

Moose and Fire on the Kenai

DAVID L. SPENCER and JOHN B. HAKALA

*Bureau of Sport Fisheries and Wildlife
Fish and Wildlife Service
U. S. Department of the Interior*

FIRES IN the boreal forest have a profound effect on the welfare of moose populations. People of many interests and backgrounds have observed and variously interpreted the resulting ecology. The inadvertent firing of a tract of land dedicated primarily to moose occurred on the Kenai National Moose Range in 1947. Population surveys (total wintering populations, composition counts and moose calf counts) have been conducted and permanent study plots examined since the fire occurred. The purpose of this paper is to examine the resulting data and to present the various moose and fire relationships which have appeared as a result of these observations.

Similar burning patterns on the Kenai Peninsula have occurred frequently in the past. The moose population and plant succession data from the 1947 Burn are supplemented by observations of other areas burned prior to this time.

THE KENAI NATIONAL MOOSE RANGE

The studies were conducted on the lowlands of the Kenai Peninsula which is located between Prince William Sound and Cook Inlet in south-central Alaska (Fig. 1). This 9,000 square mile area is divided into two distinct physiographic divisions: The Kenai Mountains on the east rise in elevation to 6,000 feet and are heavily glaciated and snow-capped; the Kenai lowland, or plain, on the west, has charac-

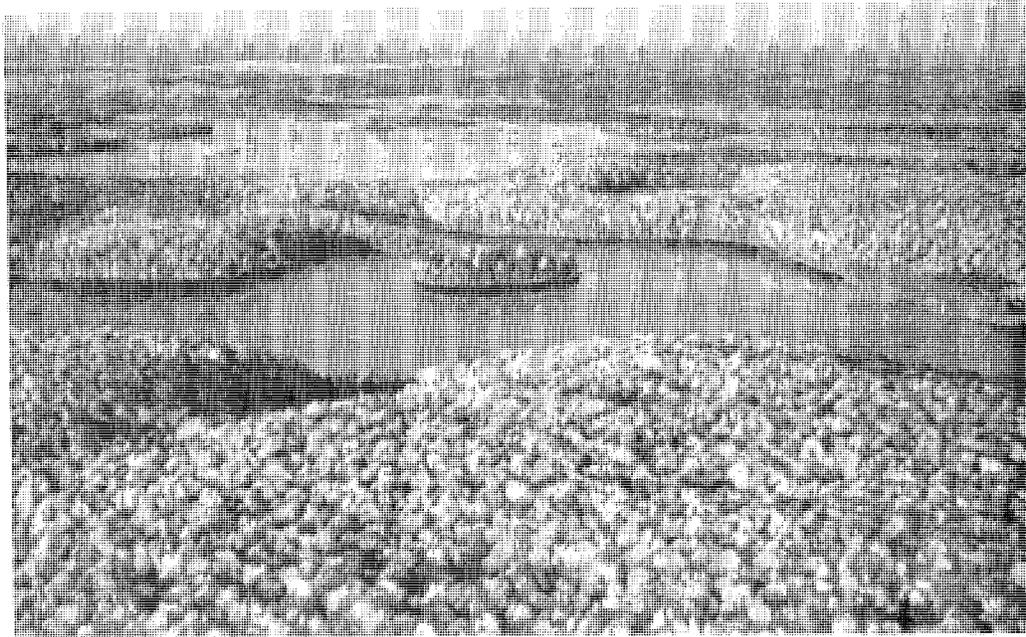


Fig. 2. Lowland area is dotted with more than 1,000 lakes.

teristics of much of interior Alaska. This discussion deals with the features of this lowland.

The area appears as a vast plain of some 3,000 square miles, composed of flats, low ridges, hillocks and muskegs, dotted with more than 1,000 lakes (Fig. 2). The general elevation is 50 to 300 feet, with benchlands (Fig. 3) rising to 2,000 feet between Skilak and Tustumena Lakes and again in the Caribou Hill area. It was formed by a vast valley glacier and consists of a thick sheet of glacial deposition along with water-laid sands and gravels. A thin loess mantle extends over much of the area.

Climatically, the region exhibits characteristics of both maritime and continental zones. Annual precipitation is 17 to 20 inches with an average snowfall of 55 to 60 inches. Snow accumulation is usually less than three feet. The mean annual temperature is 33°F. The growing season averages 88 days, usually beginning about June 11 and ending September 6.

White spruce, *Picea glauca* (Moench) Voss; paper birch, *Betula papyrifera* Marsh. var. *kenaica* (W. H. Evans) A. Henry; and quaking aspen, *Populus tremuloides* Michx., dominate the forest vegetation on the better drained soils. The poplars, *Populus tacamahacca* Mill. and *P. tricarpa* Torr. and A. Gray; black spruce, *Picea mariana* (Mill.) Britton, Stern and Pogg; willow (*Salix sp.*) and green alder, *Alnus*

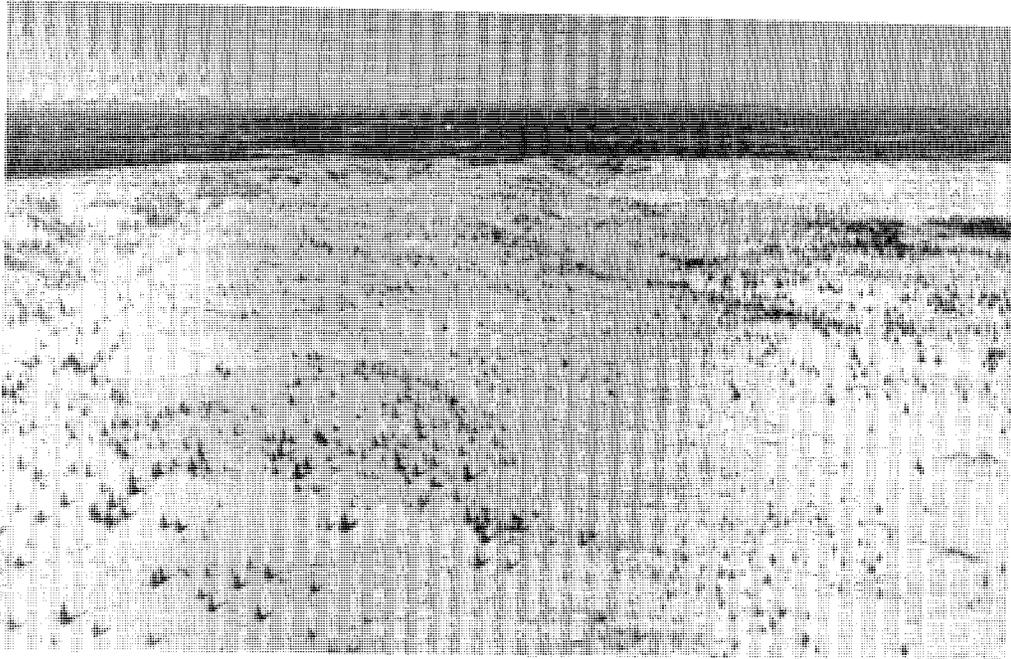


Fig. 3. Benchlands rising to 2,000 feet between Skilak and Tustumena Lakes. This is excellent late fall and early winter moose feeding area.

crispa (Ait.) Pursh, grow on the wetter sites and in the better drained areas that have been burned repeatedly by fire. Thickets of alder and devil's-club, *Oplopanax horridus* (J. E. Smith) Miq., grow in some areas near the coast. The muskegs are covered by sphagnum moss (*Sphagnum sp.*), low shrubs and a few black spruce.

The Kenai National Moose Range was established by Executive Order in this region in 1941. Typical moose habitat, it includes 1,800,000 acres of the best moose range. Located in the northwestern part of the Kenai Peninsula (Fig. 1), two-thirds lies within the great Kenai Lowland.

HISTORY

Little was known of the Kenai Peninsula's biological characteristics before 1875. Until the nineties, it was evidently Stone caribou, *Rangifer arcticus stonei* Allen, country and moose were scarcely known to old residents. Lifelong dwellers on the Kenai, now in their ninth decade, recall that in their youth they hunted white sheep at the head of Kasilof (Tustumena) Lake for winter meat. Caribou were native to the Kenai Peninsula but were extirpated about 1913, presumably because of unfavorable forage changes (destruction of lichen range), blockage of migration routes and hunting remnant populations.



Fig. 4. Alaska moose, *Alces gigas* Miller.

Between 1871 and 1910 widespread fires created habitat favorable to moose (Fig. 4), and in the present century the Kenai has become famous for its great moose herds. Many moose capes and antlers were exported from the Kenai Peninsula toward the close of the nineteenth century. Mr. Dall DeWeese collected six moose specimens for the National Museum during an 1898 expedition in the Tustumena Lake area. These included the type specimen of the Alaska Moose, *Alces gigas* Miller, an adult male (Lutz, 1960).

A rapidly growing moose herd became evident about 1910, coincidental with the disappearance of caribou. Sportsmen from many lands were attracted to the excellent hunting on the Kenai and to the record moose trophies. Market hunting, associated with fox farming and construction of the Alaska Railroad, flourished during the period. Increasing interest by scientists and sportsmen led to suggestions as early as 1916 that the area be designated a game range. A large moose herd has existed to the present time, probably reaching peaks of abundance in 1922-23 and again in recent years (Fig. 5).

Early management investigations were made by Alaska Game Wardens Culver, Walker, and Hardy during 1923 and 1924, when moose were experiencing die-offs as a result of severe winters and food competition with the snowshoe hare, *Lepus americanus dalli* Merriam. A formal proposal was made by the Alaska Game Commission

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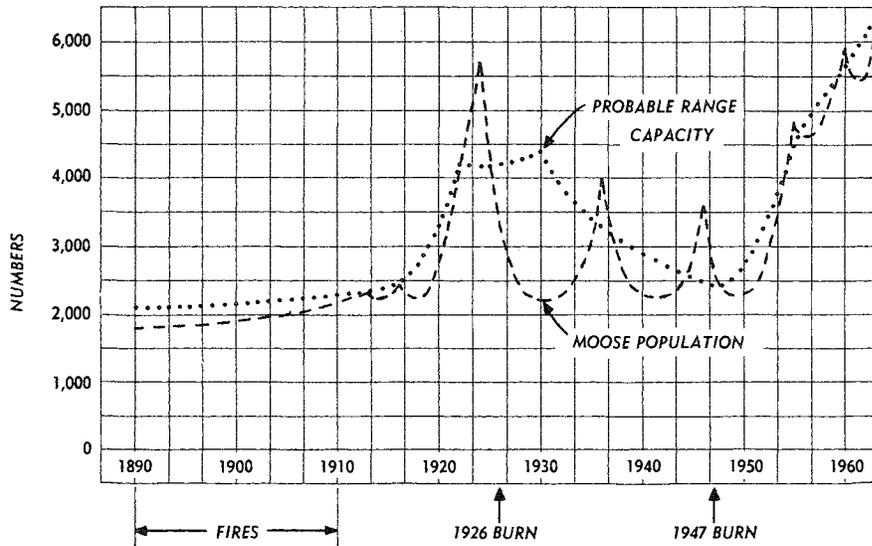


Fig. 5. Estimated population and probable range capacity 1890-1960.

for a national moose reserve in 1932 but the proposal was held in abeyance. For nine years investigations of the proposed range were continued by Lawrence J. Palmer, Frank Dufresne, Hank Lucas and others. These studies confirmed the value of the region as a moose range. The Kenai National Moose Range was established by President Franklin D. Roosevelt on December 16, 1941 (Executive Order No. 8979) as a part of the National Wildlife Refuge System.

FORESTS AND FORAGE, FIRES AND MOOSE

The Kenai lowland is typical interior forest, containing a mixture of white spruce, black spruce, poplar, aspen and Kenai white birch. These are grouped according to Sandor into the following forest types: Aspen, aspen-birch, birch, black spruce, cottonwood, white spruce, white spruce-aspen and white spruce-birch (U.S.D.A., 1955). White spruce is the climax type on well-drained soils. Black spruce is invariably a dominant type on poorly drained forested sites. Other types represent various transitional stages toward climax forests, a matter that has been given detailed study by Lutz (1953).

Fully stocked forest stands (Fig. 6), where growth has passed be-



Fig. 6. Fully stocked forest stands produce insufficient browse to sustain large moose herds.

yond availability of browse for moose, produce insufficient forage to sustain large moose herds. Moose management is therefore concerned with the early plant successional stages where deciduous browse is available, and with factors that retard succession and maintain browse stands in seral hardwoods.

The tree species of importance as moose browse in this area are: Kenai paper birch, aspen and cottonwood. Associated shrub species of significance as winter moose food from the standpoint of palatability and availability are: numerous species of willow, particularly those attaining small tree size, *Salix bebbiana* Sarg., *S. scouleriana* Barr., *S. arbusculoides* Anderss. and *S. Barclayi* Anderss.; Bog birch, *Betula glandulosa* Michx.; and Dwarf arctic birch, *Betula nana* L. ssp. *exilis* (Sukatch.) Hult., Serviceberry, *Amelanchier alnifolia* Nutt.; Mountain ash, *Sorbus scopulina* Greene; and Mooseberry viburnum, *Viburnum edule* (Michx.) Raf., are of minor importance.

The pattern of forest types on the Kenai National Moose Range is evidence that for a long period fire-caused vegetative changes have occurred which have produced forage capable of supporting moose. It is therefore probable that moose have existed on the Kenai for long periods (Lutz, 1960). Within recorded history it seems likely that the

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greatest impetus to the production of large moose populations was through widespread fires occurring about 1870 to 1900. The first records of very large populations were in 1913 and 1916, followed by other peaks in 1922-23, 1936, 1945 (Spencer and Chatelain, 1953) and in 1960. These large populations attracted attention due to die-offs resulting from populations exceeding the capacity of the range and associated severe winter conditions. The hypothetical course of moose populations based on recorded information and the observation of habitat types is presented in Figure 5.

The extent and pattern of former burns, the probable vegetative development in these burns, and evidence of past heavy browsing indicates that moose populations during the past 75 years were probably lower than present numbers.

In 1964 the Kenai Moose Range had an estimated wintering population, after harvest, of 5,500 moose. The reported 1963 harvest (harvest tag system) was 761 moose—518 males and 243 females. This Range population exceeds any previous qualified estimate for the entire Kenai Peninsula, a population largely supported by forage in the 1947 Burn.

THE 1947 BURN

A fire starting from road construction on June 3, 1947, burned relatively unimpeded for six weeks until extinguished by late summer rains. (At this time, forest fire control organizations were inadequately equipped to cope with fires of this size.) The heart of the lowland (310,000 acres) from Skilak Lake northwest to Swanson River was burned. All types of the interior forest were represented with a large number of relics remaining—tracts unburned by reason of topography, ground, fuel or fire behavior. These include pure stands of birch and aspen and some mature white spruce-birch forests located on ridges.

The nature of vegetative growth within the 1947 Burn indicates that no fire had occurred here for more than fifty years. Available winter forage for moose was therefore at a low level. The area encompassed within the Burn had been closed to moose hunting for fifteen years prior to the fire. In spite of this, the region supported only a sparse moose population. A January 1949 survey recorded 273 moose in the burned area.

VEGETATIVE SUCCESSION FOLLOWING BURN

Twelve succession transects (Figs. 7, 8) were established within the burned area in 1950 and rechecked in 1955 and 1961. These have provided a quantitative record of vegetative change (Fig. 9); a record supplemented by observation of a variety of successions in progress on various types. Plant successional development of interest to moose management is as follows.

Spruce reproduction (Fig. 8), white and black, is nearly universal over the entire burn. This revegetation started immediately following the fire and now shows dense stocking with dominants five feet high, forecasting a loss of the forage value of hardwood browse species in another fifteen to twenty years.

Aspen, prominent throughout much of the original stand in scattered trees or small groves, resulted in heavy and immediate vegetative regrowth through root suckering (Fig. 10) and later through



Fig. 7. Twelve plant succession plots were established in 1947 burn area. Photo shows severely burned black spruce stand revegetating to sedges and herbs.

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seedling stock (Fig. 11). Much of this aspen has been retarded or killed by heavy moose browsing and natural competition. Some aspen stands have been underbrowsed with a result that pole stands up to 3 inches dbh have developed (Fig. 12).

Approximately one-fifth of the 1947 Burn has revegetated to birch (Fig. 13) through reseedling from remaining mature trees. These birch stands have dense stocking with dominants ten feet high. Spruce reproduction is less dense here than in other areas of the burn. Utilization of birch reproduction has been moderate and it is expected that much of this stand will proceed to maturity.

Areas where only grasses, forbs and spruce have returned are in the minority (Fig. 14). Willow reproduction, in varied density throughout, shows evidence of heavy browsing.

The revegetation of this burned area has been determined largely by the vegetative types existing prior to the fire. Supplements have



Fig. 8. Checking vegetative plot prior to control burn.

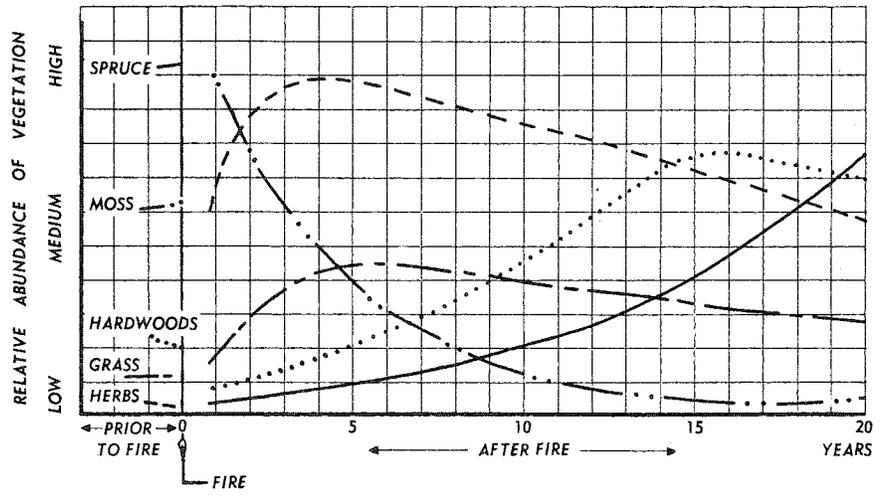


Fig. 9. Quantitative record of plant succession 1950-1961.

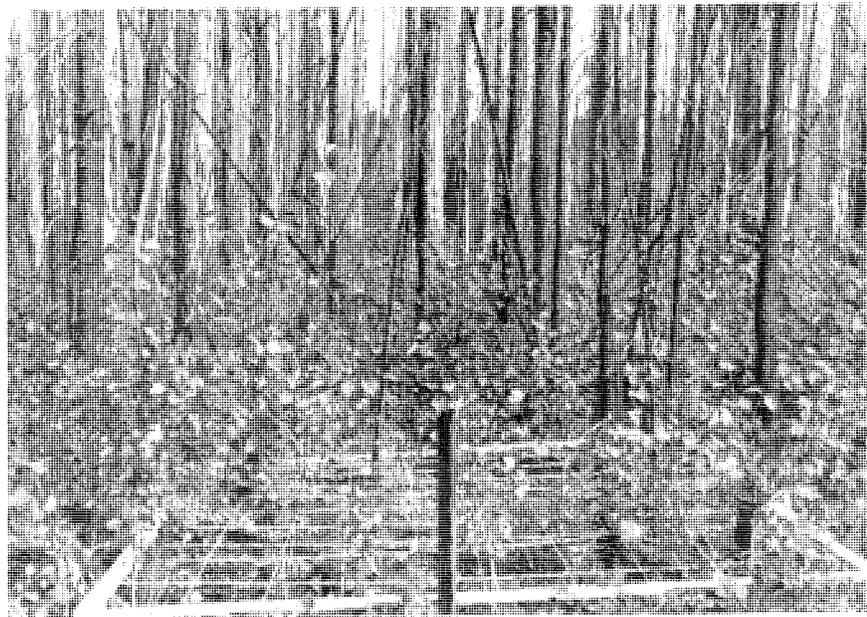


Fig. 10. Aspen, prominent throughout much of the original stand, resulted in heavy and immediate vegetative regrowth through root suckering.

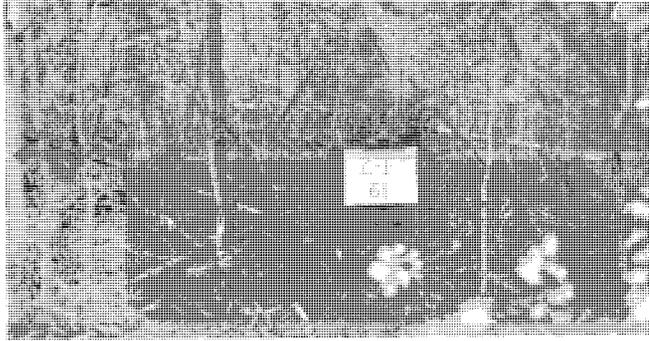


Fig. 11. Aspen seedlings invading sites supplementing growth by root suckers.

Fig. 12. Underbrowsing by moose resulted in pole stands 3 inches dbh.

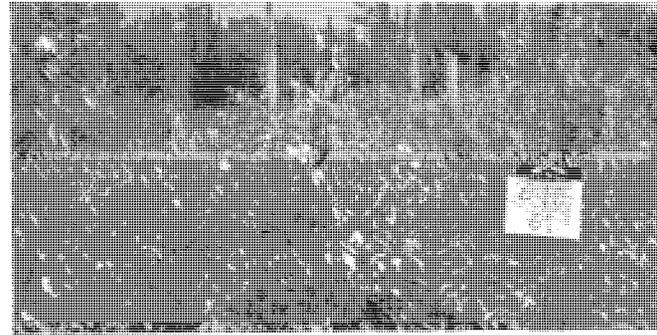


Fig. 13. Approximately one-fifth of the 1947 Burn revegetated to birch.

Fig. 14. Areas where only grasses, forbs, and spruce returned are in the minority.

been added by the light seeding species—willow, aspen and birch. Seventeen years after the burn this developing hardwood vegetation now appears to have reached the peak in forage production (Fig. 9). A high level of forage has been maintained for eight years and conceivably may continue an additional eight to ten years for a total of sixteen to eighteen years. If conditions remain unchanged, most forage value will be lost in twenty years.

MOOSE POPULATIONS

Moose population data obtained by aerial surveys is summarized in the following graphs.

Figure 15 presents the estimated moose population, sample area counts from which population estimates were derived and the annual moose kill on the Range from 1949 to 1964. Winter losses were experienced in 1956-57 and 1961. Harvest for 1961, 1962 and 1963 were about equal to the annual increases.

Figure 16 shows the bull-cow ratio within the 1947 Burn and elsewhere on the Range. Note that this ratio has declined at a greater rate than the remainder of the Range because of heavy hunting pressure within the Burn area. With the advent of cow seasons in 1962, it is believed this ratio will tend to stabilize.

Figure 17 presents the calf-cow ratio in the 1947 Burn area as compared to the remainder of the Moose Range. This ratio is derived from late November surveys when a number of moose, equal to about one-half the population, is examined from the air and recorded by class: bull-cow-calf. In general, the 1947 Burn has supported a higher calf crop than the remainder of the area, however, there has been a gradual overall improvement in the calf-cow ratio during the 1951-1962 period. Downward fluctuations are noted in 1955, '56 and '61, presumably the result of poor forage conditions and resultant reduced vigor of cows caused by the severe winters of 1954, '55 and '60. These fluctuations do not appear in the remainder of the area, a condition that may reflect lack of cover in the burn area or low height of the majority of browse plants.

Figure 18 presents the percentage of the moose herd that utilized the 1947 Burn area during November composition counts and January inventories. Both surveys show a similar pattern. In 1950, three

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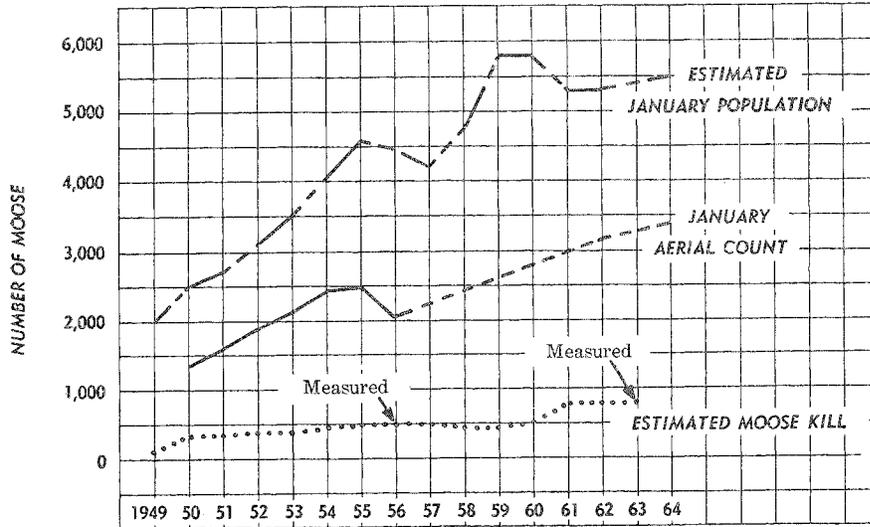


Fig. 15. Estimated moose population, sample area count, and annual moose kill 1949-1964.

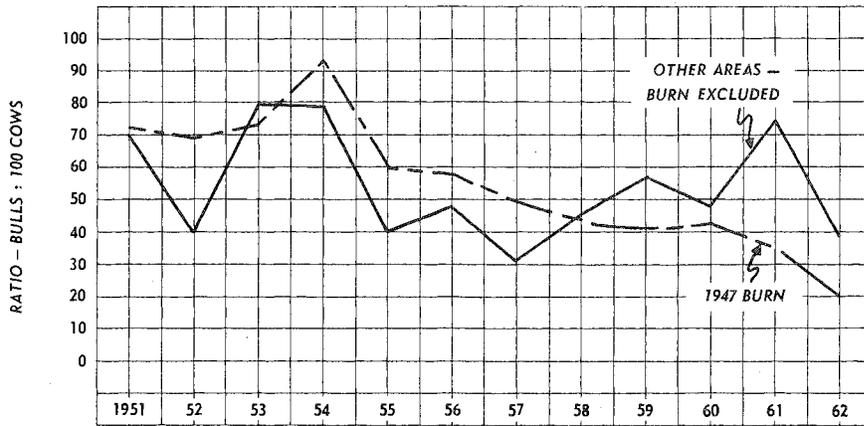


Fig. 16. Bull ratio depicting use of the 1947 Burn versus other areas.

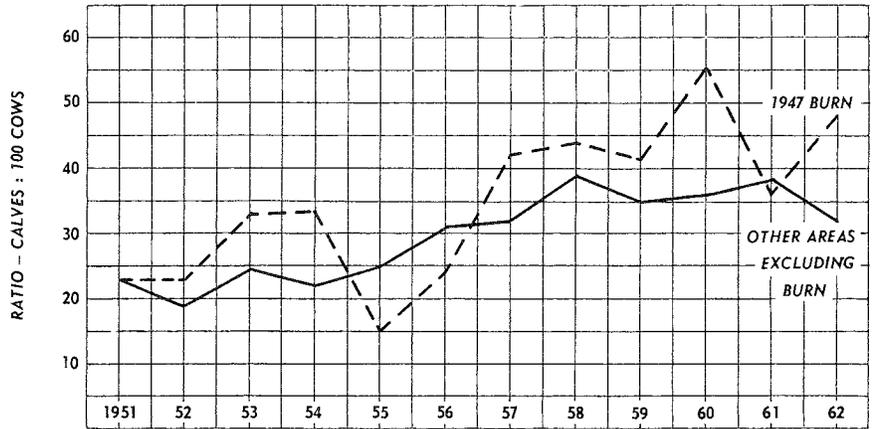


Fig. 17. Calf ratio depicting use of the 1947 Burn versus other areas.

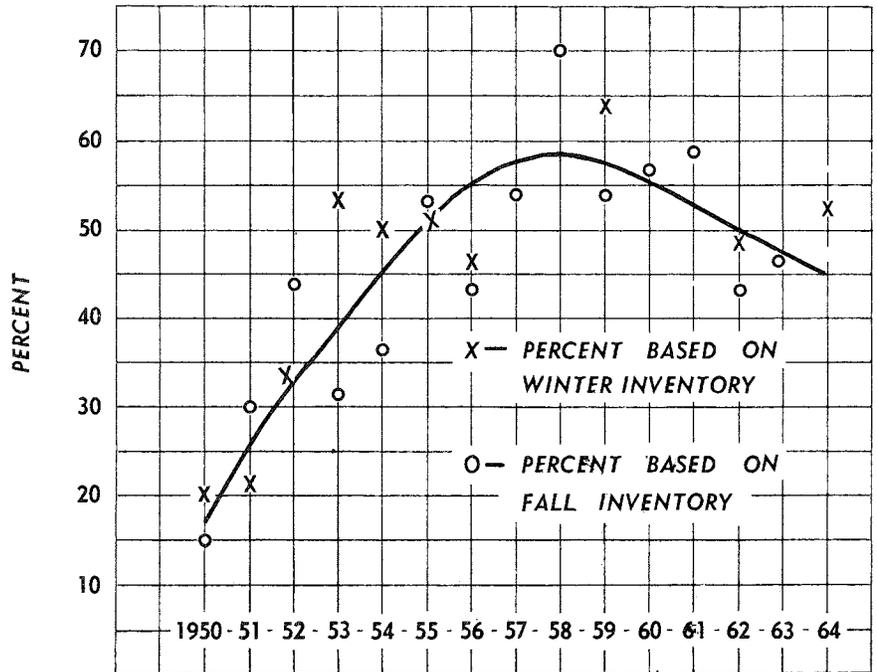


Fig. 18. Curve showing percent of moose herd using 1947 Burn area.

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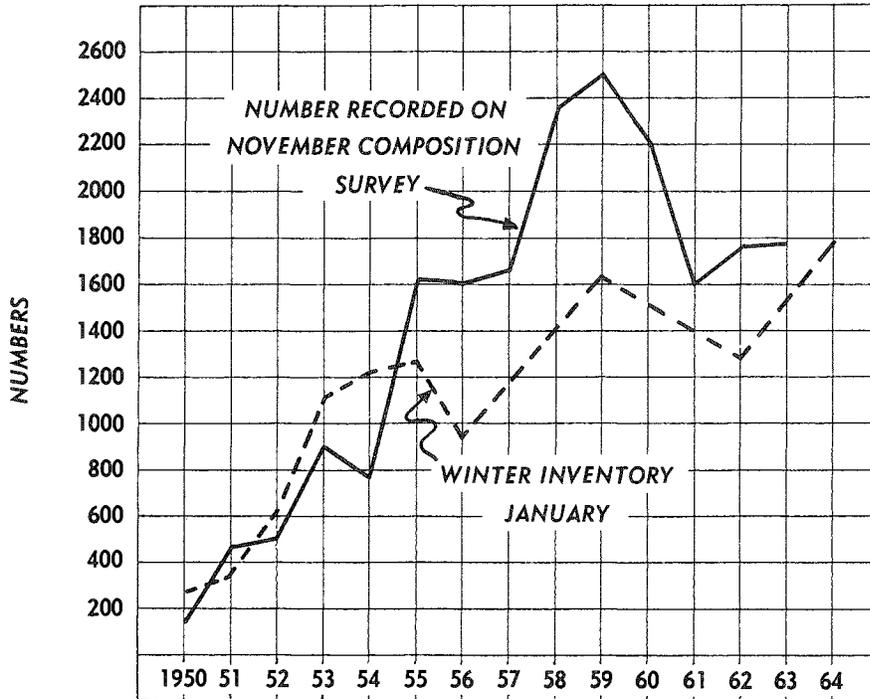


Fig. 19. Moose counts, 1947 Burn area.

years after the fire, about 15 percent of the herd used the burn area. This rose to roughly 60 percent of the herd in 1958. Since then a decline has been evident. It is believed that the decline reflects increased hunting in this area rather than a reduction in available forage.

Figure 19 records two series of actual moose counts within the burn area. Total numbers varied from a low of 140 in 1950, three years after the fire, to a high of 2,500 in 1959, twelve years after the burn.

Surveys designed to record the pattern of calving were conducted between 1957-1963 within the 1947 Burn. These consisted of an average of 20 early morning flights from May 15 to July 5, with an average of 200 moose tallied per survey. All flights covered the same unit, selected because of open visibility. Figure 20 records the peak of calf-cow ratios on these surveys. Fluctuations within this period

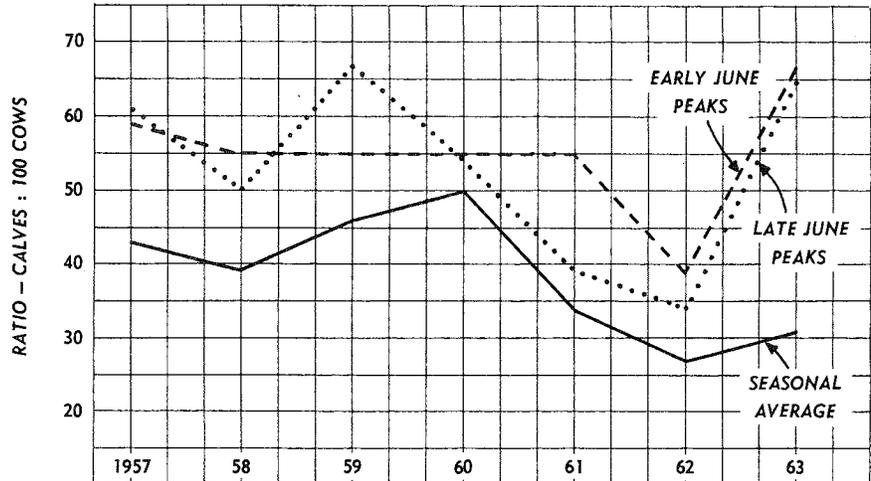


Fig. 20. Summary of calf production aerial surveys.

are thought to reflect the winter conditions preceding the calving period.

More than 150 lakes suitable for aircraft use are located within the 1947 Burn. Much of the Burn is therefore accessible to locating moose from the air, after which a landing is made and the animal harvested. The center of the area is 40 miles from Anchorage and, as a result, moose within the Burn are subject to maximum hunting effort and high hunting success.

An estimated one-third of the moose using the 1947 Burn are resident, although they shift within the area. It is a favored calving ground, a phase of life history where some preference is indicated for muskeg or marshy areas. Cows and calves move out of the Burn area in July. Wintering moose populations usually move into the Burn in early December (Fig. 21) drifting in from the eastern mountains and southern foothills. They disperse toward the highlands in May.

Seasonal movements of moose into and within the Burn tend to be irregular and are influenced greatly by winter weather conditions. Moose concentrations are not prominent during mild winters. Severe snows concentrate moose and extend travel for feeding into areas which are relatively unbrowsed in mild years. Uneven use of the forage within the Burn results from varied feeding travel. This,

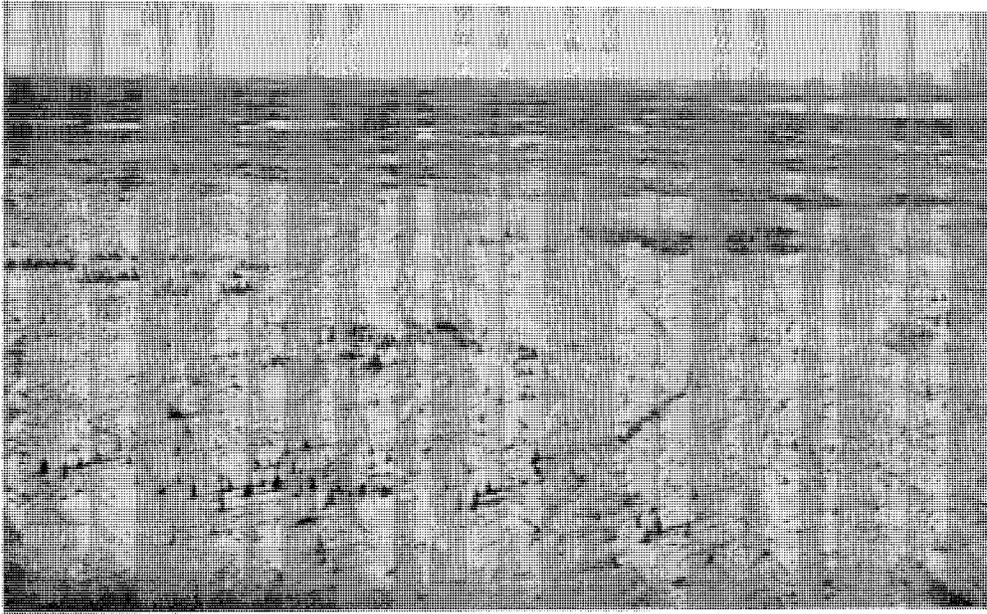


Fig. 21. Winter moose range.

in turn, influences the number of years that forage plants are available for use and, to some extent, the course of plant succession.

In summarizing the effects of the 1947 Burn on the Kenai Moose Range herd, it is apparent that improving forage conditions within the Burn permitted increasing moose population, whereas the trend prior to the Burn was that of a declining population because of deteriorating winter forage.

The Burn covered roughly one-fourth of the winter moose habitat on the Range. Three years after the fire, 15 percent of the herd was recorded within the Burn, whereas 10 to 12 years after, 55 to 60 percent of the herd was found to winter there. November calf ratios rose during the 1950-62 period from 23 calves per 100 cows to 40 to 50 calves per 100 cows. The calf ratio was higher than that on the remainder of the Range, although not spectacularly so.

OTHER BURNS

Prior to the large 1947 Burn, other fires on the Range produced a variety of post-burn conditions. A few of these are reviewed:

Kasilof area. Approximately 10,000 to 12,000 acres in a settled area has repeatedly burned, most recently in 1926. Since 1920 it has sup-



Fig. 22. Habitat improvement work, 1926 Burn area. Spruce has been removed by "Cats" equipped with shearing blades.

ported high wintering populations over much of the period which has resulted in a hedge-like growth of birch and willow about five feet high. Live willow rootstocks producing browse can be traced back 50 years. Although much of this range is badly deteriorated due to overuse, much forage is still produced. Exclosures dating back to the early '30's show tree size birch but no available forage. Spruce invasion has been slow and sparse.

Silkok area. A white spruce tract of approximately 4,000 acres burned in 1926. Revegetation resulted in dense even-aged spruce which canopied in the early 1940's. It concurrently developed a good browse stand of willow, birch and aspen and was heavily used until 1950. The browse stand has become decadent but has supported a fairly uniform snowshoe hare population in recent years. Spruce has now been removed from the entire area by habitat improvement work to rehabilitate browse growth (Figs. 8, 22).

Funny River plateau. This 20,000 acre benchland, about 1,000 feet in elevation, burned most recently about 1885 to 1890 and probably covered a previous burn. The area continues to support heavy willow growth, hedged by browsing to 4 to 5 feet high. Invasion by spruce has been slow but is increasing in recent years. It has support-

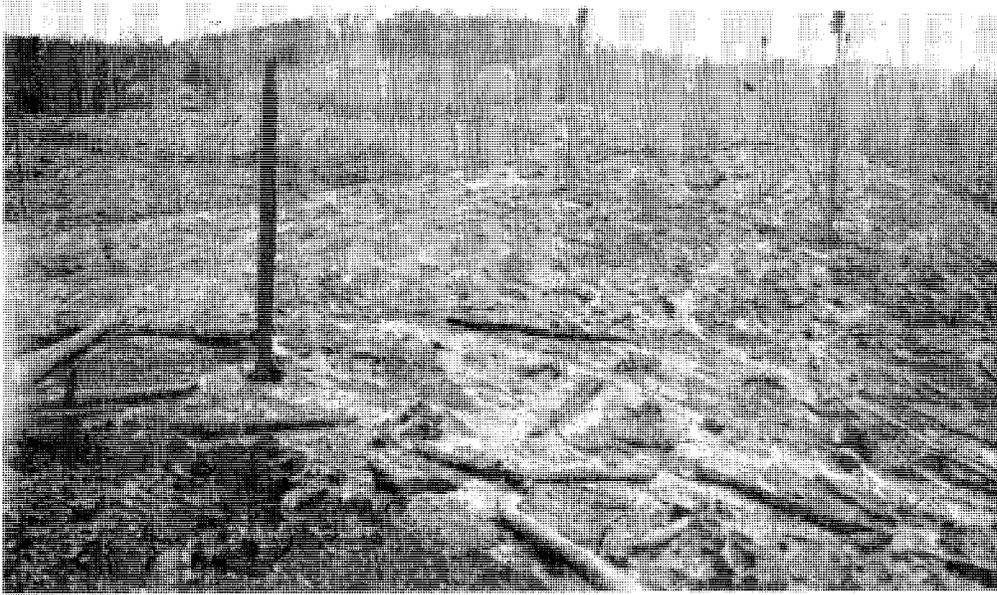


Fig. 23. Engineer Lake fire, July, 1963.

ed heavy fall and winter moose populations for over 40 years and was a favored hunting area in the days of extended pack horse hunts.

Chickaloon River. This poorly drained tract of 2,000 acres burned around 1900. It revegetated to a pure and dense stand of black spruce and apparently never supported any hardwood browse stage.

Bedlam Lake. A 10,000 acre white spruce-birch stand burned in 1915 to 1920. It revegetated heavily to birch with sparse stocking of spruce and provided a significant wintering site during the 1930's and 1940's. However, much of the birch stand grew out of reach and the area no longer supports browse growth of importance.

Engineer Lake. Four hundred acres of the 1947 Burn were reburned in July, 1963, by a hot fire (Fig. 23) which removed all windfalls and moderately heavy spruce reproduction. At the end of the summer birch and willow rootstock showed regeneration by basal resprouting (Fig. 24).

SUMMARY OF FIRE AND MOOSE RELATIONSHIPS

1. Vegetation immediately following the 1947 Burn was largely determined by the previous stand. Revegetation was through both vegetative and seeding reproduction. Types following the fire were numerous and variable in response to the original forest cover and to severity of burn.

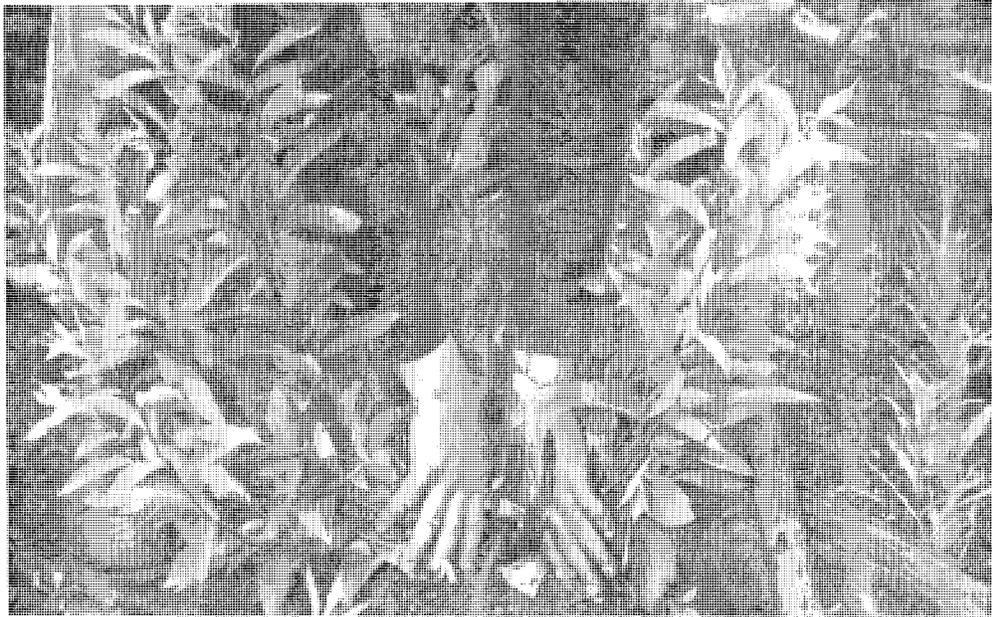


Fig. 24. Willow rootstock showing regeneration by basal resprouting, Slikok Lake burn.

2. A mixed type of browse stand—preferably willow-birch-aspen—is of much greater forage value than a predominantly pure stand of aspen or birch.

3. Revegetation by spruce—white or black—generally appeared inevitable when permitted by seed sources and has occurred over nearly all of the 1947 Burn.

4. On the 1947 Burn browse growth began through aspen root sucker growth the summer immediately following the fire. Browse growth providing winter forage progressively developed, and appeared significant in attracting moose within five years after the burn. Heavy browse growth was reached in about seven years with maximum growth about 15 years after the burn.

5. After burning in the boreal forest, under suitable conditions, there is a period extending from 5 to 20 years, occasionally 60-70 years or longer, when moose forage conditions are favorable.

6. As winter forage in the Burn increased, the moose wintering population increased both through accelerated production in the herd and through animals drawn from other less favored wintering areas.

7. A slow progressive increase in calf production occurred for ten years after the 1947 Burn, followed by relatively stable production with yearly fluctuations influenced by weather.



Fig. 25. Climatic conditions limit use of controlled fire to produce moose feed. (Slikok Lake burn).

8. Climatic conditions: severity of winters, snow depth, ice, temperatures and wind have highly variable effects on seasonal feeding movements of moose and hence on the utilization of the browse stand. The 310,000 acre 1947 Burn, with an overall wintering population of five moose per square mile, is probably stocked close to sustaining capacity in severe winters. Nevertheless, there are wide areas that are under-utilized and where birch and aspen are developing to pole size unimpeded by browsing activity. Other large tracts are over-utilized.

Frequent severe winters appear to distribute utilization and may actually be favorable in the long-term view by retaining browse species at an available height.

9. Viewed solely from the standpoint of moose management, forest fires in this forest zone have generally been beneficial through the production of winter browse in sufficient quantity to maintain large moose herds. Duration of browse growth and volume produced is highly variable. Some areas have produced no browse growth following fires.

There is evidence that a single reburn at a proper interval will extend the browse production period of an area through the reduction of developing spruce growth. Repeated burns may favor grasses and forbs with elimination of browse and spruce growth.

FUTURE COURSE OF KENAI RANGE WORK

The dedication of the Kenai National Moose Range to the perpetuation of the Alaskan moose obviously requires a priority in habitat management directed to the maintenance of vast areas of hardwood browse required to support a moose herd of the present size.

The many other values in the area, public outdoor recreational use, adjacent settlement, fisheries resources and economic use of the area, can no longer tolerate widespread fire. Therefore, adequate winter range must be created by adequately planned and funded habitat improvement work.

To date the leading means of habitat improvement work has been through mechanical means—the eradication of spruce pole stands by heavy tractors with specialized shearing blades and rolling choppers. Roughly 5,000 acres have been so treated.

Under certain conditions controlled burning has been used (Fig. 25). It appears at this time that light burning within the 1947 Burn may reduce developing spruce cover and yield an extended period of forage production. Control Burns have numerous disadvantages—to name a few: destruction of humus on rocky and loess soils subject to erosion, greatly restricted period of application limited to a variable number of days per year, extensive preparation and support required, and reduction of visibility by smoke—an aircraft hazard.

Chemical treatment for the elimination of spruce has been inadequately developed to date although more experimentation is indicated.

Large scale timber utilization is a most favorable possibility for moose range improvement. Although not economically possible at this time, this use may be important in future management.

The Kenai National Moose Range has a highly complex ecology and land use program. In addition to the moose, excellent habitat is provided for Dall sheep, *Ovis dalli kenaiensis* Allen; mountain goat, *Oreamnos kennedyi* Elliot.; brown bear, *Ursus kenaiensis* Merriam; black bear, *Euarctos americanus perniger* (Allen); fur animals; the trumpeter swan, *Olor buccinator* Richardson; and other waterfowl.

It provides spawning areas for commercial salmon resources valued at over three million dollars annually, while the sport fishing and boating opportunities exceed those of many entire states. It is one of

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the most important outdoor recreational tracts in Alaska with increasingly heavy public use. It includes the only oil field in Alaska with production of 30,000 barrels per day, while hundreds of thousands of acres of timber await productive use. These considerations require careful planning, zoning and development of only the necessary winter moose range, to prevent the loss or damage of the other values of the area.

Overall is the inherent objective to retain a natural unit of wildlife habitat—large undisturbed tracts of environment.

ACKNOWLEDGMENTS

The studies reported herein were made as functions in the management of the Kenai National Moose Range during the period 1948 to 1964. Work was conducted under the direction of refuge managers in charge including Willard A. Troyer, current manager, and former refuge managers H. J. Johnson and the authors.

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