INTERRELATIONSHIPS OF WEATHER, FIRE, AND MOOSE ON THE KENAI NATIONAL MOOSE RANGE, ALASKA

by

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Moose populations on the Kenai National Moose Range in Alaska were monitored by spring, fall, and winter aerial surveys. Data indicate a positive response in moose productivity and density to disturbance by wildfire. Weather data indicated that summer precipitation and temperature influenced the type of habitat created by fire. Precipitation, temperature, and snow depth during the winter modified moose productivity and density. Severe winter weather slowed increases and accelerated declines while mild winter weather accelerated increases. Habitat quality appeared to determine whether the population was increasing or decreasing.

Weather has often been discussed as an important factor affecting ungulate populations (Edwards 1956, Bishop and Rausch 1974, Coady 1974, Peterson 1975). Severe winter weather reportedly affects food availability (Peek 1974), reproductive rates (Pimlott 1959), susceptibility to predation (Peterson and Allen 1974), calf survival (Bishop and Rausch 1974), and cow-calf bonds (Sigman 1977), in moose, *Alces alces*.

Severe winter weather in the form of high precipitation, cold temperatures, and deep snow appeared to reduce moose productivity and survival on the Kenai National Moose Range in Alaska. Moose populations have been monitored on the refuge since the 1950's and have responded to disturbance by fire with an increased reproductive rate and higher densities (Bailey 1978). Climatological data suggest weather conditions have modified fire history, the habitat created by fire and moose population dynamics. This paper reviews the history of moose populations on the refuge and examines the positive and negative effects of weather on moose.

STUDY SITES

The 688,000 ha Kenai Moose Range is located in south-central Alaska and encompasses much of the lowland boreal forest on the Kenai Peninsula. The Peninsula has been repeatedly burned since the early 1900's and the resulting vegetation types form a mosaic pattern of unevenly aged stands of mature and regrowth timber (Spencer and Hakala 1964).

A large meandering fire in 1947 burned approximately 125,000 ha of spruce forest and left an estimated 60,000 separate stands of burned vegetation (LeResche et al. 1974). The regrowth vegetation is a mixture of aspen, *Populus tremuloides*, paper birch, *Betula papyrifera*, and willow, *Salix spp.*. White spruce, *Picea glauca*, and black spruce, *Picea mariana*, are scattered throughout the regrowth vegetation and compose a larger percentage of the cover as succession proceeds. Throughout this burned area are scattered stands of mature trees that did not burn. Regrowth vegetation is now 7-10 meters high and is becoming less and less desirable moose habitat (Oldemeyer et al. 1977).

A large fire in 1969 burned approximately 35,200 ha of the mature lowland forest west of the 1947 burn. This area is now predominately an aspen, paper birch, and willow regrowth. Because the 1969 fire burned hotter than the 1947 fire, the area was uniformly burned and consequently little edge was produced.

METHODS

Survey data collected from 1949 through 1979 were analyzed to establish composition and density trends in the refuge's moose population. Aerial survey data included:

1. Spring calf counts conducted from transects established on the Moose and Chickaloon River calving flats from 1957 through 1970. The average sample size per year was 1,688 moose with a range of 795-3,505.

2. Composition counts conducted on transects during November and December since 1950 to determine herd age and sex structure. The average sample size was 2,094 moose with a range of 348-4,736.

3. Total transect and selected quadrant counts (Evans et al. 1966) to census winter moose density and distribution.

The problems associated with aerial censusing are recognized (LeResche and Rausch 1974) and this paper will discuss trends rather than the specifics of moose population ecology.

Climatological data recorded at the Kenai airport since 1944 were were used to determine winter and summer weather patterns. A winter severity index was developed by summarizing greatest monthly snow depth, total precipitation, and average temperature from October

through April of each winter. Data in each category were ranked into one of ten equal classes. A ranking of 0 was given data points in the lowest class, while those in the highest class were given a 9 ranking (Table 1). The ranking from each of the three categories was added together to get an annual winter severity. Theoretically, the most severe winter, one with a high snow depth, high precipitation, and low temperature, could have a rank of 27. The mildest winter, one with low snow depth, little precipitation, and warm temperatures, could have a rank of 0. The mildest winter recorded from 1944-1977 had a ranking of 5 while the most severe had a ranking of 21.

Table 1. Winter Severity Index Ranking (Oct-April) at Kenai, Alaska based on data from 1944 through 1977.

Rank	Total Greatest Monthly Snow Depth (cm)	Total Winter Precipitation (cm)	Average Winter Temperature (C°)
9	123.4 - 134.0	12.4 - 13.3	-9.10 - -8.39
8	112.8 - 123.4	11.5 - 12.4	-8.39 - -7.68
7	102.2 - 112.8	10.7 - 11.5	-7.68 - -6.97
6	91.6 - 102.2	9.8 - 10.7	-6.97 - -6.26
5	81.5 - 91.6	8.9 - 9.8	-6.26 - -5.55
4	70.4 - 81.5	8.0 - 8.9	-5.55 - -4.84
3	59.8 - 70.4	7.1 - 8.0	-4.84 - -4.13
2	49.2 - 59.8	6.3 - 7.1	-4.13 - -3.42
1	38.6 - 49.2	5.4 - 6.3	-3.42 - -2.71
0	28.0 - 38.6	4.5 - 5.4	-2.71 - -2.00

RESULTS AND DISCUSSION

FIRE HISTORY

Weather data collected from the Kenai airport help explain differences in the type of habitat created by the fires in 1947 and 1969. The summer of 1947 was slightly drier than normal (Fig. 1) and temperatures were slightly lower than average (Fig. 2). In contrast,

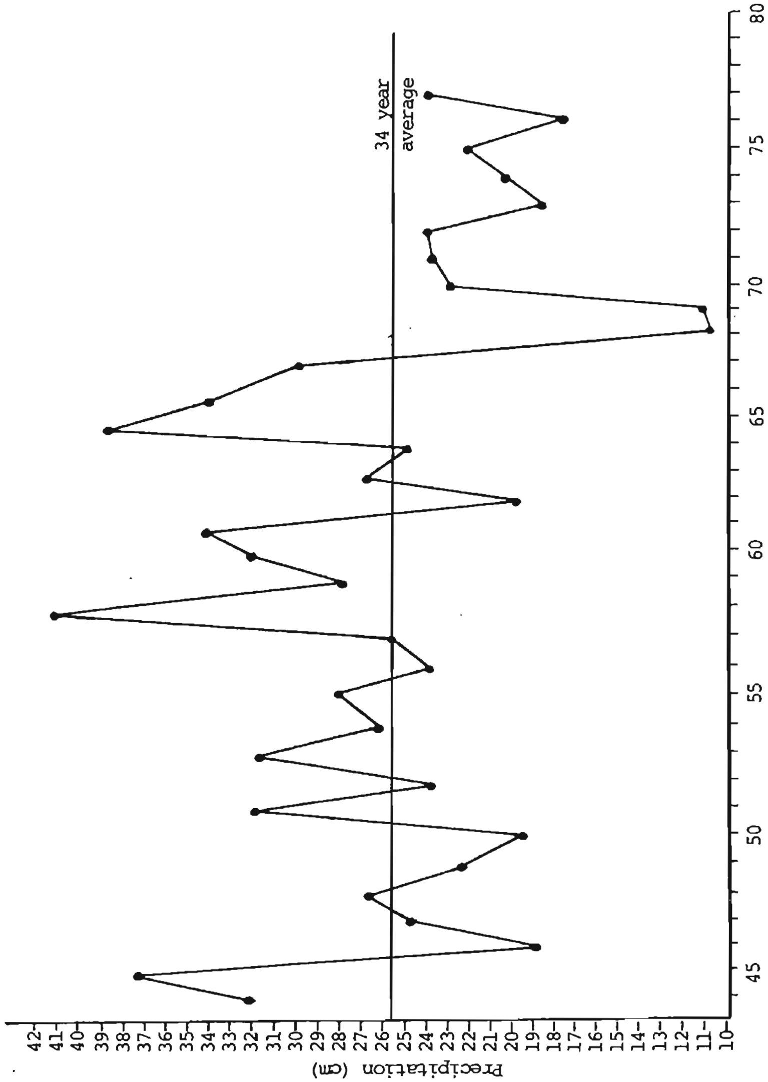

Fig. 1. Total summer precipitation (May - Sept.) at Kenai, Alaska, 1944-1977.

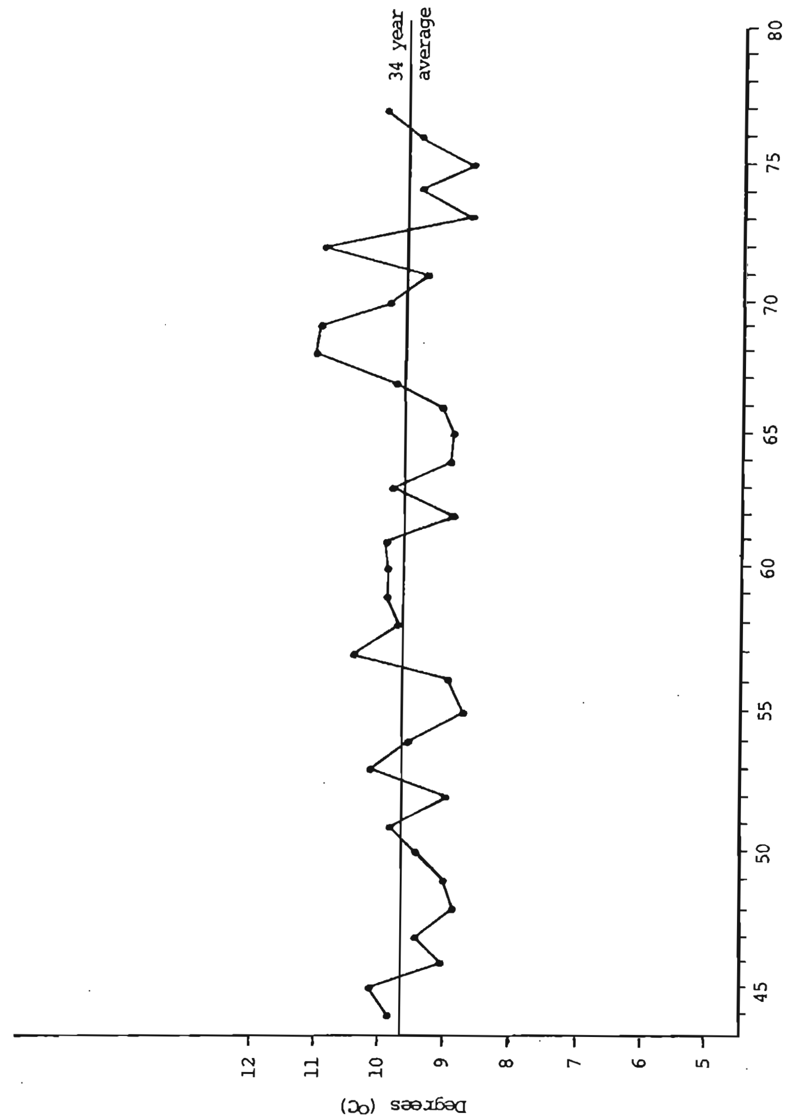

Fig. 2. Average summer temperatures (May - Sept.) at Kenai, Alaska, 1944-1977.

the summers of 1968 and 1969 were the driest (Fig. 1) and warmest (Fig. 2) recorded. Both fires set back plant succession and caused an increase in the types of plants moose eat. It is unknown if the hotter fire in 1969 or the drier summers after 1969 have caused a different density or composition of browse species to revegetate that area compared to the 1947 burn area. The major difference in the type of habitat resulting from these fires was in the amount of edge created.

The habitat created by fire during hot, dry weather may not be as beneficial to moose as that created by fires occuring in relatively normal summers because less edge is created. Telfer (1974), Hamilton and Drysdale (1975) indicated moose only travel a short distance from cover to utilize disturbed areas. Lynch (1975) and Mound (1977) suggested moose will not use disturbed areas very far from vegetative cover as winter range. The 1947 burn left numerous unburned areas and provided both food and cover within a small area while the 1969 fire created a large opening. Surveys in the 1969 burn area and mechanical crushed areas indicated that moose use these disturbed areas extensively in fall but leave them by early winter. Since fire suppression is most effective during mild summer weather (Johnson, Pers. Comm.*) and least effective during hot dry weather, it is suggested that modern fire suppression programs are most effective in stopping the type of fire that creates the highest quality moose habitat.

If moose do not utilize recently disturbed areas as winter range, there may be a short term negative effect associated with large fires. An area the size of the 1947 burn may have caused, at least initially, a concentration of moose in the remaining unburned habitat. Likewise,

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after the 1969 fire, moose that previously used that area to overwinter had to move elsewhere. Increased competition immediately after a burn might cause a decline in the amount of food per moose and result in lower calf production. This may have taken place on the Kenai after both the 1947 and 1969 fires. Spencer and Hakala (1964) reported that moose declined during severe winters and that moose use of the 1947 burn area was affected by snow depths. Snow depth and cold temperatures affect moose movements and consequently food availability (LeResche 1972, Coady 1974, Peek 1974). Since it takes less snow to cover shorter, young browse, newly burned areas are probably available to moose for a shorter period of the winter than are unburned areas. The number of calves per cow and number of twins per producing cow during the early 1950's were among the lowest reported (Kenai National Moose Rnage 1950) (Fig. 3) even though the winters were not particularly severe. After the burn in 1969, there was a sharp drop in the fall calf counts (Fig. 4) although the winter of 1969-70 was the mildest recorded. This suggests that fires may have a temporary negative effect on moose populations. The condition of alternate habitat, amount of edge within the burned area, and weather conditions probably determine how detrimental large disturbances may be to moose.

WINTER SEVERITY

The winter severity index (Fig. 5) combines the relative negative effects of high snow depth (Fig. 6), high precipitation (Fig. 7), and low temperatures (Fig. 8) during winter. Winter severity fluctuated widely with no major groupings of either mild or severe conditions from 1946 through 1956. From 1957 through 1961 and 1968 through 1970,

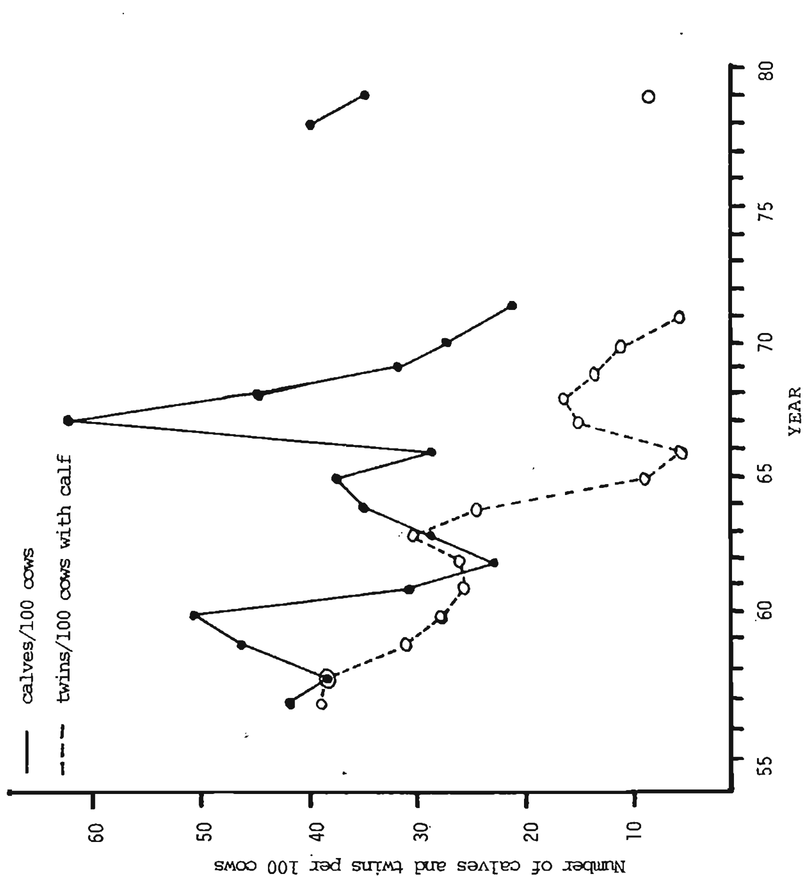

Fig. 3. Moose calves per 100 cows and twins per 100 producing cows in the spring on the Kenai National Moose Range from 1957-1971.

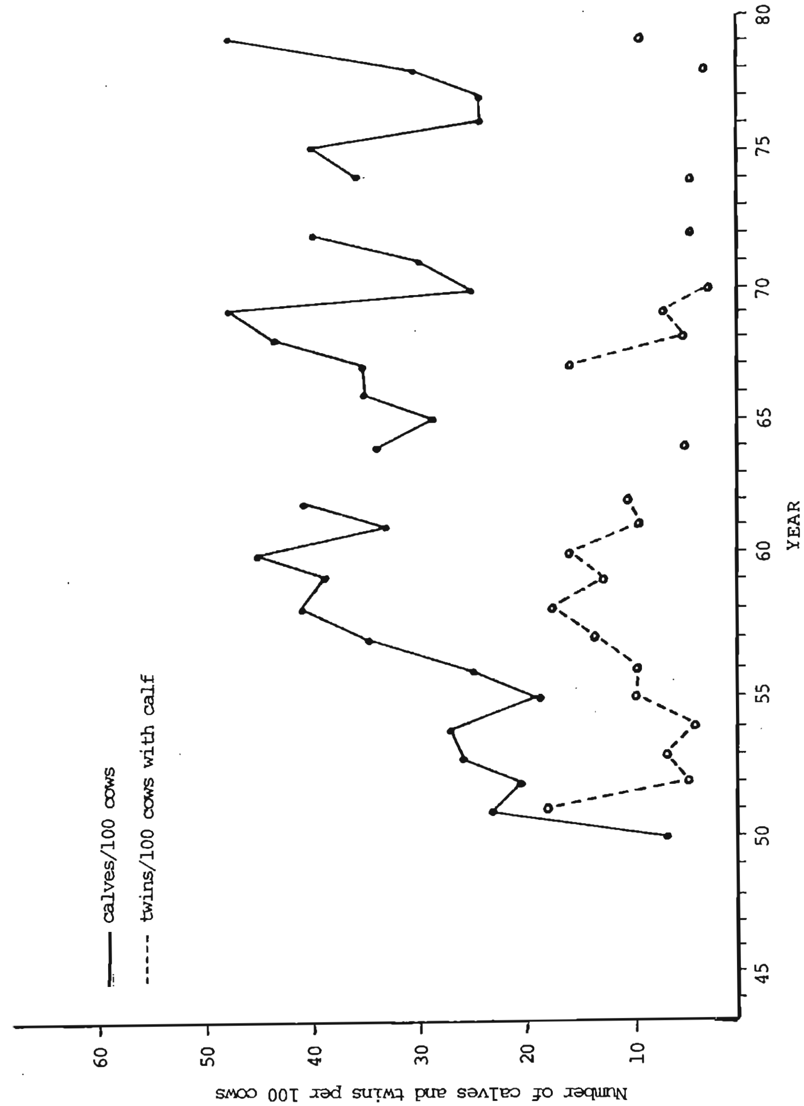

Fig. 4. Moose calves per 100 cows and twins per 100 producing cows in the fall on the Kenai National Moose Range, 1950-1979.

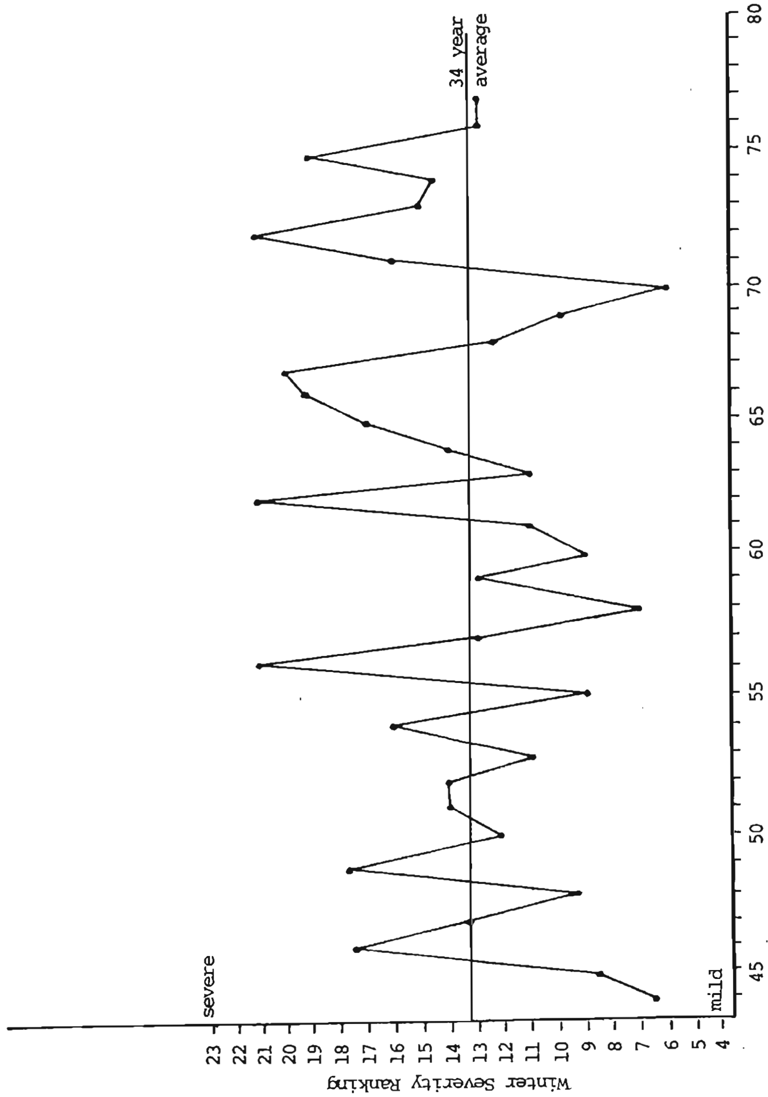

Fig. 5. Severity index of winter weather (Oct. - April) at Kenai, Alaska, 1944-1977. Winter of 1943-44 would be 1944...

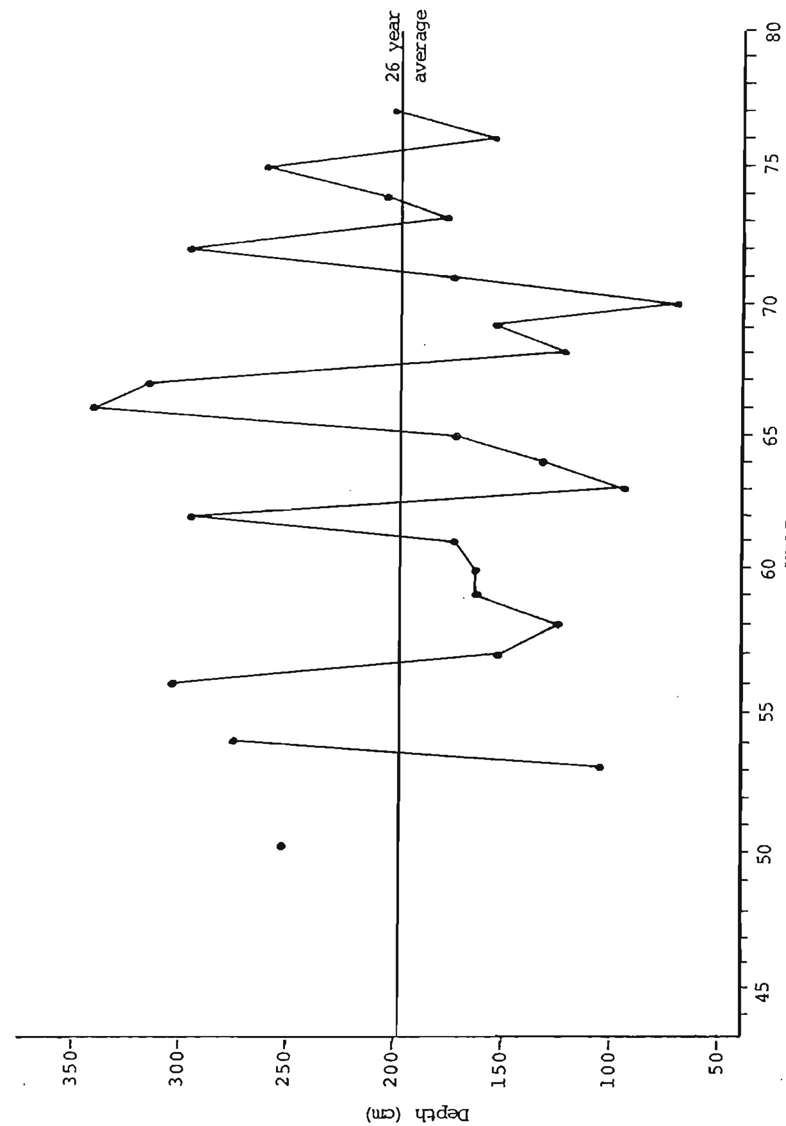

Fig. 6. Total monthly greatest average snow depth (Oct. - April) at Kenai, Alaska, 1944-1977. Winter of 1943-44 would be 1944...

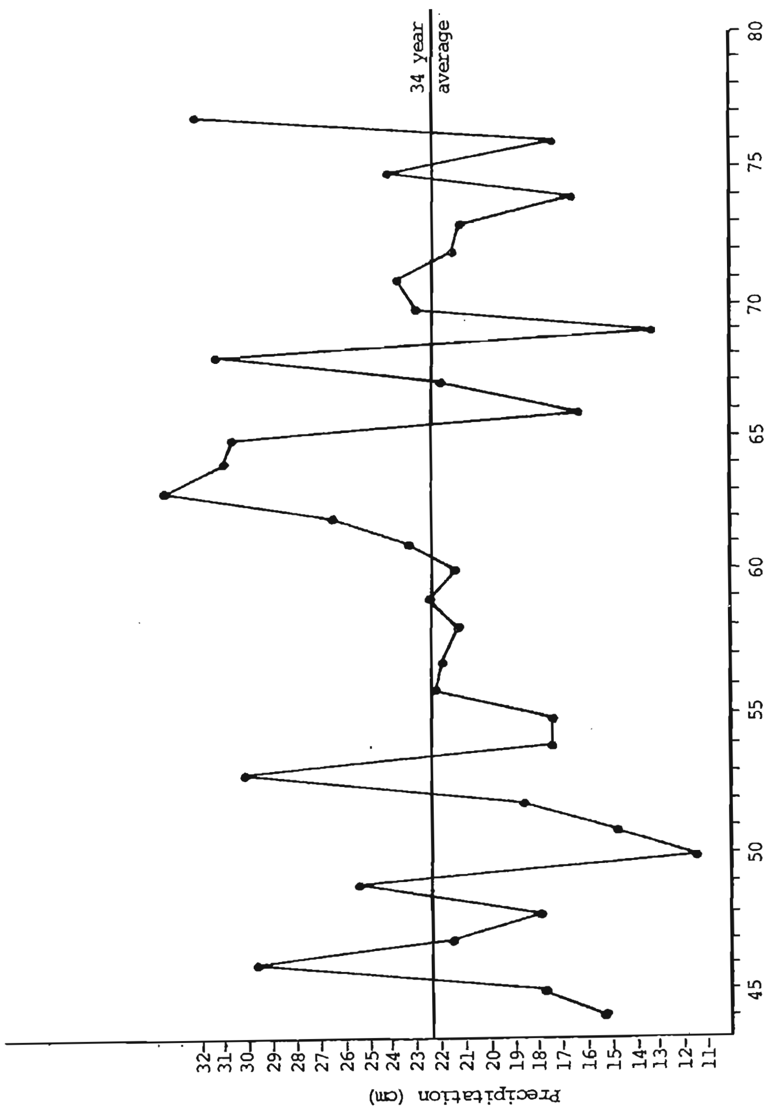

Fig. 7. Total winter precipitation (Oct. - April) at Kenai, Alaska, 1944-1977. The winter of 1943-44 would be 1944...

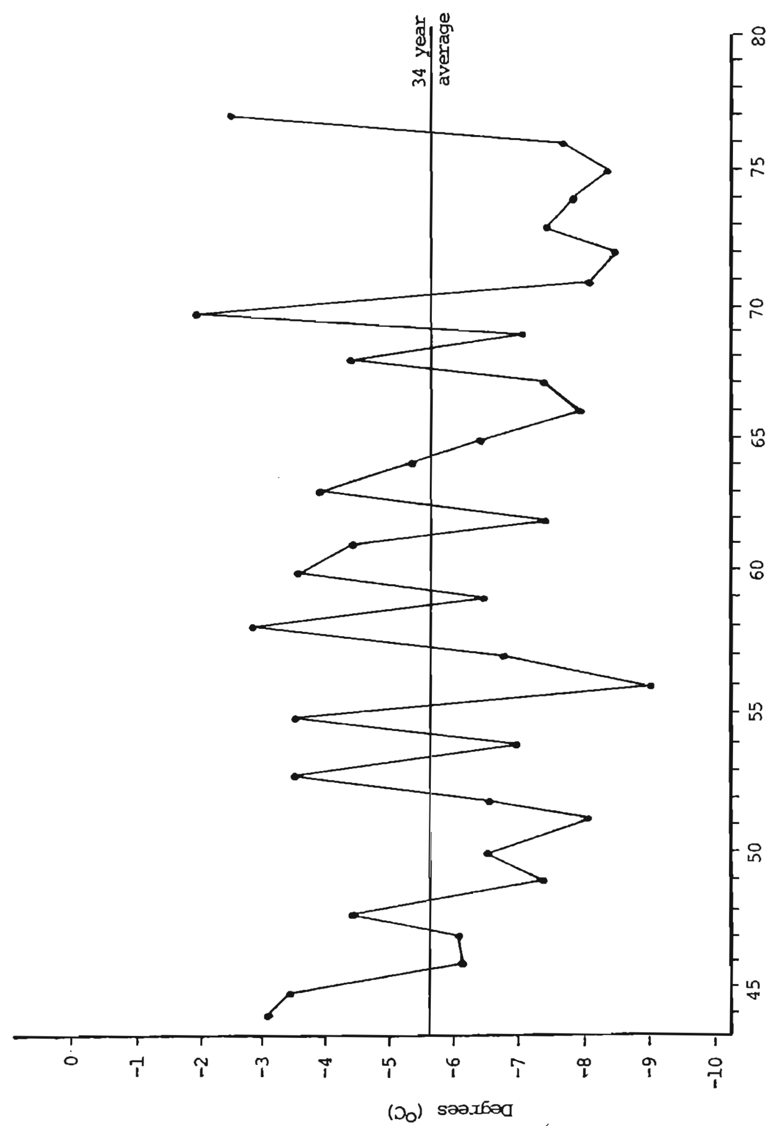

Fig. 8. Average winter temperatures (Oct. - April) at Kenai, Alaska, 1944-1977. The winter of 1943-44 would be 1944...

there appeared to be a series of relatively mild winters while from 1964 through 1967 and 1971 through 1975 the winters were harsher than normal (Fig. 5).

Winter weather on the Kenai lowlands often came in groups of either mild or severe conditions. Edwards (1956) made the same observations in British Columbia and stated that although hunting, predation, and range all affect declines in ungulate populations, it seemed more than coincidental that these factors were usually noticed during periods of severe winter weather. This may also hold true on the Kenai Peninsula where sharp changes in production and density appeared to be initiated by changes in winter weather severity.

Several authors have commented that snow depth may affect food availability (LeResche 1972, Coady 1974, Peek 1974, Mound 1977). If moose productivity reflects their nutritional conditions as reported by Pimlott (1959) then data from the Kenai indicates that winter severity influenced food availability, moose condition, and possibly, pre-natal mortality. Calf production seemed to be lower in summers following severe winter weather while after mild winters, there appeared to be increases in moose productivity.

Peaks or up swings in calf production appear to be related to the successive years of mild weather that occurred during the late 1950's and 1960's. In 1953, six years after the 1947 fire, moose were increasingly using the burned area around the Moose River as a spring calving ground. Spring calf counts started on this area in 1957 indicated that the highest twinning rate occurred 10 years after the 1947 burn (Fig. 3), and is supported by fall information (Fig. 4) that indicated a peak of multiple births in the late 1950's. The number of

multiple births decreased steadily from a high point in 1957 while the number of calves per cow fluctuated greatly with a high peak in the late 1950's. Triplets were seen in both 1958 and 1959 (Kenai National Moose Range 1958, 1959) and reinforce the probability that the late 1950's were the high point in calf production. There appeared to be a slight upswing in number of multiple births and calves per cow during the late 1960's. which coincides with a series of mild winters.

Consecutive years of severe winter weather appeared to result in sharp drops in calf production. Spring and fall composition counts (Figs. 3 and 4) indicate declines in the twinning rate and number of calves per cow during the early to mid 1960's and again in the early 1970's. The apparent drops in calf production occurred during two periods of successive severe winter weather (Fig. 8) and suggest a relationship between low calf production and severe winter conditions.

The Kenai moose population steadily increased from 1950 through 1970 (Fig. 9). A slight decrease from 1965 through 1967 may have been due to sampling error but is worth noting because it occurred during a series of severe winters and suggests a change in calf survival or production. The population crashed from approximately 9,000 moose in 1971 to about 3,500 by 1975 and has stabilized at that level. The large decline of 1971-75 was related to poor range conditions (Oldemeyer et al. 1977), poor moose condition (Franzmann 1977), and 5 consecutive years of severe weather. Kenai moose were reported to be depending upon non-browse foods during the early 1970's (LeResche and Davis 1973). Since the use of non-browse foods may be strictly controlled by snow depth (Peek 1974), Kenai moose were exceptionally susceptible to starvation during severe winter weather.

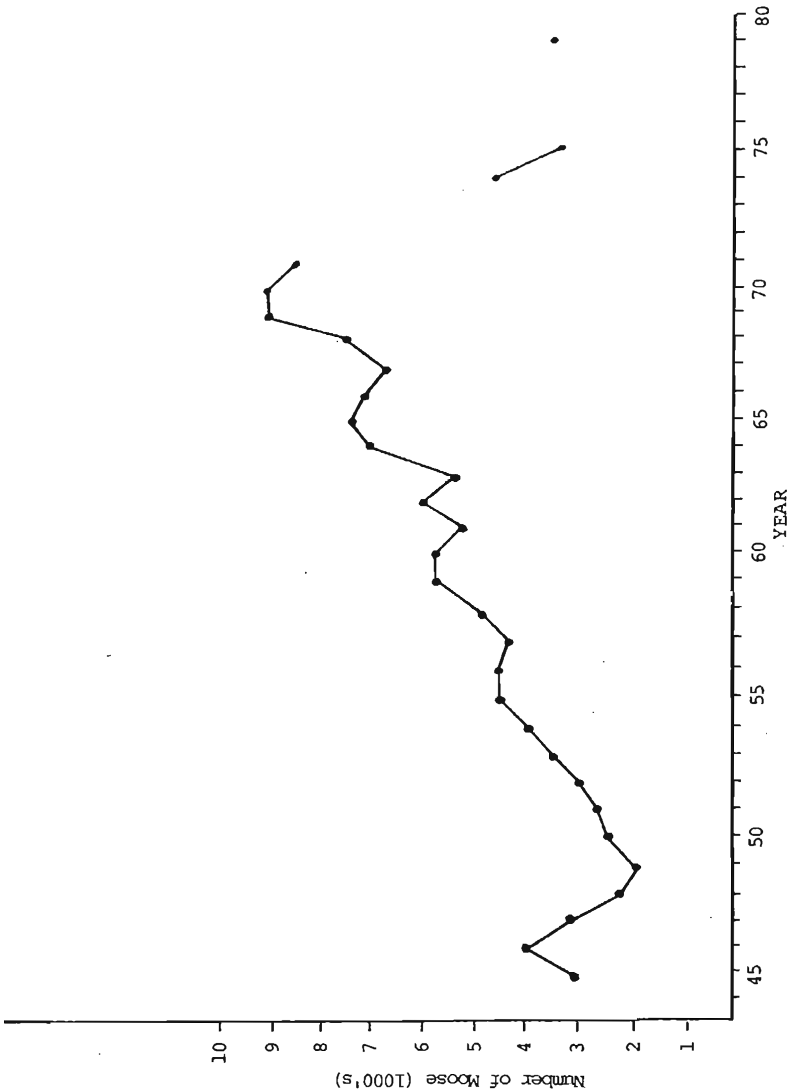

Fig. 9. Estimated moose population of the Kenai National Moose Range, Alaska, 1945-1979.

Additional factors impacting the moose population on the refuge during the late 1960's and early 1970's may have been antlerless moose hunts and an increasing wolf population. Antlerless hunts were initiated in 1960 and continued through 1966. The hunts were stopped in 1967 but started again from 1971 through 1974. By coincidence, cow hunts were conducted during periods of severe winter weather. In 1967, cow-calf ratios were up as was the twinning rate even though the winter of 1967 was severe. Antlerless hunts may have stimulated reproduction in the herd by reducing moose densities. Antlerless hunting was stopped from 1967 through 1970 which coincides with 3 years of mild weather. This combination of stimulated reproduction, mild winters, and little wolf predation might have been major factors resulting in the record high moose densities recorded in 1969 and 1970 (Bishop and Rausch 1974). LeResche and Davis (1973) also suggested that the mild winters of 1968, 1969, and 1970 may have caused extraordinarily high moose densities capable of altering plant species composition. The reinstatement of cow hunts in 1971 and an increasing wolf population in the early 1970's, coinciding with a series of severe winters may have accelerated the population decline.

The relationship between winter weather, calf production, and population densities is not a direct cause and effect relationship. The severity of winter weather appears to modify population structure, but does not determine the overall trend of the population's reproductive or density patterns. A steady increase of decrease of a population's density and reproductive rates is probably determined by habitat quality (Bishop and Rausch 1974). Severe winter weather may suppress increases, or accelerate the rate of decline while mild winter weather has the potential to speed up population increases or dampen their decline. Population density trends do not appear to be significantly affected by temporary phenomenon such as a single winter but several successive years of either mild or severe weather may cause noticeable changes in the reproductive patterns and/or densities of moose.

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