
Unit 22	67	17.2	38	6.9	2.8	38	.37	.16	38	63.6	17	38	508	110	38	5.3	2.7	38
	Ranks below class 4			Ranks between classes 5 & 6			Ranks below class 4			Ranks between classes 8 & 9			Ranks below class 4			Ranks between classes 5 & 6		

[a] Condition class values follow Franzmann and Schwartz (1983).

Table 6. Reproductive history of collared moose, April 1981-September 1982.

Collar No.	Age (yr)	1981 Apr	May	Jun	Jul	Aug	Sep	Oct	Nov[a]	Dec	1982 Apr	May	Jun	Jul	Aug	Sep[b]	Total recruit.[c]
1	6	2 yrlg 4/14		alone 6/9					0			0 5/7	1 calf 6/16			1	3
2	9	2 yrlg 4/14		2 calves 6/9	?[d]	?	1 calf 9/17		1			1 yrlg 5/7	2 calves 6/15	cow died 6/24		0	3
3	8	alone 4/14		2 calves 6/9			?	?	1 calf 11/19			1 yrlg 5/7	1 calf 6/16			1	2
4	7	1 yrlg 4/14	2 calves 5/27	?	?	alone 8/6			0			0 5/7	2 calves 6/17	alone 6/30		0	1
5	5	2 yrlg 4/14	1 calf 5/26						1			1 yrlg 5/7	2 calves 6/16	?	1 calf 8/5	1	4
6	6	2 yrlg 4/14	2 calves 5/27						2			2 yrlg 5/7	2 calves 6/17			2	6
7	3	alone 4/14	1 calf 6/3						1		alone 4/9	0 5/7				0	0
8	3	alone 4/14	1 calf 6/3			alone 9/16			0			0 5/7	1 calf 6/25			1	1

Table 6. Continued.

Collar No.	Age (yr)	1981 Apr	1981 May	1981 Jun	1981 Jul	1981 Aug	1981 Sep	1981 Oct	1981 Nov[a]	1981 Dec	1982 Apr	1982 May	1982 Jun	1982 Jul	1982 Aug	1982 Sep[b]	Total recruit.[c]
9	9	2 yrlg 4/14	1 calf 6/9						1			1 yrlg 5/7	1 calf 6/15			1	4
10	4	1 yrlg 4/14	alone 6/4						0			0 5/7	2 calves 6/4			2	3
11	16	alone 4/14					1 calf 9/17		alone 11/9			last seen 5/7	unk	unk	unk	unk	0
12	7	1 yrlg 4/14		2 calves 6/3					2			2 yrlg 5/7	2 calves 6/17		1 calf 8/3	1	4
13	3	1 yrlg 4/14	2 calves 5/27						1 calf 11/6			1 yrlg 5/7	alone 6/17			0	0
14	14	1 yrlg 4/14		2 calves 6/9					2			2 yrlg 5/7	2 calves 6/17	1 calf 7/18		1	4
15	2	1 yrlg 4/14		alone 6/3					0			0 5/7	1 calf 6/11			1	2
16	5	1 yrlg 4/14		1 yrlg 6/9	?	1 yrlg 8/6			alone 11/9			0 5/7	1 calf 6/30			1	2

Table 6. Continued.

Collar No.	Age (yr)	1981 Apr	1981 May	1981 Jun	1981 Jul	1981 Aug	1981 Sep	1981 Oct	1981 Nov[a]	1981 Dec	1982 Apr	1982 May	1982 Jun	1982 Jul	1982 Aug	1982 Sep[b]	Total recruit.[c]
17	12	alone 4/14		alone 6/9	?	?	1 sm calf 9/16		1			1 yrlg 5/7	yrlg	yrlg	yrlg	0	1
18	3	alone 4/14		?	?	?	alone 9/16		0			0 5/7					0
19	8	alone 4/14		?	?	alone 8/6						0 5/7	calf 6/30			alone	0
20	6	1 yrlg 4/14	2 calves 5/27	?	?	?	alone 9/16					0 5/7	2 calves 6/16	1 calf 7/1		1	2
29	9	alone 4/14	2 calves 5/27						2			2 yrlg 5/7	1 calf 6/17	adult died 7/18		0	2
42	unk	1 yrlg 4/14	2 calves 5/27	?	?	?	1 calf 9/16		1		lost radio 1/27	1 yrlg ?	unk			unk	unk
Totals		19 yrlg from 22 adults, 1980-81 season	26 calves from 22 adult cows						17 calves alive from a known 26			15 yrlg produced, 1981-82 season	24 calves from 20 adult cows			14 calves alive from a known 24	48 (34 yrlg and 14 calves from 3 reproductive seasons
Comp.		87 yrlg/100 cows	118 calves/100 cows						77 calves/100 cows			68 calves/100 cows	120 calves/100 cows			70 calves/100 cows	

[a] Number of 1981 calves alive at this date.
[b] Number of 1982 calves alive at this date.
[c] Includes number of yearlings produced + number of calves alive as of September 1982.
[d] ? = Cow not observed during this month.

Table 7. Unit 22 cow moose movement summary, April 1981-September 1982.

Visual Collar No.	No. of observ.	Mean distance traveled between sightings		Moose migrated out of "parent" drainage		Maximum distance traveled from point of capture		Moose returned to "parent" winter range		Closest distance moose returned to point of capture (winter range)	
		Km	Mi	Yes	No	Km	Mi	Yes	No	Km	Mi
1	12	5.0	3.1		No	29.1	18.1	Yes		2.3	1.4
2	10	11.9	7.4	Yes		39.6	24.6		No	30.7	19.1
3	10	9.7	6.0		No	17.7	11.0	Yes		.8	.5
4	11	7.7	4.8		No	13.7	8.5	Yes		1.0	.6
5	11	17.5	10.9		No	50.5	31.4	Yes		9.0	5.6
6	11	13.8	8.6		No	25.1	15.6	Yes		2.6	1.6
7	11	25.1	15.6	Yes		70.0	43.5	Yes		1.3	.8
8	10	20.4	12.7	Yes		61.3	38.1	Yes		9.8	6.1
9	11	13.7	8.5	Yes		44.2	27.5	Yes		.2	.1
10	9	16.9	10.5	Yes		79.2	49.2		No	60.5	37.6
11	7	38.9	24.2	Yes		96.5	60.0	Yes		8.0	5.0
12	10	21.7	13.5	Yes		48.3	30.0	Yes		4.2	2.6
13	10	8.4	5.2		No	15.8	9.8	Yes		5.9	3.7
14	12	9.0	5.6		No	16.7	10.4	Yes		.8	.5
15	7	37.2	23.1	Yes		77.9	48.4		No	47.6	29.6
16	12	7.9	4.9		No	19.6	12.2	Yes		2.3	1.4
17	12	9.2	5.7		No	17.4	10.8	Yes		3.4	2.1
18	9	28.6	17.8	Yes		82.4	51.2	Yes		1.8	1.1
19	10	30.4	18.9		No	32.3	20.1	Yes		.6	.4
20	11	12.9	8.0		No	40.0	25.0	Yes		6.2	3.9
$\bar{X}$		17.4	10.8	N = 9	N = 11	43.9	27.3	N = 17	N = 3	10.0	6.2
±SD		10.1	6.3			26.1	16.2			16.6	10.3

Table 8. Unit 22 bull moose movement summary, April 1981-September 1982.

Visual Collar No.	No. of observ.	Mean distance traveled between sightings		Moose migrated out of "parent" drainage		Maximum distance traveled from point of capture		Moose returned to "parent" winter range		Closest distance moose returned to point of capture (winter range)	
		Km	Mi	Yes	No	Km	Mi	Yes	No	Km	Mi
21	10	17.3	10.8	Yes		59.5	37.0	Yes		16.7	10.4
22	12	6.4	4.0		No	8.2	5.1	Yes		1.0	.6
23	10	24.3	15.1		No	54.7	34.0	Yes		9.8	6.1
26	10	10.3	6.4		No	28.6	17.8	Yes		.6	.4
27	10	22.8	14.2		No	46.0	28.6	Yes		4.3	2.7
29	9	21.7	13.5	Yes		58.2	36.2	Yes		1.6	1.0
30	10	26.3	16.4	Yes		65.8	40.9	Yes		6.4	4.0
34	10	9.2	5.7		No	20.7	12.9	Yes		4.8	3.0
35	10	28.2	17.5	Yes		75.9	47.2	Yes		23.5	14.6
36	10	8.2	5.1		No	17.1	10.6	Yes		1.6	1.0
37	10	12.1	7.5		No	39.9	24.8	Yes		17.7	11.0
40	10	8.4	5.2	Yes		25.1	15.6	Yes		2.4	1.5
50[a]	4	8.7	5.4		No	19.1	11.9	Unk		--	--
51[a]	4	9.8	6.1		No	20.1	12.5	Unk		--	--
53[a]	3	24.8	15.4	Yes		61.1	38.0	Unk		--	--
54[a]	4	4.0	2.5		No	3.4	2.1	Unk		--	--
55[a]	4	26.7	16.6	Yes		76.4	47.5	Unk		--	--
56[a]	4	18.7	11.6	Yes		46.7	29.0	Unk		--	--
57[a]	4	9.0	5.6		No	17.9	11.1	Unk		--	--
58[a]	4	24.3	15.1	Yes		69.8	43.4	Unk		--	--
$\bar{X}$		16.1	10.0	N = 9	N = 11	40.7	25.3			7.6	4.7
±SD		8.2	5.1			23.5	14.6			7.7	4.8

[a] Movement data only available from May-August 1982.