curnua DC.) and creosotebush, grazing capacity declined. Some of the tarbush died in recent drought years, and the invasion of the grassland sites by this species was set back.

Summary and Conclusions

During years of low precipitation on black grama and tobosa grasslands and associated shrub ranges of the Southwest, herbaceous cover is reduced and in years of more favorable rainfall it recovers. During a series of dry years on the Jornada Experimental Range in south-central New Mexico basal area of black grama was reduced to approximately the same point irrespective of grazing intensity. Recovery of black grama was greatest where grazing usually removed less than 40 percent of the herbage. Tobosa maintained its greatest basal area under somewhat heavier grazing, which removed 40 to 55 percent of the annual herbage growth.

Sustained grazing capacity does not exist on these semi-desert ranges. There are periods of high forage production and periods of low forage production (Lantow and Flory, 1940). Correspondingly, stocking may be high in some periods and in others there is virtually no capacity. During periods of deficient rainfall, forage production declined irrespective of the grazing use and the best management. Twice in 40 years on the Jornada Experimental Range it was necessary to remove nearly all the cattle during extreme drought periods, despite application of the best known techniques of range management.

Where shrubs such as mesquite are in the initial stages of invasion of the grassland areas an active and continuing program of brush control is mandatory. Otherwise, an ever-increasing decline in grazing capacity must be anticipated. Once the mesquite sandhills stage is reached, it is presently not economical to attempt control (Knox et al., 1951).

LITERATURE CITED


Range and Livestock of Kodiak Island

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The need for successful basic industries in Alaska regardless of size, has become increasingly evident since the advent of Statehood. Although comparatively small and somewhat obscure, the livestock industry of northeast Kodiak Island may satisfy a portion of this need.

This paper presents a general history and description of the range and livestock of the northeast portion of Kodiak Island rather than results of intensive studies. Northeast Kodiak is the area, approximately 307,200 acres, northeast of a line between the head of Kizhuyak Bay and Ugax Bay (Figure 1).

History

The value of the range lands of northeast Kodiak is not a recent discovery. The Russians recognized this value, when in 1794, the first cattle, a Siberian breed, were introduced. About 300 of these cattle were maintained in the vicinity of what is now the town of Kodiak from 1795 to 1868 by the Russian American Company (Elliott, 1887). Strains of this original Siberian breed are still seen today.

During the latter part of the 1800's several small herds of cattle were maintained on Kodiak by the Alaska Commercial Company. These cattle were fed hay prepared from native grasses for two to six weeks each winter. The remainder of the time they foraged for themselves (Piper, 1905).

The Frye-Bruhn Company of Seattle, meat packers, imported about 200 head of Hereford cattle in July 1903. This operation was located near English Bay, an area now known as Old Womens Bay. During the first winter and early spring these cattle were allowed to drift to the high precipitous slopes and...
about 140 head were lost. Some of the surviving Herefords slaughtered during July 1904 furnished beef of remarkably fine quality (Piper, 1905).

In 1906 an agriculture experiment station was established on Kodiak. Dual purpose cattle, West Highland and Galloway, became the specialty of this station. Galloways were selected because of their gentle nature and polled characteristic. The experiment station continued in operation from 1906 to 1931. At termination in 1931, most of the animals were moved to the Matanuska Valley. A few were sold as breeding stock to the local ranchers, some of whom are still in operation today.

Sheep came into the picture in 1883 with the importation of 300 by the Alaska Commercial Company. These sheep came from California and many died either from scab mite infestation or lack of shelter the first winter. The survivors were slaughtered sometime in 1898.

A second effort to establish sheep on Kodiak was made by Frye-Bruhn Company of Seattle when in 1902 and 1903 about 9,000 head were shipped in from Oregon. By 1904 the remnants of this band numbered about 80 head. The loss was attributed to drowning and scab mite infestation (Piper, 1905).

Offspring of the 80 head were eventually moved to Harvester Island adjacent to the northwest shore of Kodiak and number about 47 head today. The record is vague as to the type of sheep imported but the animals on Harvester Island exhibit some characteristics of a fine wool breed.

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The flat land lying at the deltas of streams are as a rule, very heavily covered with grasses. The primary species being blue joint, Calamagrostis lanfiorfi (canadensis), salt sedge, Carex chryptocarpa (lyngbyei,) and beach rye, Elymus mollis, also coarse blue grass, Poa glumaris.”

During May 1912 northeast Kodiak was covered with 6 to 8 inches of ash from the eruption of Mt. Katmai (some authorities say Mr. Novarupta). This caused some curtailment of the grazing enterprise during 1912. The annual report of the Alaska Agricultural Experiment Station for 1914 indicated that the grass spread to more extensive areas subsequent to the ash fall. The spread of Sitka Spruce was also considered to be accelerated after the ash fall (Geogeson, 1915). Proximate analyses of blue joint grass (Table 1) indicate the value of this common species both before and after the ash fall.

**Climate**

Due to the maritime influence, the climate of Kodiak Island is generally cool and humid. Mean annual precipitation is 61.46 inches with the maximum monthly mean of 7.73 inches occurring in October and the minimum monthly mean of 3.46 inches occurring in March. Air temperature seldom exceeds 70° F. or goes below 0° F. The frost-free season varies from 86 to 201 days, the average of 166 days usually occurs between May 1 and October 15. The average maximum accumulated depth of snow is 10 inches and varies from 2 to 31 inches. The U. S. Weather Bureau station from which these records were taken is located at 21 feet above mean sea level, consequently, greater accumulation of snow and a shorter frost-free period may be expected at higher elevations.

**Soils**

A surface or upper layer of
volcanic ash from the 1912 Mt. Katmai (Novaraputa) eruption is comomn to all soils of northeast Kodiak. Two soil groups are prevalent, the uplands and the gently rolling valley bottoms. The upland soils below the ash layer generally consist of a few inches of silty loam over glacial till derived from metamorphic and acid igneous rock. Valley bottom soils are usually dark grey, moderately drained silty loams under the ash layer. These silty loams overlie coarse alluvial sand and gravel. It is axiomatic that the better drained bottom areas are more suited for the production of forage plants.

Above the ash layer in these bottom soils and immediately under the duff and litter is a 3- to 6-inch layer of light grey and yellowish-brown coarse silt that has accumulated since the eruption.

The ash layer is strongly acid and very infertile. Mixing the ash with the underlying soil by deep plowing or discing prior to seeding has been practiced with moderate success by a few of the ranchers. However, heavy fertilization appears to be necessary for any substantial forage crop production. The application of 300 to 400 pounds of lime per production. The application of 300 to 400 pounds of lime per acre results in a perceptible increase in growth for oats and domestic grasses.

Grazing Leases
Grazing lands in Alaska administered by the Bureau of Land Management, Department of the Interior, are leased under the Act of March 4, 1927, (44 Statute 1452). This act predates the Taylor Grazing Act affecting the public domain in the 11 western states by more than seven years. Unappropriated public domain in Alaska under present regulations may be leased for grazing. Such a lease provides for lessee construction and maintenance of range improvements necessary for exercising grazing privileges. Range improvements are neither constructed nor maintained by the Bureau of Land Management. On Kodiak, with few minor exceptions, all current improvements, living quarters, fences, improved pastures, corrals and silos are located on leased land. Very little acreage is in private ownership.

Ranchers holding 20-year leases are usually required to utilize 60 percent of the estimated grazing capacity of the leased area. The grazing capacity is based on estimates of available winter forage. It has not appeared economical or practical to stock the range on the basis of available summer and fall forage. Currently, 10 ranchers hold 20-year grazing leases within the area.

Annual rental usually amounts to 60 cents per animal unit or adult cow. Leases allow for the adjustment of grazing capacity estimates whenever warranted. However, the rancher is not penalized by rental increases whenever privately improved grasslands provide for an increase in utilization of the summer ranges.

Range Types
Range surveys conducted by the Bureau of Land Management during 1949 and 1956 have classified the Kodiak ranges by types in accordance with Interagency Committee guidelines (Stoddart and Smith, 1943). Seven of these types are important for livestock grazing. About two-thirds of the total area, some 205,000 acres, was classed as waste or inaccessible. Included in this type was steep topography, dense forest, and areas laid waste by slides, floods, or beach sand. Perhaps a fifth of this type could be developed for summer grazing.

The tall-grass type is characterized by perennial grasses which predominate and determine the aspect. Browse and forb species are present but of minor importance. Bluejoint (Calamagrostis canadensis), tufted hairgrass (Deschampsia caespitosa), Beach ryegrass (Elymus mollis), arctic bluegrass (Poa arctica), and sweetgrass (Hierochloe odorata), are the most important grasses.

It is estimated that 20,000 acres (about 6 percent) of northeast Kodiak fall within this type. About 1.4 surface acres are required to support one animal unit (mature cow or five mature sheep) for one month on a year-round basis.

Native hay and silage are harvested from areas within this type. Annual per-acre yields of 2 tons of hay or 4.5 tons of silage have been obtained from unused areas. Under recurrent grazing use or harvesting, forage production diminishes rapidly. Preliminary data from forage production and trend studies indicate that bluejoint decreases and tufted hairgrass increases under moderate utilization.

Moisture enduring grasses and forbs located in intermittent moist areas determine the aspect for the dry-meadow type. Plant species of major importance are, fireweed, horsetail (Equisetum arvense), Lyngbye sedge (Carex lyngbyei), and giant bluegrass (Poa eminens). The dry-meadow type comprises only 370 acres or less than 1 percent of the total area.

The wet-meadow type (Figure 2) is characterized by sedges, rushes, and moisture-enduring grasses that remain succulent

<table>
<thead>
<tr>
<th>Table 1. Proximate analysis of blue joint grass</th>
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<tr>
<td>Protein N X6.25 Fat N. F. Ex. (Carbo) Fibre Ash (Percent)</td>
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<td>Bur. of Chemistry, 1904 7.18 4.58 1.03 40.37 42.94 3.90</td>
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<td>Unknown Lab. 1927 5.00 5.37 1.60 45.23 38.40 4.40</td>
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<td>Merchants Exchange Lab. 1950 9.25 4.60 1.04 40.81 38.80 5.50</td>
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throughout the year. It also includes recurrently flooded tidal flats. Major forage plants are Lyngby sedge, bluejoint grass, white cottongrass (Eriophorum scheuchzeri) plus a few forbs and shrub species.

Normally 1.7 surface acres of the meadow types are required to sustain one animal unit for one month. An estimated 5,715 acres or 1.8 percent of the total area is classed as wet meadow.

The perennial-forb type is estimated at 22,935 acres, 7.5 percent of northeast Kodiak. It includes all untimbered areas where perennial weeds predominate over other classes of vegetation. The most common plants occurring within this type are fireweed, goldenrod, horsetail, Nootka lupine (Lupinus nootkatensis), Angelica (Angelica geniculata), yarrow (Achillea millefolia), and spreading woodfern. Bluejoint and tufted hairgrass and a few shrub species are also important.

It is estimated that 2.1 surface acres of this type are required for one animal unit month. Generally, the forb type occurs along the upper better drained slopes and is utilized as summer-fall range.

Approximately 25,980 acres, 8.5 percent, of northeast Kodiak is classed as browse type. Over 150 density estimation samples and 170 weight samples were taken of this type during the range surveys of 1949 and 1956. Within accepted limits of variability the animal-unit-month requirement is estimated at 2.1 surface acres. The most common plants occurring in this type are salmonberry, low bush cranberry, high-bush cranberry (Viburnum edule), willow, and swamp birch (Betula nana-exilis). A few forbs such as fireweed, goldenrod, angelica, and yarrow as well as bluejoint, sweetgrass, and tufted hairgrass are also present.

Forested areas supporting an understory of grasses, forbs and shrubs determine the aspect of the conifer type. Conifers, principally Sitka spruce (Picea sitchensis) are restricted to the extreme northeast portion of Kodiak Island and the Cape Chiniak areas. From past records, it appears that the occurrence of spruce is increasing. Open stands of spruce are moderately utilized for grazing during the late fall and winter. About 6.1 surface acres are required for one animal-unit month. The open spruce stands provide shelter for the livestock during periods of inclement weather.

About 15,430 acres of this type are within the area. Primary plant species having grazing value are, spreading woodfern, horsetail, fireweed, Sitka vetch (Vicia gigantea), bluejoint, tufted hairgrass, and silvery sedge (Carex canescens).

The deciduous timber type is generally confined to the better...
drained flood plains along the water courses. Balsam poplar (Populus tacamahaca) is the primary tree species. Approximately 11,550 acres (3.7 percent) of northeast Kodiak is classed as this type. Major forage plants include fireweed, horsetail, Jacob's ladder (Polemonium pulcherrimum), bluejoint, tufted hairgrass, and a few shrubs.

It is estimated that 2.1 surface acres of this type will carry one animal unit one month. The overstory trees comprise only a small portion of the total forage plant composition because of their inaccessibility to livestock.

During calendar year 1959, 93 tons of native hay and 790 tons of silage (estimated) were produced on Kodiak. About 60 percent of the ensilage consisted of oats grown on improved range land. It was also estimated that 55 percent of the range grazing capacity was utilized.

Current Status of Livestock

The present livestock inventory of northeast Kodiak includes 1,320 head of beef cattle, 70 head of horses, and 165 head of sheep. This is an increase over 1950 when only 450 head of cattle and 55 horses were located within the area. Generally, the cattle are mixed even though purebred bulls are used by most of the ranchers. Since range breeding and exchange of bulls between ranches is a common practice, the livestock progeny are oftentimes difficult to distinguish as to breed.

The most common beef cattle breed on Kodiak is the Hereford with the Aberdeen Angus following a close second. The Santa Gertrudis is an exception. These breeds as well as the Galloway and West Highland, appear to be adapted to the range and climatic conditions of Kodiak (Figures 3 and 4). Newly imported animals require additional care during the first year of acclimation. Range habits and diets are considerably different than those of the western states. Usually, the newly introduced animals are bulls and consequently are more valuable.

Supplemental feed such as silage, hay, grain, and prepared concentrates are generally fed during January, February, March, and April. This is particularly true of bulls, heavy cows, and yearling calves. Over 130 tons of concentrate feed and grain were fed during 1959.

The most critical time, from the standpoint of death loss is during March and April. The average annual loss of about 10 percent over the past 10 years is attributed to malnutrition, brown bear predation, poisonous plants, and falls from the precipitous slopes.

Beef production, during 1950, was about 15,000 pounds. In 1959 almost five times that much, 72,300 pounds, was reported sold to Kodiak and Anchorage consumers. The average selling price of standard quality beef FOB Kodiak was $50 CWT in 1950 as compared to $44 CWT in 1959.

The only sheep on Kodiak distinguishable from the standpoint of breed characteristics are Columbia. The Columbia was introduced to Kodiak about 1953. During 1959 approximately 1,200 pounds of wool grading about 1/4 blood or a spinning count of 48, was clipped.

About one-half of the horses used in ranching operations can be traced to a Tennessee walking horse imported to Kodiak about 1945. Horses appear to be long lived and very well adapted to year-round range conditions. During 1959 there were three studs in service on the Island; two of which are offspring of the Tennessee Walker.

Currently, Kodiak Island is the center of Alaska's beef cattle industry. The ranchers here are independently organized as Kodiak Stockgrowers Association. Through this association the livestock industry on Kodiak has been developing at a slow but accelerating rate in the face of lowering beef prices, unstable markets, and increasing operating costs. This has been only one facet of Alaska's livestock industry. In southwestern Alaska, from Kodiak Island to Umnak Island of the Aleutian group, over 25,350 domestic livestock utilized less than 50 percent of the estimated grazing capacity of leased Federal range land in 1959.
Grass Seed Production from Seeded Range Lands

CHESTER L. CANODE AND J. K. PATTERSON

Millions of acres of range lands in the Northwest have been depleted of perennial grasses to the extent that only revegetation with adapted forage grasses will restore them to their production potential. Although many problems concerning range revegetation remain unsolved, a large amount of information is available on the cultural techniques necessary for establishing and maintaining grass under various conditions. Several superior grasses have been developed or selected and seed stocks are available from commercial sources.

At the present time only a small percentage of the range lands are being seeded even though proper cultural practices are generally known and seed is available. The prime reason for this situation appears in the economics of range seeding. General recommendations specify 6 to 9 pounds of seed per acre to produce adequate grass stands in a reasonable length of time. Seed of improved range grasses from commercial sources costs from $.40 to $1.00 per pound. Narrow operating margins make it necessary for the rancher to reduce seeding cost.

Records of the Idaho State Office, Bureau of Land Management, U. S. Department of the Interior, indicate the potential of seed production from range seedings. This agency secured 990,000 pounds of seed of crested wheatgrass (Agropyron desertorum (Fisch.) Schult.) and a small quantity of intermediate wheatgrass (Agropyron intermedium (Host) Beauv.) seed during the years of 1956 and 1957 from range lands seeded in South-central Idaho. Yields for these 2 years averaged approximately 50 pounds of clean seed per acre, without fertilization, in an area receiving between 8 and 10 inches of annual precipitation (Figure 1). The seed was harvested on a contract basis with the price for clean sacked seed in 1956 ranging from $0.16 to $0.22 per pound. In 1957 the average contract price for harvesting was $0.13 per pound for clean seed. As a general policy, the Bureau retains all the seed harvested for the seeding of federal range lands.

The research reported here was designed to determine the feasibility of producing seed from seeded ranges to provide an economical source of seed and in some instances to provide a cash income crop to pay a portion of the seeding costs.

Methods

The study was located on the McGregor Land and Livestock Company Ranch at Hooper, Washington at an elevation of approximately 1,500 feet. The soil was a silt loam overlying basalt rock to a depth of about 3 feet. Precipitation averaged from 12 to 13 inches with 3 to 4 inches being received during the growing season.

In the fall of 1951, crested wheatgrass was seeded at a rate of approximately 6 pounds per acre in rows 1-foot apart. In the fall of 1952, the area was divided into 8 x 20 foot plots and treated with ammonium nitrate at 0, 20, 40, 60, and 80 pounds of nitrogen per acre. Fertilizer treatments were replicated three times and the same rate applied to the designated plot each fall during the growing season. Seed yields were taken in 1953, 1954, 1956, and 1957. The plots were not harvested in 1955 because of excessive shatter.

Another experiment was planted in the same area in March 1956 to determine if varieties or strains of other grass species would produce economical seed yields under limited rainfall. Fifteen varieties or strains (Table 1) were planted in 12 x 30 foot plots replicated 4 times. The row width in this ex-