MIGRATIONS AND POPULATION MIXING OF MOOSE ON THE KENAI PENINSULA (ALASKA)

by

Robert E. LeResche
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska

Abstract: Four hundred-thirteen sightings of 283 adult moose (Alces alces gigas) tagged on the Kenai Peninsula revealed migratory patterns, concentrating areas, and separate population identities of moose representing an aggregate number of nearly 10,000 animals.

Most of the groups studied were seasonally migratory, and moved from lowland wintering areas to calving areas in springtime, thence (in early summer) to upland summering--rutting areas, and back to wintering areas in early-mid winter. This group comprised many large bulls and cows, but very few calves. Sexes were segregated during the early summer migration to the highlands, when males migrated earliest. Sexes intermingled during rutting in fall.

The other population segment (comprising predominately cows with calves and younger bulls) remained resident in lowland areas year-round.

Specific drainages were the sites of rutting by the same individuals year after year, and individuals followed stereotyped migration paths for more than one year.

One calving area was a concentrating spot for individuals from all rutting areas studied (many 60-80 kilometers distant).

Moose in the lowland areas of the northern Kenai Peninsula receive considerable hunting pressure in the few restricted areas where access exists. In late fall, moose herds in these areas characteristically have a low proportion of bulls, and trophy-size bulls are extremely rare. Although lowland areas contain a higher proportion of calves within the herd, calf production in some years is lower than anticipated (e.g.: 33 calves:100 cows in November, 1970). Most of the area in question is seral birch range remnant from the 1947 Burn, and birch browse is in great abundance. However, substantial numbers of moose have died during severe winters in the area. Population estimates by personnel of the Kenai National Moose Range suggest substantial numbers of moose (7900 $\pm$ 1400 minimum in early 1971), but concern has been expressed regarding the numbers and welfare of the "lowland" moose, especially in relation to hunting pressure.

The moose traditionally using climax willow ranges in foothills and mountains, but wintering on the lowland areas, receive little hunting pressure. These groups characteristically exhibit a high bull:cow ratio and a low proportion of calves.

With the formalization of moose management plans for the peninsula and the designation of certain areas as trophy, foothunting and maximum sustained yield hunting areas, delineation of these various groups, their interactions, their seasonal movements, and their calving and breeding sites, has become imperative. Further, the proposed classification of more than one million acres of the area as wilderness (which would preclude habitat manipulation), as well as the possibility of a limited access road bisecting part of the area, requires specific knowledge of the migrations of these moose. Descriptions of populations and their move-

ments would 1) allow harvesting of desired portions of specified moose herds and prevent harvesting of trophy-class bulls while they are away from trophy-management areas (and perhaps antlerless), 2) prevent unnecessary restriction of activities (e.g.: by wilderness designation) in areas of key winter range, where habitat manipulation might someday become necessary, 3) contraindicate development of small areas seasonally crucial to large numbers of moose (e.g.: during calving, rutting, or wintering) and 4) provide valid data relative to possible obstructions presented by future proposed highways and other projects.

The few studies of moose migrations that have been undertaken have shown that such movements vary with the population studied. Goddard (1970) reported an Ontario study similar to ours. His recoveries were few (59 of 328 marked moose) but he documented movement from summer to winter ranges (done previously by Edwards and Ritcey, 1956; Kraft, 1964 and Houston, 1968) and suggested there was no net movement into heavily hunted areas.

Phillips and Berg (1971), with many relocations (2,000) of few (27) radioed Minnesota moose, recorded individual home ranges of 2-10 square miles, winter confinement to less than 100 acres, average daily movement of 0.60 miles, identical mean daily movements of cows and bulls, and 0.5-21 mile movements from winter to summer ranges. VanBallenberghe and Peek (1971) also radio-tracked moose in Minnesota. They showed summer localization, winter confinement by snow, adjacent winter and summer ranges of an individual, and a rapid 12-mile movement by a rutting bull. Mercer and Kitchen (1968) described dispersal of moose introduced onto the Labrador Peninsula. LeResche (1968) and LeResche and Davis (1971) reported

localization of parturient females and their new calves, and LeResche (1972) suggested internal triggering as a factor in moose migrations. Bishop (1970) reported that a Tanana Flats (Alaska) calf-tagging study suggested that both resident and migratory individuals were present in these lowlands in spring. Didrickson (pers. comm.) reported adult moose tagged in the Matanuska Valley (Alaska) moved nearly 60 miles on occasion.

METHODS

The area of the Kenai Peninsula studied includes approximately 2,700 square miles (7,000 square km.) of moose habitat. Nowhere within the area is human habitation more than sparse, and no major man-made habitat alterations exist. More than 95% of the area is entirely without human habitation, the majority being contained in the Kenai National Moose Range and Chugach National Forest. One paved road bisects the area east to west.

This study considers the area in terms of the following major physiographic/habitat locales (Figure 1):

1947 Burn: Lowland seral birch (Betula papyrifera) area burned in 1947. Contains Moose Research Center. Approximately 600 square miles.

Moose River Flats: Lowland Muskeg - black spruce (Picea mariana) calving concentration area. Approximately 100 square miles.

Skilak Loop: Lowland seral winter concentration area. Approximately 200 square miles.

Kenai Mountains: (containing Mystery Creek Basin) and Skilak-Tustumena Benchland. Mountainous climax willow (Salix spp.) ranges. Approximately 1300 square miles.

Kenai Lowlands: Unburned white spruce (Picea glauca) Birch and Aspen (Populus tremuloides) - muskeg areas. Approximately 500 square miles.

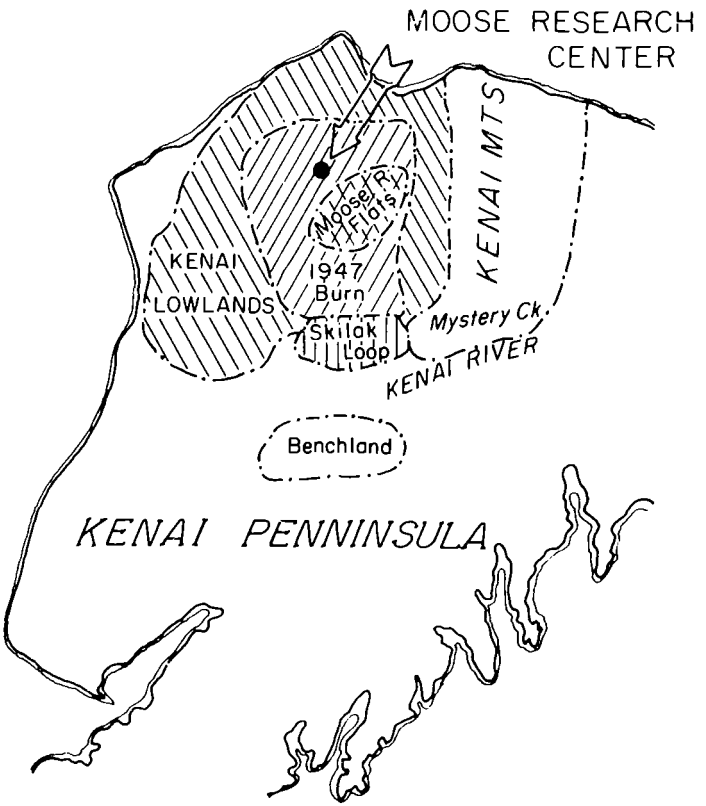

Figure 1. Major physiographic/habitat areas on Kenai Peninsula (Alaska) study area.

Table 1 lists moose marked 1) in October 1968 at Mystery Creek, 2) in March 1970 at Skilak Loop, 3) in June 1970 at the Moose River Flats, 4) in March 1971 at the Skilak-Tustumena Benchland, 5) in May 1971 at the Moose River Flats, and 6) from August 1969 through May 1971 at the Moose Research Center. The moose represent, respectively: 1) a rutting group, 2) a wintering concentration, 3) a calving concentration, 4) a late-winter remnant group in a fall rutting concentration area, 5) a calving concentration, and 6) inhabitants of the 1947 Burn area during all months of the year. Figure 1 shows tagging areas.

Moose were tagged using helicopters or fenceline traps (LeResche and Lynch 1972) at the Moose Research Center and succinylcholine chloride in projectile syringes. Groups 1, 2 and 6 were ear-tagged and collared to be distinguishable from afar by group and sex but not (except for a few pendant-carrying animals in Group 6) as individuals. Animals in Groups 3, 4 and 5 were made identifiable as individuals by numbered pendants and/or collars and/or color-coded collars. All animals were distinguishable individually when "in hand" by numbered metal ear-tags.

Sixty-five reconnaissance flights were made during the study period (October 1968 - June 1971) in PA18-150 "Supercub" aircraft. The flights involved approximately 200 hours flying time. Several sightings were also contributed by tourists and hunters. Eighteen tagged animals were reported killed.

FINDINGS

Table 2 lists the 413 recoveries and sightings of tagged moose recorded. When analyzed by season, location and (tagging) group, these sightings suggest several facts relative to population identities, movements, and concentrating areas.

Table 1: Numbers of moose tagged and marking schemes used on the Kenai Peninsula, Alaska, October 1968 - May 1971.

	Males	Females	Sex ?	Calves	Total
Mystery-Dike Creek (timberline rutting area) October 1968	10	18	0	0	28
Skilak Loop (lowland wintering area) March 1970	16	52	1	0	69
Moose River Flats (lowland calving area) June 1970	26	43	2	0	71
Moose Research Center (lowlands)	3	40	0	7	50
Moose River Flats May 1971	10	51	0	0	61
Skilak-Tustumena Bench (timberline rutting & wintering area) April 1971	2	2	0	0	4
Totals	67	206	3	7	283

MARKING SCHEMES

Area	Male		Female		Pendants
	Collar	Ear	Collar	Ear	
Mystery Creek	Yellow	Left Orange	Red	Right Orange	None
Skilak Loop	Blue	Left Orange	White	Right Orange	None
Moose R. Flats (1970)	Blue	Left Green	White	Right Green	Red A1-A100
MRC	Blue	Left Silver	White	Right Silver	White 51-100
Moose R. Flats (1971)	Yellow/ orange*	Left Yellow	Pink/ red*	Right Yellow	Red C1-C100
Skilak-Tustumena Benchland	Yellow/ orange*	Left Yellow	Radio	Right Yellow	Red: "C-series"

* Colored stripes on both sides of collar make the moose identifiable as individuals.

Table 2: Recoveries and sightings of marked moose, Kenai Peninsula, through June 1971.

Tagging Site		MONTH Jan. Feb.	March April	May June	July Aug.	Sept. Oct.	Nov. Dec.	Totals
Mystery Creek	21	Females	14	14	12	7	16	87
	1	Males	1	14	6	5	1	28
	22	Total	15	31	18	12	17	115
Skilak Loop	4	Females	51	15	19	20	19	128
	2	Males	9	2	0	1	1	15
	6	Total	60	17	19	21	20	143
Moose Research Center	3	Females	4	7	1	6	5	26
	0	Males	1	4	1	4	0	10
	3	Total	5	11	2	10	5	36
Moose River Flats	6	Females	4	49	11	7	8	85
	4	Males	1	8	8	2	11	34
	10	Total	5	57	10	19	9	119
								413

Population Identities

Several biological "populations" (i.e.: randomly interbreeding groups) are represented by the groups of tagged moose. In one case certainly (Mystery Creek) and at least partially in another (Moose Research Center tagged animals), true populations were tagged as such. In the other sites of concentrated tagging effort, various separate breeding popula-

tions were tagged together during nonbreeding aggregations.

The Mystery Creek population is probably typical of 10-15 separate breeding groups which gather in separate drainages on the west and central slopes of the Kenai Mountains. All but one recovery of moose tagged in Mystery Creek (in October) made between September and October in the two years since tagging occurred within approximately two miles of the tagging site. All drainages of the area described were searched during this time. This group of moose, then, was very traditional in concentrating in a precise drainage during breeding season.

During winter, most sightings of moose from this population occurred in the large flatland areas of the 1947 Burn to the west of Mystery Creek. During this time of year, Mystery Creek moose intermingled with lowland residents (e.g.: Moose Research Center tagged animals) and moose from other Kenai Mountain drainage breeding groups.

Mystery Creek moose typically calved along the Kenai River. Bulls inhabited the Moose River Flats during calving. Table 3 and Figure 2 illustrate the circumstantial data for the identity of this population, and Table 4 summarizes its locations during 6 two-month periods. As shown in Table 3, most observations throughout most of the year were far from the tagging (breeding) site. All sightings during September-October were near the tagging site. Thus, this population concentrates on the breeding grounds. Figure 2, which represents the mean distance of recoveries from tagging (October) site of Mystery Creek moose by month, shows differential male and female migrations to and from the breeding grounds. Aggregation of both sexes during September-October (i.e.: demonstration of population status) is evident.

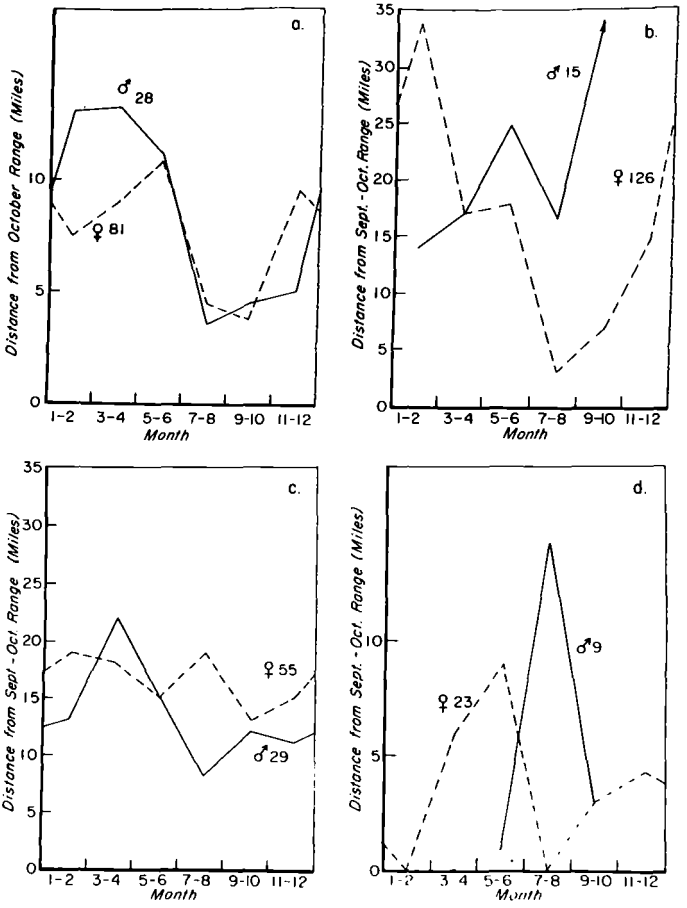

Figure 2. Mean distance from center of polygon enclosing all September - October sightings, by month. (a. tagged at Mystery Creek in October, b. tagged at Skilak Loop in March, c. tagged at Moose River Flats in June, d. tagged at Moose Research Center year-round.)

Table 3. Proportion of sightings outside of four contiguous townships from tagging site, Kenai Peninsula, 1968-March 15, 1971.

Tagging Site	Females	%	Males	%	N
Mystery Creek	35	43*	14	50*	109
Skilak Loop	34	27	2	13	141
Moose Research Center	7	30	2	22	32
Moose River Flats	16	29	21	72*	84

* Tagged in concentrating areas.

Tables 3 and 4 and Figure 2 present similar data from sightings of moose tagged at Skilak Loop, the Moose River Flats and the Moose Research Center. Table 3 shows that the Moose River Flats was a concentrating area for bulls from other areas when tagging occurred there (June), for 72 percent of subsequent sightings of these bulls were more than six miles from the tagging site.

Figure 2 implies certain things about the population status of the groups in question. Since these groups were tagged outside of their breeding areas, breeding area was estimated by circumscribing the smallest polygon about all September and October sightings of moose from each tagged group and taking the polygon center as the breeding ground. Mean distance from this center, during September-October, thus becomes a measure of group dispersal during the breeding season. A widely dispersed group, then, represents several breeding populations. For example, Figure 2 shows that both males and females (tagged at the Moose River Flats in June) were dispersed an average of more than 10 miles from the center of their breeding range during September and October. In other words, they were not concentrated on one breeding ground and the group concentrated at

Table 4. Seasonal locations of tagged moose groups, Kenai Peninsula, Alaska.

Tagging Site	Winter	Late Winter	Calving	Summer	Rut	Post-Rut
Mystery Creek	Kenai lowlands north of Skilak Loop		Moose River Flats and Kenai River	Eastern Kenai lowlands and Mystery Creek Basin	Mystery Creek Basin	Mystery Creek Basin and adjoining Kenai lowland
Moose River Flats	1947 Burn, Skilak Loop and Kenai lowlands		Moose River Flats	Kenai Mts., Benchland, Moose River Flats, 1947 Burn	Kenai Mts. & Bench-land	Kenai Mts. and 1947 Burn
Skilak Loop	1947 Burn, Skilak Loop and Kenai lowlands		Skilak Loop and south	Benchland and adjoining Kenai lowlands	Benchland Skilak Loop and Kenai Mts.	Skilak Loop and Benchland
1947 Burn (Moose Center)	1947 Burn		1947 Burn and Moose River Flats	1947 Burn	1947 Burn, Moose River Flats, Skilak Loop	1947 Burn

Moose River in June represented more than one breeding population.

Since males and females in this group had approximately equal dispersals from the breeding center, we may infer that at least some males and females from the group did breed with one another (that moose were tagged from some true populations). Sightings plotted on a map confirm this. Figure 2 also shows that the group tagged while wintering in the Skilak Loop area likely represents individuals from many populations. In contrast, the figure implies that males and females tagged at the Moose Research Center are from a true breeding population concentrated near the tagging site (see Table 3).

Figure 3 presents seasonal sighting locations of moose tagged at Mystery Creek, Skilak Loop, Moose River Flats and the Moose Research Center. This figure was used to construct Table 4. It illustrates group dispersal and reaggregation at the tagging site during the season of tagging. For example, Figure 3 shows that moose aggregated at the Moose River Flats calving grounds in May-June dispersed to many areas during other months. In the July-October period moose tagged in this group were seen 1) on the Moose River Flats, 2) in various Kenai Mountain drainages, 3) on the Skilak-Tustumena benchland, and (a special case of (1) above) in the Mystery-Dike Creek basin. The figure illustrates similar aggregations and dispersals by the other tagged groups. Areas represented on the figure are large and consequently aggregations apparent on the figure may be exaggerated. The areas do represent the major physiographic areas of the northern Peninsula, however. Further, they adequately define areas suitable for separate management practices.

Movements

Much movement information is implicit in the above discussion of

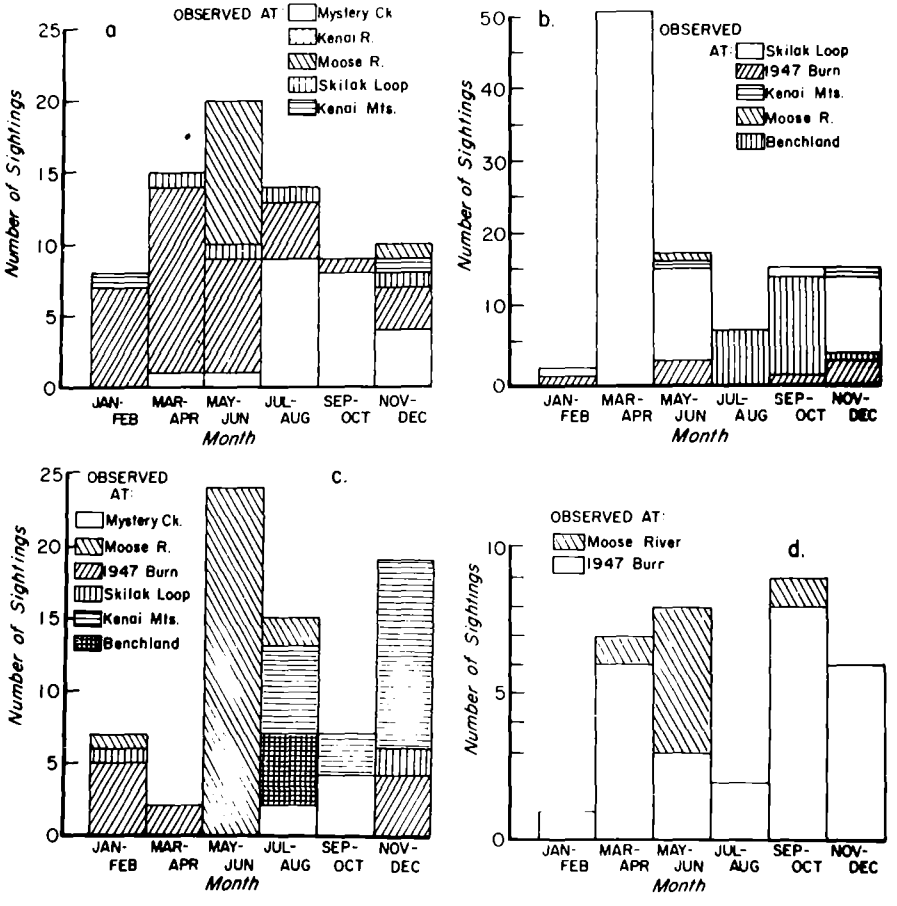

Figure 3. Monthly locations of moose tagged at a. Mystery Creek, b. Skilak Loop, c. Moose River Flats, and d. Moose Research Center.

population identity and the following account of concentrating areas. A major migration, as suggested above, occurs from the Moose River Flats (and other scattered calving areas) to the Kenai Mountains and the Skilak-Tustumena benchland. This movement typically occurs from July through September-October. Figure 4 defines the movement by plotting mean altitude of males and females by season. Sexes were partially segregated from May through August because males migrated to high country earlier than did females, which remained on calving lowlands longer. Further, males migrated to the very heads of mountain drainages, but females typically did not move so high. Intermixing occurred at breeding (September-October). After rut, males typically returned to upper drainages as females began migrating to lowland wintering areas. Most males joined them in January-February and the sexes remained mixed through June, when the upland migration once again began. Some males remained near timberline all winter.

There are important exceptions to the above pattern. A substantial portion of the population tagged at the Moose Research Center (in the 350,000 acre burned area adjacent to the Moose River Flats) was resident in that area. This is suggested by the sighting of Moose Research Center tagged individuals (cf.: Table 3, Figure 3) of which 33/36 (92 percent) were within four miles of the tagging site. It is further suggested 1) by trapping success of traps outside the Moose Research Center fenceline, which was uniformly high during all seasons, 2) by the average of more than 15 moose per square mile enclosed by building the Center's four enclosures (two completed in January, two in August) and 3) by observations adjacent to the Moose Research Center during all months of the year.

Individual animals observed several times during the study moved

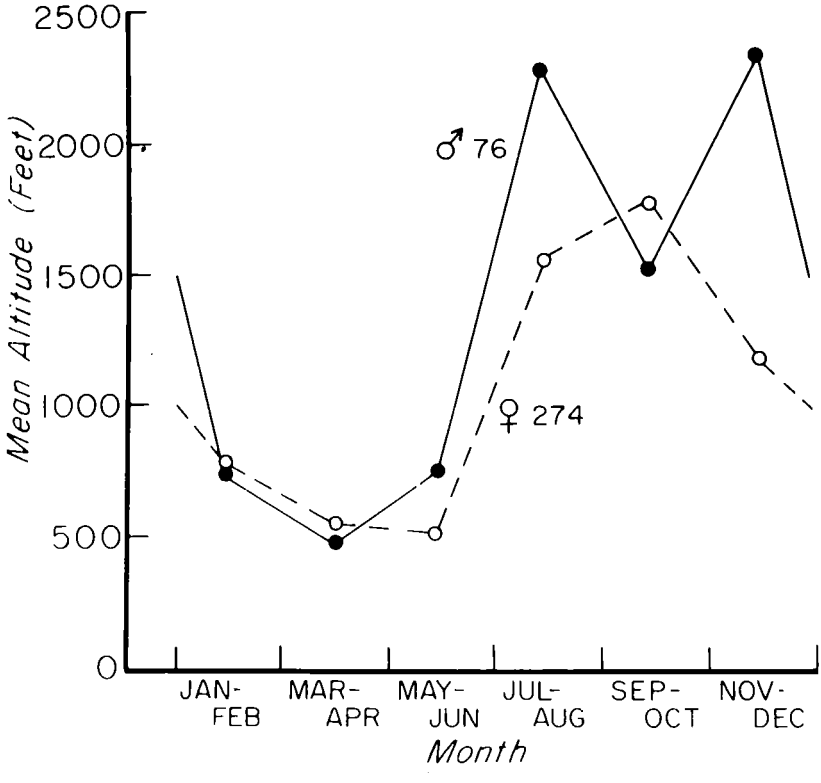

Figure 4. Mean elevation by month of 348 sightings of collared moose. Kenai Peninsula, Alaska. October 1968 - March 1971.

according to traditional patterns (Figure 5). One bull tagged in October at Mystery Creek was seen two succeeding springs at the Moose River Flats, then during southeasterly migration, and in fall back at the tagging site. A second bull, tagged at the Moose Research Center, moved in a similar pattern. The two cows illustrated were more localized.

Concentrating Areas

Concentrations of moose occurred during calving, rutting and late winter. On the northern Kenai Peninsula, greatest numbers are most concentrated during calving and rutting. Wintering areas are so vast (i.e. the 1947 Burn of more than 350,000 acres) that winter concentrations, though impressive (ca: 500-1000 animals in a township near Skilak Lake in March 1970), did not occur to such an extent as calving and rutting concentrations.

Table 5 summarizes present data re: which moose occupy which areas of the northern Kenai during which seasons. This table is organized by tagging group rather than by breeding population because of the limitations of group tagging. Concentrations of tagged moose occurred 1) on the Skilak Loop area during March-April (largely animals tagged there), 2) on the Moose River Flats during May-June (moose tagged there and at Mystery Creek), and 3) on the Skilak-Tustumena benchland and Mystery Creek basin and other Kenai Mountain drainages from July through October or December (moose tagged in Moose River Flats and Mystery Creek).

DISCUSSION

In the past, biologists have tended to speak of moose populations or "herds" in a general sense, referring to all animals present in an area. This study has shown that where moose migrations occur, animals aggregated in some seasons might represent several breeding populations. Thus,

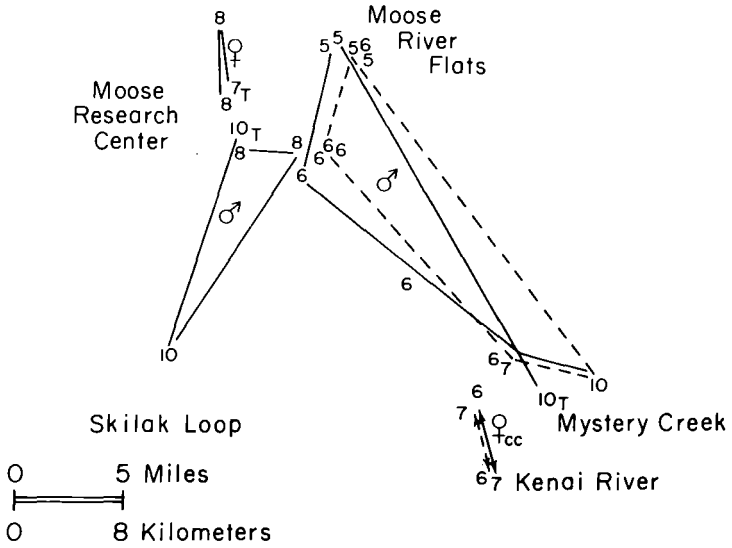

Figure 5. Migration patterns of two male and two female moose over a two-year period. "T" is tagging site, digits are months re-sighted, "c" indicates two calves present.

Table 5. Groups of moose seasonally occupying various Kenai Peninsula areas.

Area	Winter	Late Winter	Calving	Summer	Rut	Post-Rut
Benchland	Very few present	Very few present	Very few present	Skilak Loop winterers, MR Flats calvers	Skilak Loop winterers, MR Flats calvers (concentration)	A few Skilak Loop winterers
Kenai River	Mostly Mystery Creek breeders	Mostly Mystery Creek breeders	Mostly Mystery Creek breeders	Mostly Mystery Creek breeders	Mystery Creek, '47 Burn	Mostly Mystery Creek breeders
Mystery Creek Basin	None present	A few Mystery Creek breeders		Mystery Creek breeders and Moose River Flat calvers (concentration)		Mystery Creek breeders, MR Flat spring, Skilak Loop winterers
Kenai Mts. north of Mystery Creek	Very few present	Very few present	Very few present	Moose River Flats calving population (concentration)		
Moose River Flats	Few present	Moose River, Mystery Creek and '47 Burn calving grounds (concentration)			Few present	Few present
1947 Burn	Residents and Moose River Flats calvers		Residents and Skilak Loop winterers	Residents	Residents	Residents Moose River Flats calvers
Skilak Loop	Benchland breeders and some Moose River calvers	Benchland breeders (concentration)	Benchland breeders (concentration)	Few present	Few present	Benchland breeders and some Moose River calvers

specialized habitat where seasonal aggregations occur can be important to several moose populations. In addition, small mountain drainages where the same individual moose congregate each fall can be critical to the survival of these sub-populations.

Moose in the same region may represent two types of populations: migratory and resident. These populations are separate in summer and fall, and mix during winter and spring. The results presented here suggest that migratory groups, which move to upland climax ranges during summer and remain there until early winter, are predominately older bulls and cows with low calf production. In contrast, the population resident in the seral lowland communities contains a high proportion of productive cows and few bulls older than three to four years. The discrepancy in bull proportion and ages is surely due in part to greater hunting pressure in the more accessible lowlands, but perhaps has a behavioral basis as well. Similarly, differences in productivity may result from habitat differences, or more likely from behavioral changes in females between years when they raise calves successfully and when calves are lost. More repeat sightings of individually-recognized animals should clarify these points.

Habitat where calving and wintering aggregations occurred attracted moose from breeding areas as far as 80 km. distant. Where precise management of populations for different objectives is contemplated, it is of great importance to have and consider such information. For example, current management plans include managing moose in the Kenai Mountains and Benchland for trophy production and nonconsumptive (observation and photography) use, and those in Skilak Loop, the 1947 Burn and the Kenai lowlands for maximum sustained yield of meat and recreational hunting.

Such planning could come to cross-purposes were harvest to occur at times when animals from all these areas were aggregated. Furthermore, alteration or destruction of habitat where aggregations occur (for example, the Moose River Flats), or construction of barriers along migration routes, could have far wider effects on moose than previously expected.

Finally, trophy management of breeding groups in restricted upland drainages must consider that these groups may contain many of the same individuals each year, and that it might be difficult to re-establish traditional use by moose if overharvest should occur.

Because of increasing and varied recreational demands on the resource, moose management in North America must necessarily evolve to a more precise level than exists at present. Management plans may call for trophy hunting, sustained yield and maximum recreational opportunity hunting, photography & viewing, and retention (or creation) of high quality "wilderness experience" relative to moose, all within an area no larger than the Kenai Peninsula. Implementation requires first a specific knowledge of moose population identities and movements, and then a dynamic and creative manipulation of seasons, bag limits, access, "methods and means" of hunting, and public information. Only by grounding management practices on information such as presented here can we derive maximum compatible uses from our moose resource as pressure increases. We must learn to speak more specifically about ever more restricted aspects of moose ecology, population dynamics, and behavior. The moose management of the future will demand such knowledge in order to succeed.

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