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Elk herd of the East Fork of the Bitter Root River

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THE ELK HERD OF THE EAST FORK OF THE BITTER ROOT RIVER

by

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INTRODUCTION

The Bitter Root Valley of west-central Montana is approximately 95 miles long and a maximum of about 10 miles wide. It is a beautiful inter-mountain area, with a relatively moderate climate. Before the advent of the white man, members of the Salish Indian Nation made this valley their home. Through a friendly and peaceful tribe, the Salish, or Flatheads, were moved from the valley to a reservation on the shores of Flathead Lake shortly after Montana became a state. The first white settlement was in 1841, when Father Pierre DeSmet, a Jesuit priest, established St. Mary's Mission near the present site of Stevensville. Cattle were first introduced in 1842 by Father DeSmet at the Mission. Purchased by Major John Owen in 1850, the Mission became Ft. Owen and the first ranch in the valley. Ft. Owen was a major trading post, not only in western Montana but for much of the Northwest. All kinds of goods, including food, clothing, equipment, and horses, were traded by Owen and others to emigrants traveling westward.

Human habitation throughout the valley increased slowly following the establishment of St. Mary's Mission, but less than a year after the construction of Mullan's Road from Ft. Benton, Montana to Walla Walla, Washington in 1861, the discovery of gold brought many prospectors, followed by settlers, to western Montana. Mining ventures for gold, silver, lead, copper, and zinc were the origin of settlements near Hughes Creek on the upper West Fork of the Bitter Root River and near Kootenai and Eightmile Creeks on the main Bitter Root River. Mining and settle-ment in turn led to a strong demand for agricultural products. The grasslands of the valley were ideally suited to ranching, and very soon supported an abundance of livestock. There are no specific records of the numbers of cattle, sheep, and horses in the Bitter Root Valley through the 1870s and 1880s, but it seems reasonable to assume that their increase paralleled the expansion of livestock numbers in much of the West, where the last open range was fully stocked by 1890 to 1900.

The population of the Bitter Root Valley grew from 314 in 1870 to about 11,650 by 1910. Most of this expansion was due to agricultural development, primarily cattle ranching. Since then, the number of residents has remained relatively unchanged, reaching about 12,350 in 1960. During the past decade, an influx of people seeking homesites for retirement purposes has contributed to the population growth. Current centers of habitation are Corvallis, Darby, Florence, Hamilton, Lolo, Stevensville, and Victor.

Forested areas surrounding the Bitter Root Valley offer a great deal of excellent hunting, fishing, camping, picnicking, and other forms of outdoor recreation. The mountain slopes and valleys are currently habitat for bighorn sheep, mountain goat, moose, black bear, deer, and elk.* The elk, or wapiti, is probably the most important of the big-game species in the region, and is highly valued by both recreationists and sportsmen. Perhaps the area can best be symbolized by an antlered bull bugling in the fall or a group of elk grazing on an open hillside in the spring.

The elk of the Bitter Root Valley, like most other herds, have pro-

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*Scientific names given in Table 2, page 19.

vided many intangible returns for recreationists and prized rewards for successful hunters. At the same time, the elk have been extremely efficient competitors of domestic stock, particularly cattle, thereby complicating the resource administrators' problems. For many years prior to 1954, harvest regulations were established as an arbitrary formality, occurring each year from October 15 to November 15. During this same period, increasing elk numbers provided little additional hunting in the month-long seasons but caused serious damage on private holdings within the winter-range zone. A land-use study by the U.S. Forest Service and the Montana Fish and Game Department in 1953 revealed that elk-cattle competition for available winter forage was causing range deterioration and that more liberal harvest regulations in the Bitter Root Game Management Unit were necessary.

In 1954, the Fish and Game Department declared extended either-sex seasons, and there were substantial elk harvests for several years following. After smaller harvests in 1962 and 1963, however, Bitter Root residents voiced opposition to the longer and less restrictive seasons. The principal allegation was that these seasons had caused a serious decline of the once abundant elk population.

The crux of the controversy was the actual number of elk in the Bitter Root and whether or not the population had been exploited. In spite of population estimates by the Fish and Game Department in the spring of 1964, in which elk were found to be present in numbers approaching the past 10-year average, sufficient opposition persisted to have the liberalized harvest regulations greatly curtailed. Opinions regarding the elk situation continued to be so diverse that a study to evaluate certain aspects of the problem appeared justified.

I selected the East Fork of the Bitter Root River as the study area, since it supports the largest herd of elk within the Bitter Root population and therefore much of the controversy concerns this particular herd. Field work was begun in the summer of 1964 and continued through the spring of 1965. The overall purpose of the investigation was to obtain and assemble factual data on the herd for use as a management guide. Specific objectives of the study were:

1. To determine current herd numbers and establish the population trend of the East Fork elk in recent years.
2. To determine herd composition within the study area.
3. To determine reproduction as shown by reproductive tract analysis and compare this with production values derived from classification data for the East Fork herd.
4. To establish age and sex ratios of elk harvested in the study area as recorded through the hunter-checking station.

Aerial coverage has been used in past years to arrive at population estimates in the Bitter Root Unit. Because this appeared to be the most efficient and inclusive method, and in order to maintain comparable data, the use of aircraft was desirable. A Piper Super-Cub was employed to obtain the estimate of herd numbers in the spring of 1965.

Herd composition, particularly calf-cow ratios, was derived earlier from the classification of elk concentrations on the winter range. I used a spotting scope and binoculars to arrive at an acceptable degree of accuracy. Data on the sex ratio of adult animals was procured by aerial classification, since mature bulls tend to stay apart from the main herd in late winter.

Sportsmen in the field during the big-game season were encouraged to cooperate in a productivity study through pre-season notification and day-to-day personal contact. I supplied hunters with instructions and materials for collecting the biological items, and if the approximate location of a cow-kill could be described, I volunteered to collect the items myself.

Age and sex information was recorded for hunter-harvested animals as they went through the checking station, with age determinations based on patterns of dental eruption and wear. In view of the extremely light harvest in the study area, this objective was expanded to include all elk killed in the upper Bitter Root Valley during the 1964 season.

LITERATURE REVIEW

The mention of elk in American history is largely in the form of notes on their distribution and relative abundance. Many such notations appear in the field diaries of explorers, trappers, settlers, and soldiers. The records maintained by Lewis and Clark during their expedition of 1804-06 (Biddle 1962) contain the earliest account of game conditions in western Montana. Alexander Ross' fur-trading expedition through this region in 1824 furnishes further evidence of game abundance and distribution (Koch 1940). With the passing of the pioneer period in western Montana, about 1870, various observers noted that the once abundant and seemingly endless game populations were disappearing rapidly. The period from about 1890 to 1920 is generally agreed to have been the time when most big-game populations were at their lowest levels in Montana and probably the entire West (Koch 1940).

Hancock (1955) points out that early investigations dealing with elk management logically concern the Yellowstone herds, for it was there that elk problems associated with the resurgence of elk populations after protectionist measures were established first occurred. The first important study on elk is that by Preble in 1911. His investigation assessed the elk situation in the Jackson Hole, Wyoming area, including the lack of natural winter range brought about by the termination of migrations to ancestral wintering grounds, the resulting deterioration of the limited winter range, depredations of crops on private lands, and winter mortalities. Rush (1932), Murie (1934), Mills (1936), Cahalane (1938), and others have written on segments of the Yellowstone elk population. The most comprehensive work on the Yellowstone herds is Murie's Elk of North America (1951), a formal life-history study with the objective of providing a basis for elk management.

Restocking of elk in much of their former range and subsequent herd proliferations led to further management studies. Schwartz and Mitchell (1945) investigated elk conditions on the Olympic Peninsula. A reintroduction in Washington is reported by Mitchell and Lauckhart (1948), and an eruption of elk in Riding Mountain National Park in Manitoba is described by Banfield (1949). Data are presented by Green (1950) on the elk of Banff National Park, Alberta, on two herds in Utah by Rognrud (1953) and Hancock (1955), and on the Jackson Hole elk by Anderson (1958). The review of additional literature, including studies by White (1959), Burt and Gates (1959), Troyer (1960), Urness (1960), Harris (1963), and others, has provided considerable information on elk herds and elk relationships.

Current game management procedures rely heavily on knowledge of the structure of the population; that is, the proportion or number of individuals in each sex and age class. This structure is the basis of productivity. Leopold (1933) defined productivity as "the rate at which mature breeding stock produces other mature stock, or a mature removable crop" (page 22); further, where the population is kept stable, "productivity is synonymous with the annual yield" (page 171). Both potential and net productivity are of concern to game managers. The Committee on Wildlife Terminology (Krumholz et al. 1957; 375) defines reproductive potential as "the maximal ability of a species, and hence a population, to produce offspring" and net production as "the number of individuals

...that reaches maturity and is thus available for harvest."

Herd classification functions as an indicator of current herd conditions and provides a productivity trend over an extended time period. The reproductive potential, however, is not revealed by classification figures and therefore must be estimated from pregnancy determinations and/or ovarian analysis. The latter involves the longitudinal dissection of ovaries at 1- or 2-mm intervals to observe the occurence and development of Graafian follicles. Because all ova that mature and are released by the ruptured follicle are not fertilized, pregnancy determinations are a more conservative estimate of the reproductive potential.

Pregnancy determination as an indicator of productivity has been utilized for a longer period of time than ovarian analysis. Incidences of pregnancy determination are reported by Rush (1932), Mills (1936), West (1941), Green (1950), Murie (1951) Kittams (1953), Buechner and Swanson (1955), and others.

One of the earlier uses of ovarian analysis as a means of determining reproductivity is reported by Enders (1939) for a muskrat (Ondatra zibethicus) population. The achievements of Cheatum (1949), working with white-tailed deer (Odocoileus virginianus) in New York, stimulated the use of ovarian analysis as a means of determining potential reproduction in big-game species. An examination of elk ovaries by Cheatum and Gaab (1952) led to the conclusion that more knowledge of elk ovarian morphology was needed before reliable evaluation of pigmented scars could be obtained. Subsequent studies involving ovarian analysis are described by Rognrud (1953), Hancock (1955, 1957), Halazon and Buechner (1956), Burt and Gates (1959), Morrison (1960), and others. Morrison's study correlates ovarian morphology with known breeding history; in it he concludes that 1) counts of corpora albicantia -- degenerating corpora lutea of ovulation -- do not reliably measure past productivity and 2) corpora lutea of ovulation, if taken well after the peak of ovulation and in large sample sizes, are a more accurate indicator of successful reproduction. The greatest value of ovarian analysis, the author suggests, may be the determination of year-to-year trends in the ovulation rate.

Net production is determined by periodic observations of the number of offspring per total segment of mature females. Based on harvest analysis, in which the ages of adult females can be ascertained, net production often is further refined and stated as the number of offspring per total females of breeding age. Yearling female elk generally contribute very little to herd productivity. There are notable exceptions, however. For example, under conditions of a relatively high nutritional status resulting from a lowered population density, Buechner and Swanson (1955) found fetuses in uteri in 54 percent of 35 yearling cows examined during the 1954 harvest season in the Blue Mountains of southeastern Washington. And in view of the purported high productivity associated with a closely harvested herd in the East Fork of the Bitter Root River, a relatively high incidence of pregnancy within the yearling age-class was suspected.

Though of less significance than yearling female precocity, the capacity of yearling bull elk to sire offspring is also a factor in herd productivity. Conoway (1952), in a study based on testicular anatomy, found spermatogenic activity in all specimens of this age. Blunt (1959, 1961), using penned animals, observed calf production in cows of proven breeding capacity serviced by yearling bulls. Wild yearling bulls are also sexually active, and have occasionally been seen mating with receptive cows. To what extent copulation by these younger males occurs under field conditions is not known, although undoubtedly the number of adult bulls in the herd and their greater physical vigor restrict breeding activity in the yearling group.

DESCRIPTION OF STUDY AREA

Location and Size

The Bitter Root Game Management Unit, comprising all of Ravalli and part of Missoula counties, is located on Montana's western border, adjacent to the State of Idaho (Figure 1). The unit lies entirely within the drainage of the Bitter Root River and encompasses about 1.5 million acres. The study area, commonly referred to as the East Fork, is in the southeastern sector of the unit, in Management Area 27 (Figures 2 and 3). The East Fork comprises approximately 190,000 acres, bordered on the west by U.S. Highway 93, on the south by the Continental Divide, on the east by the Sapphire Range, and on the north by the poorly defined Rye Creek-East Fork divide.

Physiography

The valley of the East Fork forms Sula Basin and French Basin, together covering about 20 square miles. The elevation on the main valley floor averages 4,450 feet. High points along the south and east sides of the area are Johnson Peak, 8,880 feet; West Pintlar Peak, 9,481 feet; and Bare Hill, 8,749 feet. Lower points within the area are Fish Lake, 8,447 feet; Clifford Point, 8,280 feet; Blue Mountain, 7,451 feet; Hilltop, 7,253 feet; and McCart, 7,105 feet. The East Fork foothills consist of low spurs and ridges that ascend gradually to the mountains.

Geology and Soils

The following description of the East Fork valley and hills is taken from a soil survey of the Bitter Root Valley (Bourne *et al.* 1959): Materials underlying the flood plains of Sula and French Basins are mixed

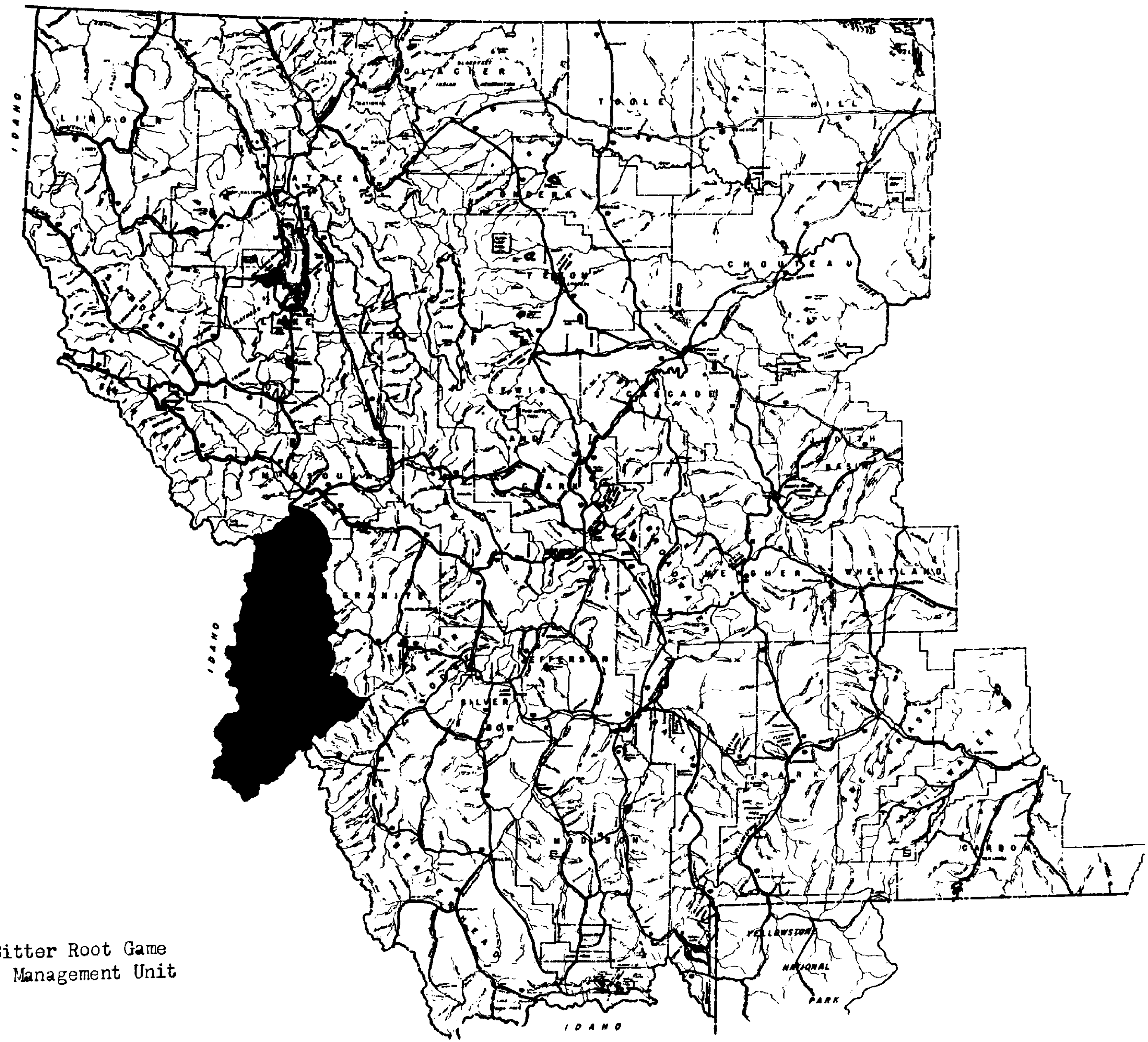


Figure 1. Bitter Root Game Management Unit

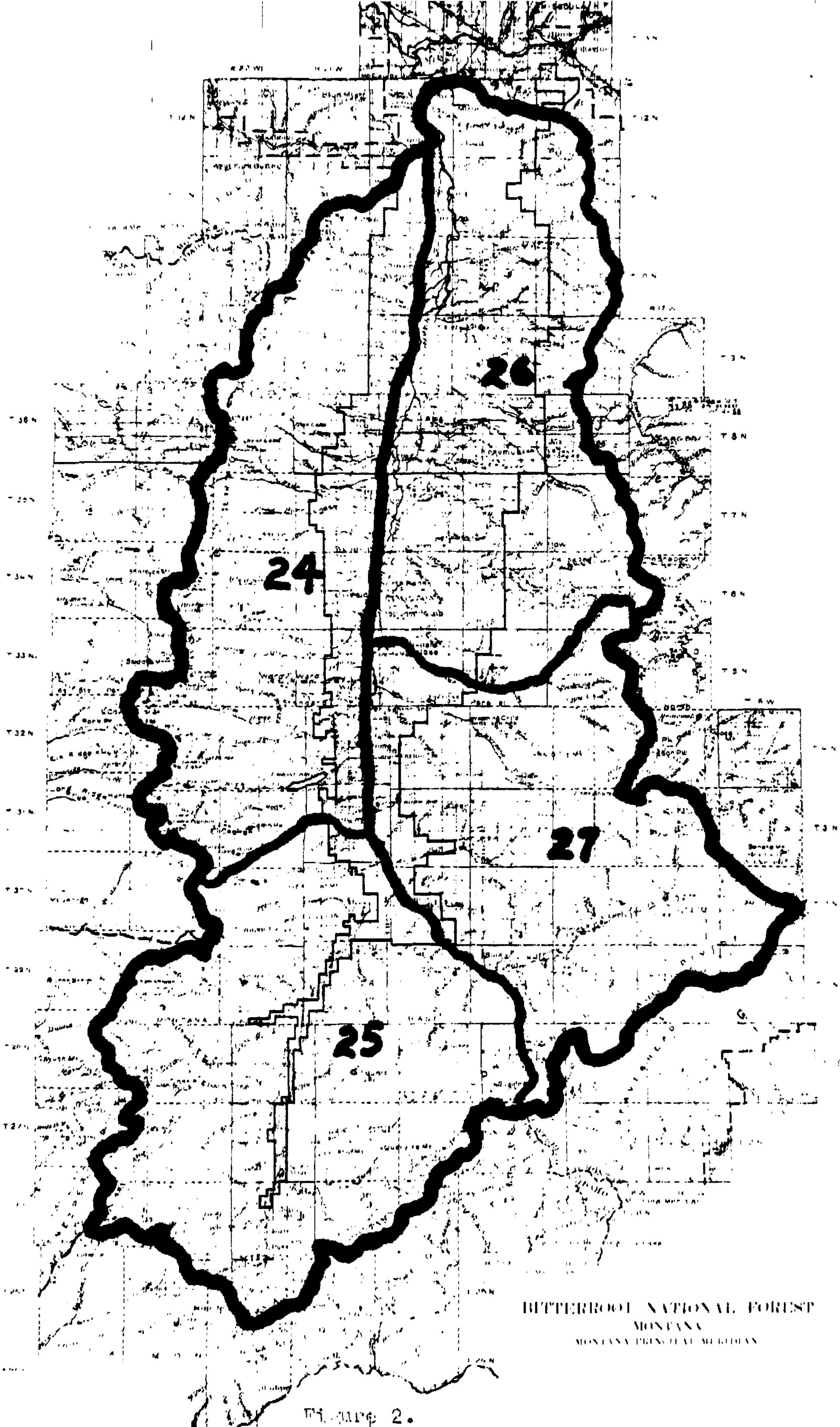
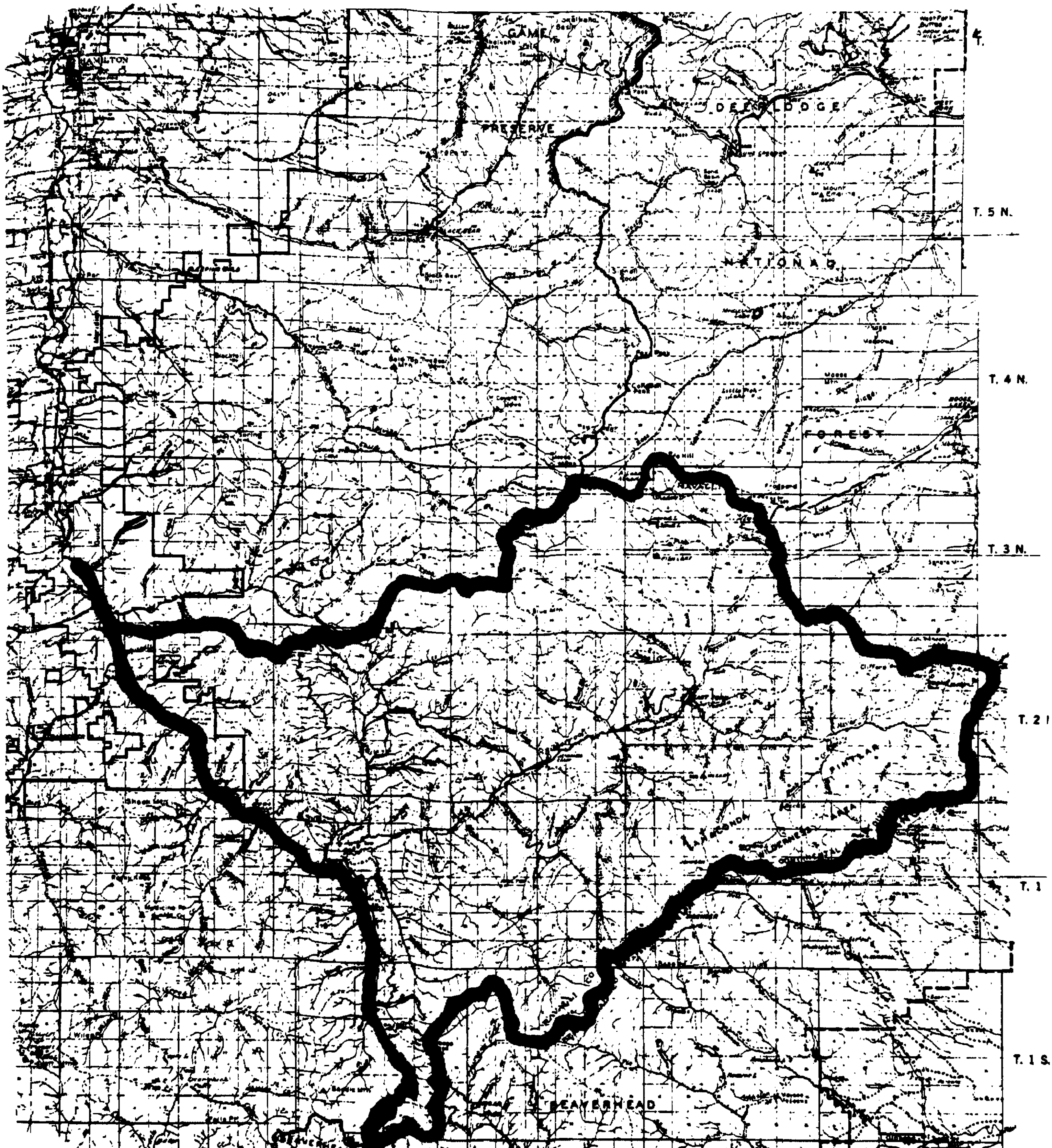


Figure 2.



The East Fork
Figure 3.

gravels mantled with loams and clays. The soils are chiefly of the Gallatin series. Parts of the hills are weathered granitic outwash like that of the high fans of the west side of the main valley, and were formed early in the glacial epoch (Pleistocene); other parts are Tertiary sandstones and silts; and the remainder is weathered granite bedrock. Wind-deposited silts and sands cover some areas. The principal upland soils are members of the Lick, Ravalli, Brownlee, Duffy, and Stecum series, and the Sula Loam variant.

In the Sapphire Range the underlying sedimentary rocks are quartzites, hard sandstones, argillites, and limestones, all of the pre-Cambrian Belt series. Soils on these formations are primarily types and variants of the Gird, Haccke, Cooney, Skaggs, Teton, Castner, Laporte, Trapper, and Holloway series. Igneous intrusions belong to the light-colored quartz monzonite family of granites and contain soils of the Brownlee, Duffy, Ravalli, Shook, Stecum, and Woodrock series.

Vegetation

The native vegetation of the East Fork includes associations of both grassland and forest plants. The Sula Basin and nearby foothills are primarily grasslands. Forests occur at the upper elevations and lower north-facing slopes of the Sapphire Range and the Continental Divide (Bourne *et al*. 1959).

The delimitation of vegetational zones based upon climatic climax associations is described by Daubenmire (1943). Six major vegetation zones are characteristic of the Rocky Mountains: alpine tundra, Engelmann spruce-subalpine fir, Douglas-fir, ponderosa pine, juniper-pinyon, and oak-mountain mahogany, of which all but the last two are clearly distinguished in the study area. Extensive tracts of lodgepole pine, which in aggregate may appear to be another distinct zone, actually represent a subclimax dominant, having invaded certain areas following devastation by forest fires. The juniper-pinyon zone, or rather its northern counterpart, the limber pine-juniper zone, does not occur in the East Fork, although individuals of both species are found there. Mountain mahogany appears in the study area as a narrow interrupted belt on south and west exposures, separated from the conifer stands by grassland vegetation. According to Daubenmire this zone is scarcely represented in the northern Rockies and generally functions as an ecotone between the needle-leaved forest and non-forested plains and plateaus. The East Fork does illustrate an interesting feature pointed out by the same author: where the mountain mahogany zone is well developed, the juniper-pinyon zone is poorly represented, and _vice versa_. (See Table 1 for a more complete list of tree species.)

The dominant native species of climax grasslands such as those of the East Fork are believed by Bourne _et al._ (1959) to be bluebunch wheatgrass (_Agropyron spicatum_), Sandberg bluegrass (_Poa secunda_), and Idaho fescue (_Festuca idahoensis_). Other species of these grasses, including A. _smithii_, A. _subsecundum_, A. _dasystachyum_, P. _ampla_, P. _scabrella_, and F. _scabrella_, are also important, as are needlegrass (_Stipa columbiana_, S. _richardsoni_, S. _comata_), wild rye (_Elymus canadensis_), pinegrass (_Calamagrostis rubescens_, C. _canadensis_), hairgrass (_Danthonia intermedia_), and junegrass (_Koleria cristata_). Daubenmire (1943) found perennial grasses of the genera _Agropyron_, _Poa_, _Festuca_, and _Muhlenbergia_ to be dominant for the

Table 1. Partial list of tree species in the East Fork.[1]

Alpine fir	*Abies lasiocarpa* (Hook.) Nutt.
Grand fir	A. *grandis* (Doug.) Lindl.
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Engelmann spruce	*Picea engelmannii* Parry
Western larch	*Larix occidentalis* Nutt.
Alpine larch	L. *lyallii* Parl.
Ponderosa pine	*Pinus ponderosa* Laws
Lodgepole pine	P. *contorta* Doug.
Whitebark pine	P. *albicaulis* Engelm.
Limber pine	P. *flexilus* James
Western hemlock	*Tsuga heterophylla* (Rafn.) Sarg.
Mountain hemlock	T. *mertensiana* (Bong.) Carr.
Western red cedar	*Thuja plicata* Donn
Rocky Mountain juniper	*Juniperus scopularum* Sarg.
Pacific yew	*Taxus brevifolia* Nutt.
Quaking aspen	*Populus tremuloides* Michx.
Black cottonwood	P. *trichocarpa* Torr. and Gray

[1]Scientific nomenclature from Little (1953).

ponderosa pine zone.

As agriculture expanded in the Bitter Root Valley, domesticated species of grasses were introduced. The escape of these grasses, along with the use of domestic species in reseeding or revegetation projects, extended the list of local flora. New additional species of wheatgrass (A. *desertorum*, A. *intermedium*, A. *trachycaulum*) and bluegrass (P. *compressa*, P. *pratensis*), as well as bentgrass (*Agrostis alba*), orchard grass (*Dactylis glomerata*), and timothy (*Phleum pratense*) are found in the East Fork.

Many broad-leaved plants (forbs) and shrubs occur in the study area. Table 27 in the appendix lists the more common of these.

It should be noted here that grasses, sedges, and forbs constitute the primary items in the diet of elk throughout the year (De Nio 1938, Morris and Schwartz, 1957). The grasslands that are characteristic of the East Fork and extend into several of its side drainages therefore provide important vegetation in this regard. While elk can efficiently utilize browse as part of their winter diet, the fact that grasses are a predominate type within the winter range and are available, for the most part, through much of the cold season increases their value.

Of the browse species, bitterbrush (Purshia tridentata) warrants special mention. This plant is found in abundance on south-facing slopes in the East Fork, most commonly in association with mountain mahogany. Bitterbrush is an excellent forage species, highly nutritious and palatable. Although it may be browsed year-round, its greatest use occurs in late fall and winter when elk are concentrated on the winter range.

Climate

The climate of the Bitter Root Valley is characterized by cool, pleasant summers and comparatively mild winters (Bourne et al. 1959). As elevation increases, so does the amount of rainfall and snowfall; the average temperature becomes lower and the growing season shorter. In the East Fork, frosts may occur in any month of the year, and the average frost-free season is probably less than 100 days (Bourne et al. 1959).

Climatic data have been collected at Sula, elevation 4,450 feet, since the winter of 1955 and have been recorded by the Weather Bureau, U.S. Department of Commerce. The average annual temperature is 41.0 degrees; January temperatures average 18.5 degrees and July temperatures 61.6 degrees. Average annual precipitation is 17.31 inches. During the same period, the record high and low were 100 degrees in July 1961 and -43 degrees in

January 1957. Weather Bureau data for Darby, elevation 3,815 feet, have been recorded since 1909 and show an average annual temperature of 45.0 degrees, with a January average of 25.0 degrees and a July average of 66.2 degrees. Annual precipitation averages 15.62 inches. Using the relationship between these two stations, brief as the record at Sula is, one can interpolate the Darby data for earlier dates and obtain an estimate of the East Fork conditions for corresponding periods.

Wildlife

Table 2 lists the major game species and large predators of the study area. Although elk are the most economically important of the endemic big game-species, five others--moose, mule deer, mountain goat, bighorn

Table 2. Selected fauna of the East Fork, past and present.[1]

Black bear	Ursus americana cinnamomum Aud. and Bach.
Grizzly bear	U. arctos horribilis Ord
Mountain goat	Oreamnos americanus missoulae Allen
Bighorn sheep	Ovis canadensis canadensis Shaw
Mule deer	Odocoileus hemionus hemionus Rafn.
Elk	Cervus canadensis nelsoni Bailey
Moose	Alces alces shirasi Nels.
Bison	Bison bison bison Linn.
Mountain lion	Felis concolor missoulensis Gold.
Lynx	Lynx canadensis canadensis Kerr
Bobcat	L. rufus pallescens Merr.
Timber wolf	Canis lupus irremotus Gold.
Coyote	C. latrans lestes Merr.
Ruffed grouse	Bonasa umbellus umbelloides Doug.
Spruce grouse	Canachites canadensis franklinii Doug.
Blue grouse	Dendragapus obscurus richardsonii Doug.

[1]Taxonomic nomenclature from American Ornithologist Union (1957), Hall and Kelson (1959), and Rausch (1963).

sheep*, and black bear--also inhabit the area. Mountain grouse--blue spruce and ruffed--are found throughout much of the forest land. Originally, bison and bighorn sheep were abundant in and about the valley of the East Fork (Koch 1940), and it is quite probable that the grizzly bear was also part of the early fauna in the Bitter Root. Mountain lion, lynx bobcat, and coyote are resident predators, as are various species of owl and hawk, including golden eagles (Aquila chrysaetos canadensis Linn.), and occasionally bald eagles (Haliaeetus leucocephalus alascanus Town.)

Turkey vultures (Cathartes aura teter fried.) and a host of smaller birds and mammals complete the fauna of the East Fork [see Wright (1963) and Weydemeyer et al. (undated)].

Land Use and Ownership

Land use and ownership within the East Fork have remained relatively unchanged since its settlement late in the 19th century. The soils of Sula Basin, which support predominately grasslands, maintain a cattle-ranching economy. The major crops are grasses and legumes required to support the livestock. Twelve ranches are currently operated in the East Fork valley, and some dryland farming has been attempted on the uplands between Sula Basin and French Basin. Because normal annual rainfall does not provide adequate water for cultivated crops, irrigation is essential.

As mentioned previously, a mild influx of citizens seeking homesites for semi-retirement purposes has paralleled the moderate population

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*Two ewes have been observed during spring aerial coverages. Originally, two pairs of bighorn emigrated from the West Fork area and established themselves in the East Fork. Both rams were poached the first season, leaving only the two ewes.

increase in the main valley over the past decade. Two such year-round homesites exist in the East Fork at present, and seven others receive limited seasonal usage.

Inasmuch as about 92 per cent of the total area is forested and about 90 per cent is in public ownership (Hamre and Watt 1957), the East Fork can maintain an active timber industry. The forests are on U.S. Forest Service lands and support an annual harvest of about 5,763 million board feet, primarily of Douglas-fir and ponderosa pine. Though lodgepole pine is quite abundant, its utility as a timber or pulp source, from an economic standpoint, is generally low.

The East Fork is a region of considerable scenic beauty, in which recreation is an important industry. A portion of the Anaconda-Pintlar Wilderness Area--41,162 acres constituting about 16 per cent of the Sula Ranger District, Bitter Root National Forest--lies in the easternmost part of the district and is the destination of many hiking, riding, fishing, and sight-seeing excursions. Forest Service officials estimated 21,600 recreation visits to the East Fork area in 1957. Of these, 27.7 per cent were fishing visits, 18.9 per cent were picnicking and camping, 11.1 per cent were hunting, and 25.0 per cent were for other purposes. A recent publication from the Northern Region of the U.S. Forest Service (U.S. Department of Agriculture undated) graphically illustrates the growth of national-forest recreation in the region of which the Bitter Root National Forest is a part. The number of visits rose from .69 million in 1945 to 5.6 million in 1960, an increase of over 800 per cent. Visits increased by .9 million--an even greater percentage--from 1960 to 1961. Since then, the number of recreation visits has continued to grow, though not as rapidly as during the 1960-61 period.

HISTORY OF THE EAST FORK ELK HERD

Native

The earliest record of game conditions in the East Fork area is recorded in the journals of the Lewis and Clark expedition of 1804 to 1806. In searching for navigable waters to the west, the expedition crossed the Continental Divide in the vicinity of Lost Trail Pass and entered the Bitter Root Valley in September of 1805. The party found game--including elk--plentiful enough to satisfy their daily requirements (Biddle 1962). On the return journey in late June and early July of 1806, game was relatively scarce in the heavily timbered Bitter Root Mountains, as it had been on the westward trip, but the party again encountered an abundance of animals upon descending Lolo Creek into the Bitter Root Valley.

Traveling up the Bitter Root Valley in March of 1824, the fur-trapping expedition of Alexander Ross found elk very numerous (Koch 1940). The Stevens expedition of 1853 to 1855, undertaken for the purposes of exploring a railroad route to the Pacific, extensively mapped this area. Koch (1940) indicates that the group probably relied on game as a food source but did not record such data.

One of the earliest pioneers in the East Fork, the late Bertie Lord, recalled moderate numbers of elk in the area when he homesteaded there in 1880, although the era of game abundance was rapidly closing. It is generally agreed that the elk of the Bitter Root Valley were at their lowest level in the decade around 1900. Than Wilkerson, the first forest ranger in the West Fork of the Bitter Root River, estimated only seven elk remaining in the East Fork area in 1902 (Hollibaugh 1942).

Reproduction

Subsequent to the creation of national forests in the late 19th century, there were attempts to reestablish elk throughout much of their former range. Transplants to many western areas were made from Yellowstone National Park, which at the time contained an estimated 30,000 to 40,000 elk (Rush 1932). In 1911, three carloads containing 60 elk were brought into the Bitter Root Valley (West 1941, Hollibaugh 1942). One carload was placed in the mountains northeast of Hamilton, Hollibaugh relates, and two loads in the East Fork area. How many of the liberated elk actually survived is not known, for they reportedly reached the Bitter Root in a poor and very weakened condition, with several mortalities occurring after arrival. On the assumption of equal numerical distribution within the cars, somewhat less than 40 animals joined the resident elk of the East Fork to originate the present herd.

Following the introduction from Yellowstone, legal elk harvests in Ravalli County were eliminated from 1913 to 1926 and, in the East Fork, again in 1927 and 1928 (see Table 3 for hunting regulations in the East Fork). The restocking and season closures apparently were successful in establishing a breeding population of elk. Serious efforts to record game numbers were begun in 1922 by employees of the Forest Service. Observations on elk abundance, as reported by Hollibaugh (1942) for the East Fork area from 1922 through 1941, are presented in Table 5, Page 33.

Numbers of elk in the East Fork increased at a modest rate. A Forest Service game study in 1936 contains a significant appraisal of the

Table 3. Hunting regulations in the East Fork, 1913 to 1965.

1913 to 1925	Closed season
1926	Bulls only, 11/12 to 11/15.
1927	Closed season
1928	Closed season
1929	Either sex, 11/11 to 11/15.
1930	" " " "
1931	" " " "
1932	" " " "
1933	" " " "
1934	" " " "
1935	Bulls only, 11/11 to 11/15.
1936	Either sex, 10/15 to 11/15.
1937	" " " "
1938	" " " "
1939	" " " "
1940	" " " "
1941	" " " "
1942	" " " "
1943	" " " "
1944	" " " "
1945	" " " "
1946	" " " " ; Br. ant. bulls* 11/16 to 11/30.
1947	Either sex, 10/15 to 11/15.
1948	Antlered bulls, 10/15 to 11/15.
1949	Either sex, 10/15 to 11/15.
1950	" " " "
1951	" " " "
1952	" " " "
1953	" " " "
1954	Either sex, 10/15 to desired harvest.
1955	" " , 10/15 to 11/15 (desired harvest).
1956	" " , 10/15 to 11/15 (desired harvest after 11/15 Br. ant. bulls).
1957	" " , 9/22 to 11/24; Br. ant. bulls 11/25 to 12/15.
1958	" " , 9/21 to 11/23; Br. ant. bulls 11/24 to 12/31.
1959	" " , 9/20 to 12/13; Br. ant. bulls 12/14 to 12/31.
1960	" " , 9/20 to 12/4; Br. ant. bulls 12/5 to 12/31.
1961	" " , 9/17 to 12/9; Br. ant. bulls 12/10 to 12/31.
1962	" " , 9/16 to 12/23; Br. ant. bulls 12/24 to 12/31.
1963	" " , 9/15 to 12/24; Br. ant. bulls 12/25 to 12/31.
1964	" " , 10/3 to 11/22.

*Branch-antlered bulls.

animals' population growth; a survey of the winter range in the East Fork district prompted the following conclusion:

> Although favorable weather and snow conditions prevented game from suffering from want of food, it was noted after snow left the area in April that the area between Camp Creek and Mink Creek has been overgrazed by domestic stock for many years previous to this winter. Very little herbaceous feed was available for game. The game badly overutilized the browse species this past winter. The browse species also show evidence of past abuse with its dead stump and a large percentage of willow clump entirely dead. Because of a limited amount of grasses in the area, it was estimated that it would take only 3 or 4 inches of crusted snow to cause a famine for the game on this area (U.S.D.A. 1936:6).

In the 25 years following restocking and harvest closures, an increasing elk population, overutilization of the winter range, and competing demands on the available forage supply by big game and domestic stock became a major problem in the Bitter Root.

By 1942 the above conditions had progressed to the point where Hollibaugh (1942) found elk to be seriously injuring the private lands of a number of ranchers in the East Fork valley. He concluded that the amount of big game making use of the range must be reduced, elk numbers having been estimated at 850. Damage complaints of elk eating and trampling haystacks in Sula Basin were registered for the first time that year.

The Fish and Game Department recognized the role of harvest in controlling animal populations and recommended more liberal hunting of elk. Four years elapsed, however, before such action was taken, and meanwhile, game-damage complaints continued each winter. In 1946, regulations were changed to permit the taking of branch-antlered bulls during an extended season. In a cooperative game census following the 1946 hunting season

(Thompson 1947), only 427 elk were estimated to be in the East Fork district. The assumption was that the branch-antlered bull season of the past fall had reduced the elk population and therefore a less liberal harvest should be reinstated for the 1947 season.

The reoccurrence of elk depredations the following year demonstrated the error of that assumption, and after the 1948 season (restricted to antlered bulls), special branch-antlered bull permits were issued in the Sula Basin in an effort to reduce the damage. A more liberal season was again recommended. The following fall--1949--a harvest of either sex was permitted during the regular season of October 15 to November 15. There was no curtailment of elk damage to haystacks, however, and animal depredations continued for the next .10 years.

It has been suggested that the soils of the Bitter Root Valley may be deficient in certain essential minerals and that this could be the reason elk raid haystacks in some winters. In a soil survey completed in 1951 (Bourne _et al_. 1959), soils of the East Fork--members of the Lick, Ravalli, Brownlee, Duffy, and Stecum series, and the Sula loam variant--were found to be low in natural or inherent fertility. But the fact that elk damage declined to minor proportions and in many cases disappeared in the East Fork from about 1960 through 1963, following five years of intensive harvests in which peak populations apparently occurred, indicates that soil infertility was not the principal cause of the depredations. In retrospect, a condition of overabundance, i.e. an elk population in excess of the carrying capacity of the winter range, seems a more valid reason for the situation.

Recent Status

Elk numbers continued to rise, reaching a peak in about 1958. Combined high elk and cattle numbers caused serious forage problems and necessitated grazing readjustments on rangelands administered by the Forest Service. Harvest seasons of variable length--early and extended either-sex seasons--were instituted in 1954. Special branch-antlered bull seasons were added in 1956. The former type of season is credited with stabilizing the herd following its 1958 peak. Annual census figures (excluding the incomplete 1963 census) range from a low of 522 in 1962 to a high of 651 in 1958, averaging 590. Six hundred and twenty-four elk were recorded in the aerial coverage of April and May 1965, closely approaching the 1958 level.

CHARACTERISTICS OF THE POPULATION

Census Methods and Animal Numbers (See Table 5 for chronological listing of counts and estimates).

Early population counts (1922 through 1945) in the Bitter Root as a whole and the East Fork in particular were obtained by ocular and aided-ocular (binoculars and/or spotting scopes) ground counts of elk concentrations on the winter range. The Forest Service maintained these records until 1942, when the Fish and Game Department assumed the task of census-taking.

The use of aircraft to secure Bitter Root game numbers was initiated in the East Fork in 1946. The department employed coordinated ground and aerial coverage that year and again in 1947 and 1951. Although adverse weather conditions in 1951 prevented concurrent coverage, Thompson (1951) concluded that air census was consistently far superior to ground census. While the 1951 elk count in the East Fork by aerial observation was not in itself particularly outstanding (223 elk were recorded), use of this technique in the area's game management was begun in 1953 on an annual basis (no separate East Fork census was taken in 1952). Since then, aerial census has been used exclusively, with ground classification as a supplement. In the census of 1955, 581 elk were seen in the East Fork. A portion of this larger count can be directly attributed to greater efficiency in aerial coverage, but actual herd increase was also a contributing factor.

A Piper Super-Cub (PA-18) is presently utilized for annual trend counts. Coverage is usually accomplished between mid-April and mid-May, when elk concentrate on the open foothills as grass begins its current-year growth. This period is often referred to as the "green-up," and the procedure is termed "green grass" counts. The optimum time to count is approximately one hour following dawn or one hour preceding dusk. Flights continue until maximum counts have been attained.

Spring observations are usually of more value than midwinter sightings, although snow cover and snow depth tend to cause grouping among the elk and also enhance the observer's image perception and facilitate spotting. In addition, grasslands on south and west slopes are often windblown during the winter, and much otherwise unattainable forage is exposed; elk make considerable use of the windblown grassy exposures throughout the mid- to late-winter period. In winter, however, a large proportion of the elk population generally remains beneath the timber canopy, where average snow depth is less, the temperature is higher, and food and cover are more consistently available.

As weather conditions meliorate with the approach of spring, snow accumulations on the south and west slopes are the first to disappear. Vegetation long covered by snow is again available, providing additional forage for elk. This supplement, as well as the forage (browse in particular) that has served the elk through the winter, is probably quite thoroughly utilized by the time grasses begin their new growth. The green-up furnishes a fresh source of highly palatable and succulent forage to supplant the waning browse. Because green-grass counts are oriented to annual vernal phenology--the same factors that influence behavioral patterns in elk--there is probably less year-to-year variability than in winter counts. All things considered, trend counts obtained during the April and May green-up have resulted in closer estimates of actual herd numbers.

Vegetative cover and terrain are such that aerial observations and ground counts of segments of the population are difficult, and a comparison between them of little value. In the cooperative game census of the East Fork in 1946 and 1947 (Thompson 1947), sportsmen, ranchers, and Fish and Game Department personnel attempted both ground and aerial coverage of portions of the East Fork winter range. The results, presented in Table 4, illustrate the success that might be expected when elk are counted in other than broad, open areas of moderate elevational difference.

Table 4. Elk census, East Fork, 1947.

Area	Ground Count	Aerial Count
French Basin	35	36
East Fork (north side)	85	25
East Fork (south side)	18	65
	138	126

Aerial count as percentage of ground count - 91.3

Riordan (1948) mentions the difficulties of counting elk from the air in rugged topography and dense cover, but Murie (1951) nonetheless feels that aerial observation is the most effective census method for the Rocky Mountain region. Buechner et al. (1951), Rognrud (1953), and others found aerial observations accounted for about 80 per cent of comparable ground counts.

The aerial coverage of 1965, part of the present study, was the most extensive and probably the most intensive ever made in the Bitter Root Unit. Using a Piper Super-Cub piloted by Courtney L. Taylor, a Montana Fish and Game Department warden in the upper Bitter Root Unit, flying was begun on April 12. Mr. Taylor has been with the Department in the upper

Bitter Root since 1953 and has flown aerial census each year. His knowledge of the area and ability as a pilot were invaluable in obtaining the aerial coverage.

Weather conditions were favorable throughout the remainder of April, and flights could be made nearly every day. We made morning flights only in the trend counts, and coverage followed the progression of the green-up from lower elevations to higher elevations, hence southward up the valley of the Bitter Root. The East Fork was the last major area to be censused: two flights, on April 23 and 24, covered the entire area, and we observed 624 elk on the winter range. Because current-year grasses were growing in only a small percentage of the area we anticipated higher counts at a later date. Flying weather was unfavorable in late April, however, and remained so in the upper Bitter Root Valley for about two weeks, the period in which the best counts were obtained the previous year. Flights On May 8 and 10, the first possible, revealed the East Fork elk to be decreasing in group size and total observable numbers. We recorded many animals as singles and groups of two to six in timbered areas above the normal winter range; apparently they were beginning the return to summer range.

The total of 624 recorded for the East Fork compares favorably with previous counts at the population peak around 1958. Considering the variability associated with making counts that represent minimum population size, the herd could be as large as or larger than in past years. Counts for the east side of the Bitter Root Unit have been recorded annually since 1951; counts for the total unit in 1953, 1954, and 1965 only.

Table 5. Elk censuses of the East Fork and the Bitter Root Unit.*

Date	East Fork			Bitter Root Unit	
	Ground Count	Estimate	Aerial Count	Estimate	Aerial Count[1]
1922	175			250	
1923	190				
1924	190				
1925	200				
1926	180				
1927	180				
1928	185				
1929	205				
1930	225				
1931	250				
1936				1424	
1937				1642	
1941				1625	
1942		850[2]			
1946	171	427[2]			
1947	149	186[2]			
1950				1650	
1951			223		530
1952					242
1953			366		786
1954			500		1023
1955			581	2090	1157
1956			541		1226
1957			541		1195
1958			651	3900	1604
1959			631		1380
1960			644		1343
1961			625		---[3]
1962			522		---
1963			341[4]		801[4]
1964			536		1149
1965			624		1629

[1]Counts shown for east side only.

[2]Figures include aerial count plus estimated additions.

[3]Counts not made.

[4]Incomplete coverage.

*For the years 1932 through 1935, numbers for Montana and Idaho portions of the Bitter Root National Forest were added together. Information from 1936 to 1941 includes the entire population of the Montana portion of the forest.

Marshall (1953) and Rognrud (1954) report total counts of 982 and 1338 in 1953 and 1954 respectively. The total of 2424 recorded in 1965 is the most complete census of the Bitter Root Valley to date. Table 6 gives a breakdown of this total by management areas.

Table 6. Aerial elk census of Bitter Root Unit by management areas, 1965.

Management Area	24	25	26	27	
Number of Elk	283	512	633	996	
Total Elk					2424

The winter range of elk on the west side of the Bitter Root Valley is restricted to small timbered areas around the mouths of the canyons. Concentrations of 20 to 60 animals, which are common for the area, are therefore often impossible to observe from the air. Animal numbers recorded from aerial coverage of the east side can, however, be compared from year to year. Table 5 shows the peak of the East Fork herd to have coincided with that of the east side population in 1958. Thus a period of seven years has lapsed between the first recorded east side high of 1604 in 1958 and that of 1629 in 1965.

As indicated, herd numbers in the East Fork have increased since 1951, with some short-term declines. Insufficient data are available to construct a growth curve of the population. Based on aerial trend counts, a peak in the population was reached in 1958, but whether this was the first or one of several in the growth sequence is not known.

Recent management procedures have tended to maintain a stable population that is compatible with other resource uses. Inasmuch as the East Fork area of the Bitter Root Unit contains the largest segment of the Bitter Root elk population, much of the total management has been based on this herd. Latest trend counts indicate the desired level of herd numbers at 500 to 600 animals.

Age and Sex Composition

While comparison of herd numbers obtained by periodic observations indicates gross variations in population levels, the classification into sex and age groupings provides more diagnostic information about the population. The sex ratio of the adult portion of the population and the number of young per total adults or number of young per total adult females can be determined immediately. With this information, the current productivity of the herd can be estimated, and the results of past management policies, especially of harvest, can be assessed. Perhaps more important than evaluating former polices is the application of age and sex data toward future management. Classification data is most useful in this respect.

Table 7 is a record of intermittent observations of herd composition in the Bitter Root Unit. These data were obtained through aided-ocular ground sightings of elk on the winter range, usually during the months of March and April. The classification of large numbers of elk at any one observation is not impossible but often difficult, with topography the principal deterrent. Bulls in the Bitter Root usually retain their antlers until about mid-April, but bulls in velvet may be seen by the time antler drop is noticeable. Spike bulls seem to be the last to lose their antlers in the spring.

The 1956 through 1965 totals of Table 7 indicate an overall ratio of

Table 7. Herd composition based on ground observations in the Bitter Root Unit.

Year	Mature Males	Spike Males	Mature Females	Young of Year	Ratio Males	Ratio Females	Ratio Young
1936-37	158		590	214	27	100	36
1941-42	29	2	276	20	11	100	7
1952-53	42	14	44	21	127	100	48
1953-54	56	4	131	74	46	100	56
1956-57	106		260	144	41	100	55
1957-58	93		135	79	68	100	59
1958-59	22	9	210	119	15	100	57
1959-60			176	76		100	43
1960-61			37	27		100	73
1961-62			154	81		100	52
1962-63	23	14	196	85	19	100	43
1963-64	17	8	155	72	16	100	46
1964-65	7	5	187	90	6	100	48
1956-65 Totals	268	36	1510	773	20	100	51

20 males and 51 young per 100 adult females for the Bitter Root Unit. The low value for males should not suggest intensive bull harvest but rather their absence from the main herd and consequent unavailability to ground classification during this time of the year. As shown in Table 8, production in the East Fork has averaged 55.7 calves per 100 cows for the years when classification data have been recorded by separate areas.

Table 8. Spring calf-cow ratios for the East Fork area.

Year	1956	1957	1958	1959	1960	1962	1965
Calves per 100 cows	57	58	57	60	52	53	53

We attempted some classification during the aerial census coverage of 1965. The 1964 calves were in many cases insufficiently distinct in external characteristics to be separated from young mature cows and small antlerless bulls. For this reason, the calf-cow ratio (35:100) was considerably lower than previous ground classification (48:100) indicated.

The sex ratio of males to females, $1\frac{1}{2}$ years old and older, seems to be a more accurate reflection of herd composition. The aerial classification of 726 animals resulted in a sex ratio of 61 bulls per 100 cows. No previous information on sex ratios obtained by aerial coverage is recorded for the Bitter Root elk. A ratio of 61 bulls per 100 cows suggests a differential harvest, but this is not entirely substantiated in the harvest analysis, which shows a ratio of 105 bulls per 100 cows. We must therefore assume that an accurate accounting of the male segment of the herd has yet to be obtained.

Although only a small percentage of the total Bitter Root elk population has been classified annually in the era of recent management, totals for this time indicate a properly managed herd. Again, the adult male segment of the herd is probably underestimated, due to the isolation of mature bulls from the main herd at the time of classification.

Productivity

Cow elk are commonly thought to conceive for the first time during the third rutting season after birth, at an average age of about two years and four months (Murie 1951). In the northern Yellowstone elk study of 1932, Rush stated that "about 98 per cent of the two-year olds and older, with the exception of the extremely old ones, are pregnant." Investigations of elk pregnancies recorded in reduction programs between 1935 and 1951 (Kittams 1953), showed about 86 per cent of all cows (1053 specimens) $2\frac{1}{2}$ years old and older to be gravid, with a spread of 74 to 94 per cent. Of 364 and 240 specimens aged three years plus in Kittams' 1949-50 and 1951 collection, 79 and 94 per cent respectively were pregnant. In a herd-reduction program conducted by the Wyoming Game Department in the winter of 1935-36, Murie (1951) found pregnancies in 89.2 per cent of 334 mature cow elk; in a similar program in Yellowstone National Park in 1943, he found 90.4 per cent of 156 cow elk pregnant. Cheatum and Gaab (1952), using the presence of corpora lutea of the current gestation as an indication of pregnancy, noted that the incidence of breeding success in age classes 4½ to 9½ was 100 per cent. Further, 93.7 per cent of 32 cows aged 10-14 years had been bred successfully.

In the past, observations on incidences of pregnancy in yearling cow elk were usually reported as anomalies (Mills 1936, Coffin and Remington 1953, and Saunders 1955). As noted earlier, Buechner and Swanson (1955) found high incidences of yearling pregnancy following a lowered population density in an elk herd in the Blue Mountains of southeastern Washington. These authors postulated that better nutrition through greater availability of forage per individual was the principal factor responsible for the increased natality in the yearling female class. Unpublished data collected following the 1961-62 reduction of the northern Yellowstone herd by Park Service personnel indicated an increased natality both in yearling and older cows (McLaughlin 1964). Reduction-data analysis at the Montana Fish and Game Department's Wildlife Research Laboratory supported the Buechner and Swanson theory (Greer 1964). It is also probable that nutrition is the cause for variation in pregnancy rates of mature cow elk.

The East Fork elk have been under relatively intensive management since 1955, but the present study is the first investigation of the herd's productivity. The objective of the current analysis was to determine productivity per age class, with particular emphasis on yearling cows. To facilitate data accumulation, I inserted a news item concerning the proposed study and its aims in three local newspapers (see page 91 in appendix), placed a large sign at the main entry to the study area informing hunters of the study, and throughout the hunting season circulated mimeographed reminders (see pages 92 and 93 in the appendix) to hunters in the field and at the Darby checking station. Materials needed for the collection of biological items were made available to each hunter as he was contacted, and guides and outfitters using the study area were provided with complete collection kits.

Of the 14 cow elk harvested in the study area during the reduced hunting season of 1964 and reported through the checking station, only four usable reproductive tracts were collected. One additional tract was obtained from a cow that had been critically injured by a bull elk during a trapping program. I analyzed ovaries and examined uteri for evidence of ovulation and pregnancy. The method of ovarian analysis was similar to that of Cheatum (1949): ovaries were preserved in a 10-per cent formalin solution, sliced longitudinally at 1- to 2-mm intervals, and observed macroscopically for the presence of corpora lutea and the development of Graafian follicles. Uteri were dissected longitudinally from the horns to the cervix, and pregnancy was determined by the presence of embryological membranes or a fetus.

Findings are presented in Table 28, page 94 in the appendix, although the sample size for the study area was so small that no firm conclusions could be formulated. However, two of the five cows were pregnant, and nongravid specimens EF-1, age 3½, and EF-2, age 1½, both collected in early October, had ovulated. The degree of follicular development suggested a high probability of conception during a subsequent estrus in the breeding season. Specimen EF-3, a yearling collected in November, had not ovulated. Several follicles 2-5 mm in average diameter were present, but the probability that this animal would have ovulated and conceived during the breeding season was low.

Frequently used indices of productivity are the ratios of young to adults or young to adult females derived from herd composition and harvest data. According to herd composition data in Table 7, the number of young per 100 adult females has ranged from seven to 73 in the Bitter Root Unit; the average for 1956 through 1965, however, is 51 young per 100 adult females. Figure 4 shows the ratios of young per 100 adult females, in the classification and from the harvest, for the study area. The mean of the classification data is 54 per 100 adult females. The ratio in the harvest averages 43 calves per 100 adult females. Any correlation between the two ratios is not apparent in the graph.

Herd Losses

The continuing number of losses attributable to old age, malnutrition, and disease appear to be of such low magnitude as to be inconsequential in the population trend. Rognrud (1956) lists winter losses of elk in the East Fork during the 1955-56 season. From eight specimens observed, seven deaths were caused by starvation or probable starvation. Six of the total were calves. Liberal hunting seasons are credited with reducing starvation losses and with contributing to fewer deaths from old-age and disease. Predation, accidents, and illegal harvest still exert

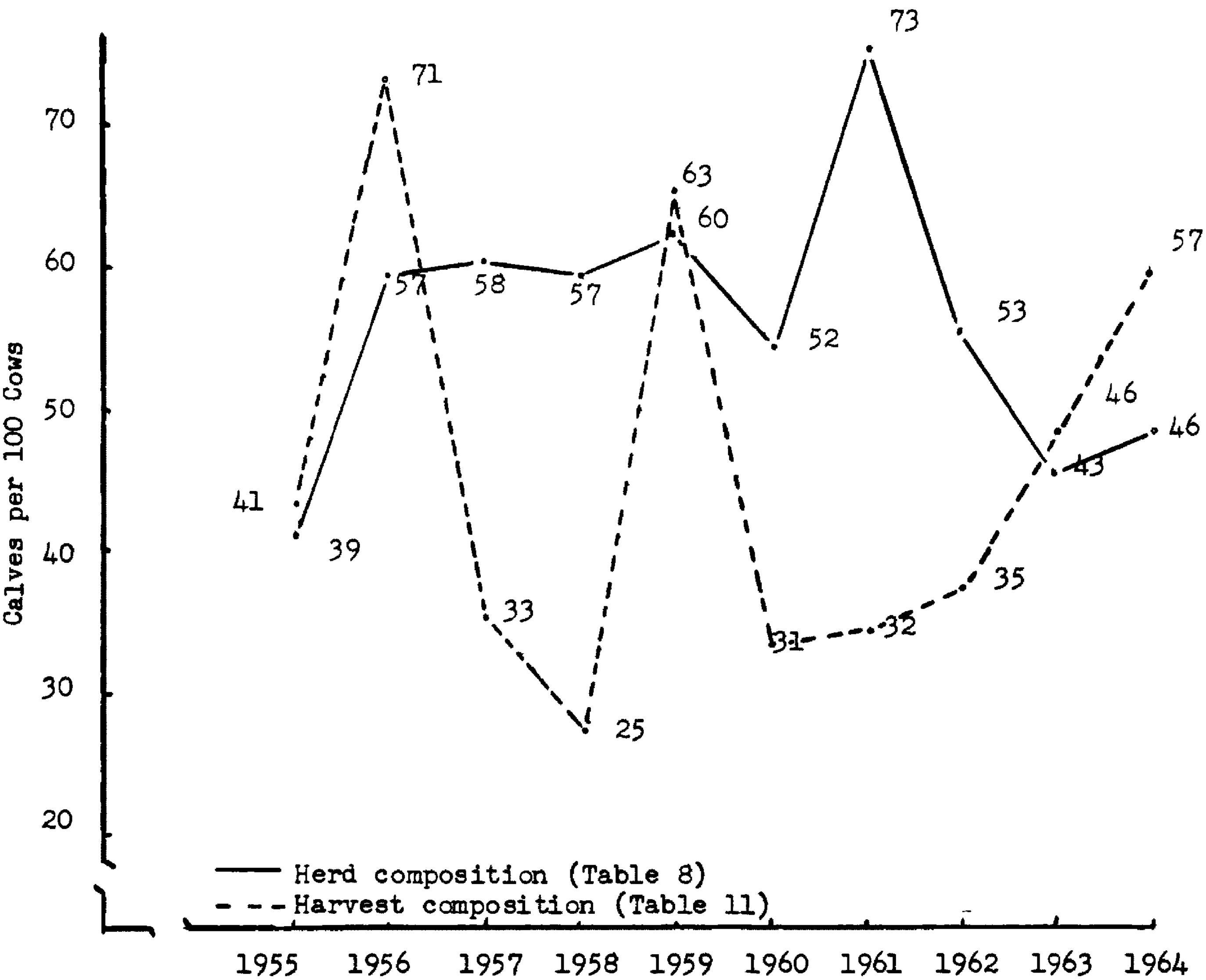


Figure 4. Comparison of calf Ratios, East Fork.

an influence upon the population, though of minor proportions. The mountain lion, uncommon in the area, is the only predator in the Bitter Root Unit capable of inflicting real damage to an elk. On one occasion during the aerial coverage of 1965, we saw three coyotes hazing two adult female and one calf elk. From the physical appearance of the elk, it appeared unlikely that the coyotes would have much success in their venture. The death of the eighth 1955-56 specimen (see above) was accidental, and in

1958, in the entire Bitter Root area, three elk were estimated lost as a result of highway accidents. Poaching in an area such as the Bitter Root Valley occurs in spite of the best policing efforts of game wardens. Actual losses to illegal harvest (estimated by Hartkorn in 1959 as less than 100 animals per year for the entire unit) are not considered a significant drain on the elk population.

The legal harvest in the East Fork, as recorded at the Darby checking station, is shown in Table 9 as a percentage of the total harvest in Area 27 and the upper Bitter Root. In evaluating this table, we should take into account that the Skalkaho Creek (south side) and Sleeping Child drainages are not recorded in the upper Bitter Root harvest, even though they are part of Area 27 (see Figure 2, page 13). This is because the game checking station is located about one mile south of the town of Darby and can effectively collect data only from Rye Creek southward. Thus in Table 9 it appears that 75.8 per cent of the harvest in Area 27 has been East Fork elk, although if the two above drainages were included, the percentage would be considerably lower. The segment of the upper Bitter Root harvest contributed by the East Fork herd has averaged 40 per cent of the total for the 10-year period. Harvest information for the upper Bitter Root--the West Fork and the Rye-East Fork area--has been obtained annually since 1953. A comparison of the East Fork data with this information has greater meaning than the foregoing: from 1955 through 1961, the East Fork contribution to the total harvest in the upper Bitter Root averaged 45 per cent.

Mild weather, which allowed elk to remain on the summer range during

Table 9. Harvest in the East Fork as a percentage of Area 27 and the upper Bitter Root.

Year	Harvest Area: Upper Bitter Root	27	East Fork		Percentage of: Upper Bitter Root	27
1955	540	344	286		53.0	83.1
1956	428	255	194		45.3	76.1
1957	523	273	198		37.9	72.5
1958	475	291	240		50.5	82.5
1959	627	306	230		36.7	75.2
1960	716	391	330		46.1	84.4
1961	664	369	303		45.6	82.1
1962	456	263	118		25.9	44.9
1963	395	100	67		17.0	67.0
1964	207	63	46		22.2	73.0
Totals	5031	2655	2012	Avg.	40.0	75.8

the hunting seasons, and a shorter season in 1964 were the principal factors responsible for the low harvest recorded the last two years in the East Fork. Harvest in the West Fork (Management Area 25) has been relatively stable during the 10-year period. Weather is a factor there also, but a combination of more rugged topography and higher elevations in the main Bitter Root Range is conducive to adverse weather conditions earlier in the year.

Figure 5 is a comparison of the elk census and elk harvest for the East Fork. In spite of the low harvests in 1962, 1963, and 1964, the average annual harvest has accounted for 35.3 per cent of the average annual population estimate. Prior to the 1962 season, the percentage was 40.4.

Harvest Composition

The composition of the harvest is often a reflection of management practices. Hunting seasons in the Bitter Root from 1956 through 1963 have been such as to create a differential harvest condition. The ex-

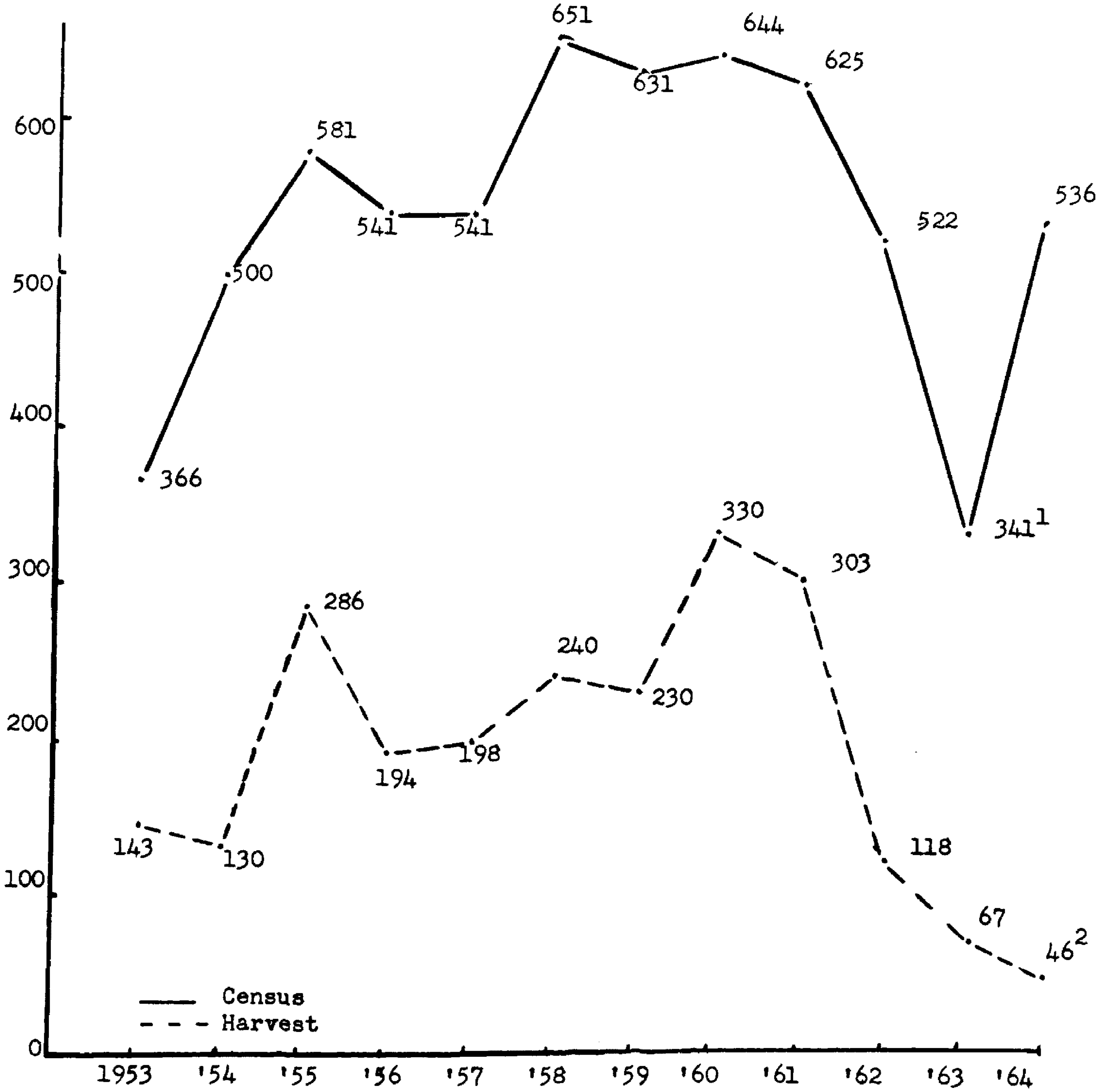


Figure 5. Elk census and elk harvest, East Fork.

[1]Incomplete coverage.

[2]Shorter season.

tended branch-antlered bull seasons, however, have thus far functioned to balance the sex ratio rather than distort it toward the male segment of the population. The average of 12 years of harvest data for the East Fork (Table 10) is a sex ratio of 104 males per 100 females. The age ratio during the same period averaged 19 calves per 100 older animals.

Visual comparison of the harvest ratio as shown in Figure 4 with the total harvest as shown in Figure 5 reveals that the harvest of calves (as a ratio per 100 cows) is inversely related to the total kill. Plotting of the calf harvest as a percentage of the total harvest (Table 10) yields a similar relationship (graph not shown). Whether this is an indication of differential vulnerability of calves or variations in hunter selectivity is not known.

Table 10. Harvest composition by sex and age, East Fork.

Year	Spike Bulls	Mature Bulls	Cows	Calves	Total
1953	11	56	57	19	143
1954	21	55	38	16	130
1955	17	112	109	48	286
1956	36	49	68	41	194
1957	23	61	86	28	198
1958	29	80	105	26	240
1959	19	63	91	57	230
1960	36	109	141	44	330
1961	27	77	151	48	303
1962	24	24	52	18	118
1963	9	20	26	12	67
1964	2	22	14	8	46
	254	728	938	365	2285

Totals and Ratios
Bulls:Cows:Calves - 105:100:39
Young:Adult - 19:100
Spike:Adult Bull - 35:100

The age composition of the kill is the ultimate determination in the harvest analysis. Because the rate of population turnover is directly related to the proportion of young animals in the harvest, information on age composition is a desirable management aid. In the absence of age composition based on age by dentition, and when data from classification and harvest indicate a relatively balanced sex ratio, charting the frequency distribution of antler points in the harvest can yield an expression of the age composition. To convey trends, the distribution for each harvest should be plotted. Such a compilation for the years 1955 through 1964 in the East Fork is given in Table 11. The sample collections were inadequate for several of the years; that is, the numbers recorded as a percentage of the total harvest were not high enough to produce a distribution having frequency values for the major point groups. On the other hand, data for 1960 and 1961--years in which high percentages of the recorded male harvest were included in the frequency distribution--are particularly useful. However, because actual age classification and antler-point distribution were not correlated for these years, the assignment of antler-point classes to specific age groups beyond the yearling class is relatively unreliable.

The relationship of nutrition to the change in antler points per age class over time has not been evaluated for this elk herd. An unsupported assumption is that the elk of the Bitter Root are subsisting on a relatively high nutritional plane. Branch-antlered yearling bulls are not uncommon in the upper Bitter Root, but the extent of their occurrence has not been determined. Comparison of the 1960 and 1961 information in Table 11 does show an increase in the percentage of small antler-point classes in the harvest and a decrease in the larger classes.

Lower jaws collected at the checking station during the hunting seasons in the upper Bitter Root and aged by dentition have been placed in

Table 11. Frequency distribution of antler points in the harvest, East Fork.

Points	1-1 #	1-1 %	1-2 #	1-2 %	2-2 #	2-2 %	2-3 #	2-3 %	3-3 #	3-3 %	3-4 #	3-4 %	4-4 #	4-4 %	4-5 #	4-5 %	5-5 #	5-5 %	5-6 #	5-6 %	6-6 #	6-6 %	6-7 #	6-7 %	7-7 #	7-7 %
1955	55	67.1	0	--	0	--	0	--	0	--	0	--	2	2.4	0	--	9	11.0	1	1.2	11	13.4	1	1.2	3	3.7
1956	35	43.2	0	--	1	1.2	0	--	4	4.9	3	3.7	3	3.7	1	1.2	14	17.3	1	1.2	17	21.0	0	--	2	2.5
1957	23	32.9	0	--	1	1.4	0	--	1	1.4	0	--	4	5.7	4	5.7	11	15.7	1	1.4	23	32.9	1	1.4	1	1.4
1958	29	43.9	0	--	0	--	0	--	2	3.0	0	--	2	3.0	3	4.5	7	10.6	2	3.0	17	25.8	2	3.0	2	3.0
1959	18	47.4	1	2.6	1	2.6	1	2.6	0	--	0	--	5	13.2	0	--	4	10.5	0	--	7	18.4	0	--	1	2.6
1960	35	25.9	3	2.2	2	1.5	0	--	6	4.4	1	0.7	15	11.1	1	0.7	23	17.0	5	3.7	37	27.4	3	2.2	4	3.0
1961	27	34.6	2	2.6	3	3.8	0	--	1	1.3	1	1.3	6	7.7	1	1.3	12	15.4	6	7.7	16	20.5	2	2.6	1	1.3
1962	24	88.9	0	--	0	--	0	--	0	--	0	--	0	--	0	--	1	3.7	0	--	2	7.4	0	--	0	--
1963	9	81.8	0	--	0	--	0	--	0	--	0	--	0	--	0	--	1	9.1	0	--	0	--	0	--	1	9.1
1964	2	16.7	0	--	2	16.7	0	--	0	--	2	16.7	2	16.7	1	8.3	2	16.7	0	--	1	8.3	0	--	0	--

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Total elk	82	81	70	66	38	135	78	27	11	12
Sample size percentage	63.6	95.3	83.3	60.5	46.3	93.1	75.0	56.3	37.9	50.0

age groups rather than year classes (Table 12). The percentage of the total harvest in each age class is unknown, and specific conclusions are difficult to present because the yearly samples are incomplete and probably biased.

Table 12. Age composition of harvest based on animals aged by dentition, upper Bitter Root.

	Yearlings		2½ years		Prime[1]		Old		
Year	No.	%	No.	%	No.	%	No.	%	Total
1957	-	-	-	-	20	71.4	8	28.6	28
1958	18	18.9	-	-	58	61.1	19	20.0	95
1959	11	16.9	-	-	48	73.8	6	9.3	65
1961	65	41.4	27	17.2	53	33.8	12	7.6	157
1962	26	27.4	20	21.0	43	45.3	6	6.3	95
1963	29	45.3	-	-	28	43.8	7	10.9	64
Total	149	-	47	-	250	--	58	-	504

[1]Prime = age 3½ to 9½; old = 10½ plus.

A survey of big-game license holders residing within the limits of Missoula, Montana by faculty and students in the School of Forestry, University of Montana in the spring of 1963 (Braun and Taber 1964) revealed that during the 1962 big-game season only 52 per cent of the bull elk killed, 40 per cent of the calves, and 53 per cent of the total kill were reported to checking stations. Any adjustment of the age-composition data given in Table 12 would probably be erroneous. It is evident from the table, however, that the percentage of yearlings in the harvest has increased and that of old animals has decreased.

During the 1964 harvest season, I made a special effort to obtain an adequate sample of accurately aged animals. One hundred and twenty-two, or 58.9 per cent of the total recorded harvest, was assigned to age groups, The calf segment in particular is probably biased: due to their characteristic size, all calves can be placed in the ½-year age class, even in the absence of dental examination. But unless teeth are present, an adult animal can only be included in the unaged-adult group. The calf segment therefore may approach 100 per cent of the known harvest, while older age classes vary at considerably less than 100 per cent. The single factor most responsible for this circumstance is that a hunter who must pack a carcass any great distance does not feel obligated to include the head, which weighs an additional 15 to 20 pounds or more and is of no value to him unless it is a mature male--his first and/or of trophy-class proportions.

Table 13 lists the age composition of the 1964 harvest in the upper Bitter Root. Animals 2½ years and younger constitute 75.3 per cent of the total harvest--63.9 per cent if the ½-year class is excluded--as recorded through the checking station. No old animals were observed in the 1964 harvest. Reference to Table 12 for 1961 and 1962 shows that 58.6 and 47.9 per cent respectively of the total harvest 1½ years and older comprised 1½- and 2½-year-old animals.

Table 13. Age composition of harvest in upper Bitter Root, 1964.

Age class	½	1½	2½	Prime	Old	Total
No. in class	36	34	22	30	0	122
Percentage	29.5	27.8	18.0	24.7	0.0	100.0

Movements

The geographic limitations of an animal population are basic to its ecology and management. Elk are hardy individuals, capable of enduring extreme temperatures [to -52° F. as reported by Gaffney (1941) in the South Fork of the Flathead River] and substantial snow depths [to 48 inches, Gaffney (1941)], of utilizing a wide variety of food materials (Murie 1951), and of making extended journeys [more than 100 miles (Anderson 1958)]. The degree of elk mobility and the duration of their occupancy of a given area can be determined by seasonal observations. Two zones are generally designated when considering area limits—summer and winter. Because summer range is extensive, and the animals have unrestricted mobility and are widely scattered, it is difficult to establish the area's carrying capacity. Winter range, however, is the measure of the possible elk herd (Murie 1951). The importance of the latter area to elk management therefore necessitates a delineation of winter-range limits.

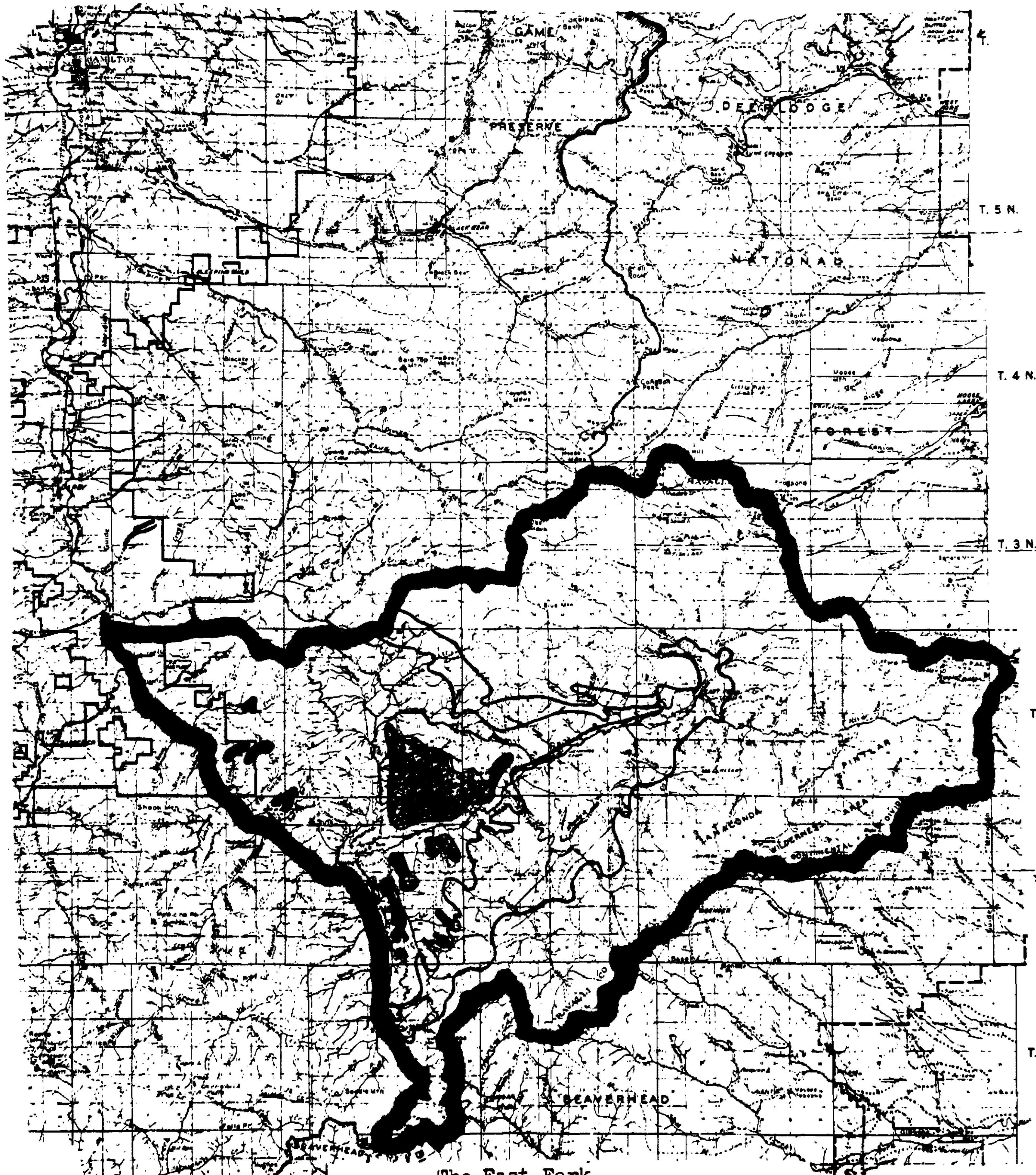
By aerial and ground observations in past years, personnel of the Montana Fish and Game Department, District II, and the Forest Service, Sula Ranger District, have established winter-range perimeters under mild, normal, and severe weather conditions. The winter-range zones, as a percentage of the total study area, were plotted by using a polar planimeter and a 1964 series 12-mm-per-mile map of the Sula Ranger District (Figure 6). These zones were found to be 55.6 per cent, 35.8 per cent, and 12.4 per cent respectively for the mild, normal, and severe conditions.

Describing the weather conditions in the Big Prairie District of the Flathead National Forest, Gaffney (1941:431) states:

> Summer temperature and precipitation are of primary importance as they effect the character of the vegetation and its growth. Of far greater importance, however, in influencing the available area of winter range, the relative accessibility of different forms of vegetation in winter, and the movements of the elk on the winter range, are the snow and temperature conditions of the range during December, January, February, March, and April.

Examination of weather data recorded for Sula shows that snow and temperature have the greatest effect on winter-range conditions during the period from November through March (see Table 29 in the appendix).

Inasmuch as environmental factors occurring during this period probably require the greatest amount of physiological adjustment by elk,



The East Fork
Figure 6.

Winter Range Zones
- Mild
- Normal
- Critical

average temperature and total precipitation for this period, as recorded at Sula, are shown in Table 14.

Table 14. Average winter temperature and total winter precipitation at Sula, elevation 4,450 feet.[1]

Year	Average temperature, °F.	Total precipitation, inches.	Adjective rating
1955-56	22.7	5.77	Severe
1956-57	24.2	4.04	Normal
1957-58	26.8	4.47	Mild
1958-59	28.6	6.95	Normal
1959-60	24.1	5.01	Normal
1960-61	29.6	7.09	Mild
1961-62	23.8	4.80	Normal
1962-63	28.4	6.94	Mild
1963-64	24.9	5.48	Normal
1964-65	26.2	8.19	Normal
Average	25.9		

[1]Winter-November through March.

Extreme snow-depth or low temperature can individually be a contributing factor in elk movements; the interrelationship of less extreme degrees of the two influences can be equally instrumental. District II personnel have established relative or adjective ratings based on the complex of temperature and precipitation as it affects the general welfare of the game. When the precipitation is above average and the average seasonal temperatures are below the rated average, the winter tends to be severe for big game: accumulation of snow causes greater energy expenditure per unit of food intake by the animal. There is usually less snow accumulation during winters when the average temperatures are above normal; these winters are rated normal, as are those in which both precipitation and average temperatures are below normal. If average temperatures are above normal and precipitation below normal, the winter is considered mild. Figure 7 is a comparison of total winter precipitation with average winter temperature. Severe winters, as evident from the illustration, are not frequent; there has been only one such winter during the 10-year period.

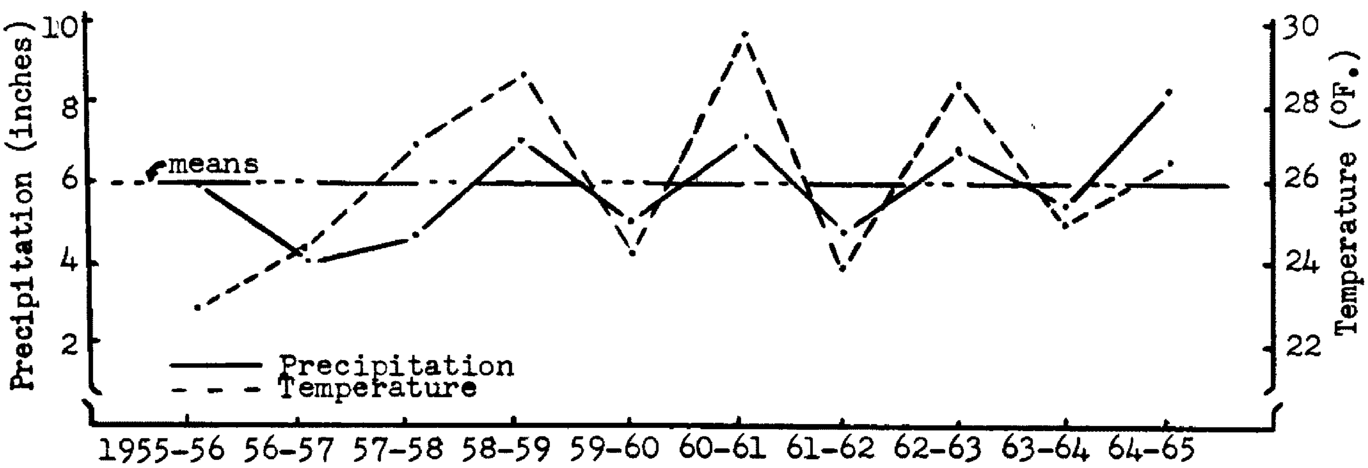


Figure 7. Annual average winter temperature and total winter precipitation, Sula, elevation 4,450 feet.

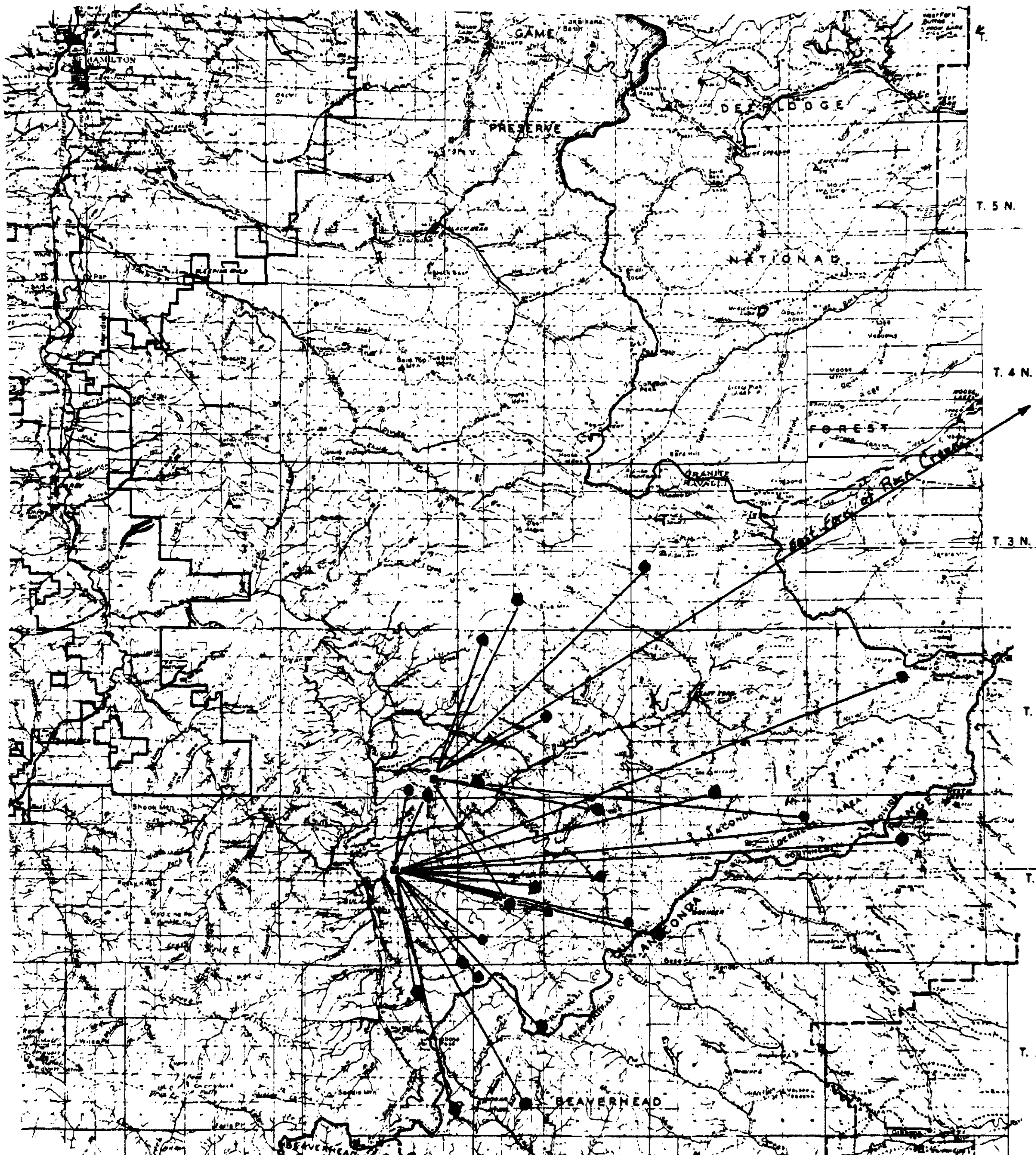
Elk migration throughout their entire range is an important consideration. Because a large proportion of the East Fork wintering area is located on private property, the movement into, duration of occupancy on, and departure from the winter range becomes a vital part of overall land management. Periodic observations made each fall in past years show that elk appear on the winter range in late November or early December. Cessation of aerial trend counts in the spring coincides with the departure of elk from the winter range in early May. For an average year, about five months is the maximum period of winter-range occupancy. Elk may move to winter range earlier and remain longer in one year than in another, depending on how soon in the fall the heavy snows come and on when the spring breakup occurs. During normal years the entire elk population moves, though not to the same specific location on the winter range and not simultaneously. Beginning with small groups, the numbers occupying the winter range gradually increase until all but the most hardy individuals have arrived by early January. Exodus in the spring is in larger groups and accomplished in a much briefer period.

In 1953 the Fish and Game Department initiated migration studies to determine whether Bitter Root elk winter each year in essentially the same area. This project has consisted of trapping elk on the winter range and marking them for individual recognition. Aluminum ear tags bearing sequentially imprinted numerals have been used exclusively, and tag return by successful hunters provides the desired information. The choice of these ear tags is unfortunate in that identification is impossible without immobilizing the animal and, in addition, necessary data on summer dispersion cannot be obtained.

Through the winter of 1964-65, 183 elk were trapped and tagged at two different trap sites in the East Fork--Pasture Draw and Riemel-Tolan Ridge. All elk were released at the sites (Table 15). Of 127 animals marked prior to the past year, 41 tags, or 32.3 per cent, have been returned from hunter-harvested animals. Table 16 and Figure 8 present data on the locations of tagged-elk kills.

Table 15. Elk trapped and tagged in the East Fork.

Winter	Bulls	Cows	Calves	Total
1953-54	5	21	7	33
1954-55	7	21	4	32
1958-59	5	19	8	32
1959-60	3	11	5	19
1961-62	4	5	1	10
1963-64	1	0	0	1
1964-65	8	36	12	56
	33	113	37	183



Bitterroot Unit Upper East - Side Area

■ Elk trap sites

● Tag-return locations

Figure 8.

There is interchange of elk between the north and south sides of the East Fork. The apparent uncertainty of wintering grounds for elk that summer along the Continental Divide (Bitter Root-Bighole Divide) is especially interesting. Several elk tagged in the East Fork of the Bitter Root River were later shot in the Bighole River drainage, indicating that some elk do not return each winter to the East Fork. In studying elk migrations in the Gallatin River area, using tagged calf elk, Brazda (1953) found similar intermingling and movements between the Gallatin and Yellowstone drainages.

Table 16. Selected tag-return locations for East Fork elk.

	Release data				Recovery data	
	Sex	Age	Date	Location	Date	Location
F 2810-2811	M	C	1-5-54	Riemel-Tolan	2-16-55	Bunch Gulch
F 2822-2823	F	C	1-18-54	" "	12-18-60	Thompson Creek
F 2857-2859	M	C	2-4-54	" "	10-16-54	Tolan Creek
F 2888-1228	F	Ad	3-4-55	" "	11-12-61	Thompson Creek
F 1231-1241	F	Ad	3-8-55	" "	10-57	Trail Creek
F 1261	F	Ad	3-27-55	" "	11-24-61	Riemel Creek
H 1009-1010	F	Ad	2-9-59	Pasture Draw	12-4-60	Meadow Creek
H 1044-1045	M	Ad	2-19-59	" "	9-19-61	E. F. Rock Creek
H 2199-2200	F	Ad	2-27-60	Riemel-Tolan	10-12-60	Hell Roaring Creek
H 2276	M	Ad	3-9-60	Pasture Draw	12-22-61	Bunch Gulch

The maximum movement recorded to date in the study area is shown by tag return H 1044-1045 from Dry Gulch, East Fork of Rock Creek, an airline distance of approximately 30 miles. The greatest distance covered in one season's movement was indicated by tag return H 2199-2200, recovered in the Hell Roaring Creek drainage, a distance of 13-16 miles. Picton (1960), in relocating tagged elk from the Sun River winter range, observed maximum one-season movements from the winter range of 28 airline miles.

Some elk apparently have a greater propensity for movement than others.

Johnson (1951) and Brazda (1953), observing summer movements of calf elk tagged on the calving grounds in the upper winter range of the Gallatin River drainage, report average distances of 11 and 14.8 airline miles respectively, with a maximum of 18 airline miles. These movements took place in July, the month in which elk are thought to have reached the limit of their migration. A summation of data from Picton (1960) on 68 tagged elk shows that the average of the maximum distances traveled, as determined by sight records for males and females, was respectively 17.0 and 21.1 airline miles. (This summation excludes males and females not recorded separately and animals tagged in May and June on the North Fork of the Sun River, under the assumption that the latter were calves marked on the calving grounds.)

Range Relationships

The grasslands of Sula and French Basin have supported a cattle industry since shortly after the Bitter Root Valley was homesteaded. From the late 1880's until about 1940, cattle, sheep, and horses were permitted to graze the ranges of the East Fork extensively. The effects of such usage were first noted in a Forest Service-Emergency Relief Administration (E.R.A.) winter study of 1936-37, when field investigators found the East Fork ranges to be in poor condition. Adverse economic conditions--low wool and mutton prices and unavailability of competent herders--in the late 1930's and early 1940's served to reduce sheep numbers in the Bitter Root. Hollibaugh's 1942 report on the East Fork winter study of 1941-42 maintained that although certain areas within the principal winter range showed signs of deterioration, the range in general was not over-utilized. Between 1945 and 1950, sheep-grazing in the East Fork declined into nonexistence, and since the latter date cattle and a few horses have been the only domestic users of the public range. While the elimination of sheep reduced domestic grazing, corresponding increases in big-game numbers (though not demonstrated by range studies) were sufficient to nullify the curtailment.

In the fall of 1952, a group composed of members of the Ravalli County Fish and Wildlife Association, the Sula Stockmen, and the Forest Service built a big-game exclosure on the East Fork of the Bitter Root River. The plot, located about half a mile west of Guide Creek on a south-facing slope, was for the purpose of demonstrating the effect of big game upon browse, timber, grass, and soil (Hamre 1952).

In 1953 the Forest Service and the Fish and Game Department completed an inspection of major East Fork ranges, finding portions of all of them in an unsatisfactory condition. Believing that combined use by elk and cattle was responsible for the deterioration, the two agencies cooperated in a project to obtain quantitative data on actual grazing pressure: standard range-condition and browse-condition transects, conifer survival plots (Hamre et al. 1954), pellet group plots, and a system of exclosures (game only, cattle only, game and cattle, and no-use) were set up in the area.

Fifty ponderosa pine and 50 Douglas-fir seedlings were planted in the spring of 1953 inside the original Guide Creek exclosure; a similar number were planted outside. Total seedling survival was low following a dry summer and fall. An examination of the plantings in the spring of 1954 revealed that 45 per cent of the 27 surviving seedlings outside the fenced plot had been browsed during the winter. When checked in the fall of that year, four times as many natural seedlings were found inside the exclosure as outside. By the spring of 1955, 77 per cent of the 22 remaining seedlings outside the exclosure had been browsed and 35 live seedlings remained inside the plot. The heavy use of the seedlings outside the plot was attributed to elk and/or deer, since tracks and droppings of both were present. When the plot was established, almost all palatable shrub species were in poor vigor as a result of heavy winter use by game. Tagged shrubs outside the plot were remeasured each spring for the next three years. Browse use on three key species--bitterbrush, serviceberry, and willow--averaged 79, 67, and 77 per cent respectively following the milder-than-normal winters of 1952-53, 1953-54, and 1954-55 (seasons in which elk should have been relatively dispersed throughout the winter range and nonbrowse forage should have been in average to above-average availability).

Two other study areas, at Jennings Camp Creek and Tepee Point, had been established in 1954 in an effort to gain factual information on game-confier survival relationships (Hartkorn 1955). The Jennings Camp Creek plot encompassed a "fill-in" planting of 8,000 confier seedlings on about 40 acres. The first examination of the subplots in the fall of 1954 disclosed a seedling survival of 78 per cent. Of the live seedings, 4.5 per cent had been browsed on the terminal shoot and 8.6 per cent on lateral twigs. A recheck in the spring of 1955 showed that 13 per cent of the 305 live seedlings had been browsed on the lateral twigs and 13 per cent had been browsed on the terminal shoot. Tracks and pellet groups indicated use by both elk and deer.

A total of 99 trees, six to 72 inches in height, were tagged in the Tepee Point study. In the spring of 1955 six per cent were found to have light needle browsing.

A program to reduce the number of domestic and wild animals on national forest lands in the Bitter Root was initiated in 1953. In the East Fork, the grazing season for livestock was shortened; cattle numbers were decreased; and horses were eliminated from the range. At the same time, more liberal hunting seasons were recommended to reduce game numbers.

Harvest seasons have been discussed previously, and a listing of season dates presented in Table 3 (page 25). Harvest data in Table 9 (page 43) show that liberal seasons were effective in facilitating larger harvests. Comparison of Tables 5 and 9 suggests that elk numbers increased until 1960 and were stabilized between 1961 and 1964 by liberal hunting regulations, only to increase again to the 1960 proportions following a less liberal 1964-65 harvest season.

Pellet group counts on permanent plots in the East Fork could offer some indication of elk abundance. However, variations in elk abundance as determined from pellet group data can be a reflection of weather conditions, hence distribution, and not represent actual numbers present for trend purposes. Pellet group data are presented in Table 17. For the year 1958, when the elk population reached a peak, pellet groups per acre were not in accord. Fluctuations characterize the data for the nine-year period, and a trend as such is not formed.

Table 17. Elk pellet group counts on permanent plots, East Fork, spring 1955-63.[1]

Site	1955	1956	1957	1958	1959	1960	1961	1962	1963
Bunch Gulch	174	291	239	174	152	---	640	960	0
Dick Creek	278	435	243	348	226	170	640	---	6
Exclosures	---	609	522	152	500	218	---	---	6
Camp Creek (M)	152	196	---	130	370	261	280	---	20
Camp Creek (L)	183	---	---	---	574	304	120	---	25
USFS Horse Pasture	161	378	478	148	522	675	---	---	40
Barley Ridge	239	217	587	239	370	130	400	140	120
Diggins Ridge	326	413	435	---	500	544	880	280	110
Wallace Ridge	435	587	674	---	500	489	---	---	176
Shirley Mountain							480	1240	74
Bunch Gulch (N)							0	1000	---
Bunch Gulch (S)							400	480	---
Average Totals	243	387	452	200	413	336	427	683	58
Average Totals, except last 3 sites	243	387	452	200	413	336	493	460	56

[1]Pellet groups per acre.

Reduction in range use by domestic stock is considerably more definitive than a reduction in elk numbers. As mentioned previously, although domestic grazing in the East Fork was curtailed to some degree prior to 1950 by eliminating sheep from the range, major efforts to adjust livestock pressure on public grazing lands in the Bitter Root National Forest were not begun until after the 1953 land-use study. To effect the adjustment, the grazing season was shortened by 30 days beginning in 1953. Since then, domestic grazing has steadily declined. Table 18 presents livestock use on forest ranges in the Bitter Root Unit for significant years from 1945 to date. For the Bitter Root National

Table 18. Livestock use on forest ranges in the Bitter Root National Forest, Montana section.

Year	1945	1950	1953	1955	1958	1963	1964
Animal Months	16,356	18,754	17,861	17,735	13,149	10,812	10,570

Forest (Montana section) as a whole, the reduction in grazing has amounted to about 39 per cent since 1953. A breakdown of the grazing reduction per ranger district within the Forest is shown in Table 19.

Table 19. Animal-months actual use per ranger district, Bitter Root National Forest.

Area	Year					1950-64	Percentage
	1950	1955	1958	1961	1964	per area	of total
Stevensville	2620	2141	624	595	526	80.0	25.5
Darby	6480	6219	6370	4414	3531	45.5	36.0
West Fork	1146	3001	1165	1360	1253	0.0	--
Sula	8508	6374	4990	3938	5260[1]	38.2	39.6

[1]The Sleeping Child fire of August, 1961 and subsequent grass seeding have developed almost 28,000 acres of desirable forage. About 75 per cent of the burn occurred in the Sula Ranger District. Because of the topography, not all of the burn area is grazed. In 1964, for the first time, 3,165 animal-months were used in the burn.

When the conifer survival plots established in 1952, 1953, and 1954 were reexamined in the spring of 1955, only in the East Fork exclosure area were there any serious affects attributable to game use. Lack of site preparation prior to planting was also a factor in the low seedling survival in that area. Conifer survival studies were reestablished by the Forest Service on Lyman Creek, Guide Creek, and Jennings Creek Divide in 1958. Seedling survival was excellent on all plots, and the studies were discontinued in 1962.

Permanent browse transects were set up by the Fish and Game Department on key areas within the East Fork winter range in 1958 and 1959. Allowable intensities of use vary with the species and vigor of browse plants, the range site, and the severity of the past winter. On vigorous plants, allowable use during severe, normal, and mild winters is 70, 50, and 25 per cent respectively. Browse condition is based on the percentage of sampled plants in form classes 3 and 6. Class limits are: 0-20 per cent, good; 20-30 per cent, fair; and 30 per cent or greater, poor. Reference to adjective weather ratings in Table 14 (page 52) and leader-use percentage in Table 20 shows that only in 1962 was leader use within the allowable intensity. Browse condition has improved considerably since 1958.

Table 20. Browse condition and utilization, East Fork.

Year	No. of plots	No. of plants	Percent in form class 3 and 6	Leader use percentage
1958	1	--	55	79
1959	5	--	51	55
1961	6	148	49	27
1962	6	175	25	21
1963	6	--	12	28
1964	6	200	26	58

Range condition transects were established by the Forest Service in 1954 and have been examined every fourth year since. The Parker Three-Step method of rating range condition has been used. Table 21 is a summary of the transect measurements for the years 1954, 1958, and 1962. The average of the 21 transects shows improvement in the condition of the vegetation.

Table 21. Range condition transect measurements, East Fork.

Area	Cluster	Condition of Vegetation[1] 1954	1958	1962
Bunch Gulch	1	13	14	16
	2	18	19	22
USFS Horse	1	12	16	18
Pasture	2	13	15	--
	3	14	19	--
	4	18('56)	17	18
	5	18('56)	17	20
Camp-Riemel	1	10('53)	12	15
	2	12('53)	14	16
	3	14('53)	14	17
	4	13('53)	12	13
	5	16('53)	18	17
	6	12	17	16
	7	11	13.5	16('64)
	8	11	14	14
	9	15	14	16
	10	22	20	--
Dick Creek	1	11	17('57)	17('61)
	2	14	18('57)	17('61)
	3	14	14('57)	17('61)
	4	13	16('57)	15('61)
Averages		14	15.7	16.7

[1]Condition of vegetation based on vegetative composition, relative plant density, and vigor of desirable grasses. Numerical and Adjective classes--Excellent 21-25, Good 16-20, Fair 11-15, Poor 6-10, and Very Poor 0-5.

DISCUSSION

From an estimated low of seven in 1902, the number of elk in the Bitter Root Valley has increased to the current level of over 2400. Whether the introduction of Yellowstone elk in 1911 was primarily responsible for the present-day herd or whether native stock would have reproduced to form the herd will remain a point of debate. Current population estimates for the Bitter Root herd are based on the 1965 aerial census. Because aerial counts represent a minimum estimate, actual numbers are unknown. Using a factor of .91, as established in the 1946-47 cooperative game census in the East Fork, an actual herd size of 2663 would exist; a factor of .82, as employed by Buechner et al. in the Blue Mountains of eastern Washington, would yield a population of 2951 animals. Since the use of a factor in determination of population size is often questionable from one area to another and from one year to the next, the trend established by minimum estimates obtained through annual aerial coverage appears to be most applicable. In addition, air census is to date the most expeditious method of enumerating elk in the Bitter Root area.

The question "How many elk should there be?" prevails. In 1953 the competition between cattle and elk for available forage in the winter range resulted in excessive utilization and range deterioration. The main area of concern were grazing lands administered by the Forest Service, which often serve as both summer range for cattle and winter range for elk. Forage preferences of these two herbivores are so similar that any dual-use approach was impossible. To improve range conditions, utilization by both species had to be reduced. Manipulation of the grazing period of cattle is the least difficult method of controlling use, and was the means first employed by ranchers and administrators in the Bitter Root. However, when the East Fork ranchers volunteered in 1953 to take a 30-day grazing cut per year, it was with the understanding that the elk herd would be maintained at its existing size.

Annual aerial censuses began that same year, with a count of 366 elk in the East Fork. Despite the increased elk numbers (581) recorded by 1955, most ranchers did not oppose the continuation of the grazing cut. The higher elk count in 1955 was probably the result of greater proficiency in aerial coverage technique combined with a slight increase in herd numbers. From 1955 to date, excluding 1963, for which the census is incomplete, the annual trend count has averaged 590, varying between 522 and 651. With lowered use of the grazing lands, the range has gradually improved. Grass transects in particular show favorable recovery. Palatable and nutritious browse, however, occurs in relatively low density on the winter range where there is continuous utilization. The lack of palatable browse presents more of a limitation to deer than to the more versatile elk.

Beginning in 1954, the Montana Fish and Game Department instituted hunting seasons of variable duration: either-sex seasons could be maintained until the desired harvest of cow elk was attained. The principal advantage of this type of season is that a harvest adequate to maintain a relatively stable population can be effected without regard to the time of occurrence of adverse weather and subsequent movement of elk from the summer range. In addition, each year's harvest can be based on population estimates, herd productivity, range conditions, and past harvest intensity. The Fish and Game Department can close the season on a 48-hour notice. This eliminates much of the public fear of gross over-harvest should severe weather early in the season lead to elk concentrations in areas readily accessible to hunters.

The 1954 harvest was poor, due perhaps to the mild weather that fall. The next year, however, early snowfall and lower than normal temperatures were responsible for the first successful hunting season of variable length. These flexible seasons were continued through 1963. But that year very mild fall weather resulted in an extremely low harvest. In 1964, a return to a season of predetermined duration and date coincided with another very mild fall, and a still lower harvest was recorded.

The East Fork harvest from 1955 through 1961 has averaged 254 elk annually, in a ratio of 98 bulls and 39 calves per 100 cows. In a comparison of aerial population estimates and harvest information for the years 1955 through 1963, we have seen that the average annual harvest has removed 40.4 per cent of the estimated average annual population.

As aerial counts represent only minimum population size, so checking station data includes only a portion of the actual harvest. From hunter questionnaires, which are a sample of total hunter numbers, the point-estimate of harvest is presented in Table 22 and compared with checking-station and aerial-census data. If, as indicated, only about 50 per cent of the harvested elk are reported through the checking station, a considerable quantity of management information is lost each year due to nonreporting hunters. In addition, questionnaire harvest

Table 22. Comparison of census and harvest information, Area 27.

Year	Aerial count	Harvest by Ques.[1]	Harvest by C.S.[2]	Percentages Col. C of B	Percentages Col. D of C	Percentages Col. D of B
1957	741	442	273	59.6	61.7	36.8
1958	972	474	291	48.8	61.4	29.9
1959	831	740	306	89.0	41.3	36.8
1960	916	789	391	86.1	49.6	42.7
1961	625[3]	625	369	--	59.0	--
1962	522[3]	478	263	--	55.0	--
1963	461[4]	298	97	--	32.5	--
1964	739	156	63	21.1	40.4	8.5
Ave.	839[5]	500	257	59.6	51.4	30.6

[1]hunter questionnaire values

[2]checking station values

[3]partial count, East Fork only

[4]incomplete coverage

[5]only years of complete coverage included

values frequently exceed the maximum rate of increase for the herd in its present composition. The 53 calves per 100 cows and 97 bulls observed in the East Fork during the present study is a 26.9 per cent annual increase. Even the pre-season classification of 47 bulls and 74 calves per 100 cows reported by Boyd and Green (1964) for the exploited White River, Colorado elk herd in 1960 represents only a 50.3 per cent annual increase. The average harvest as determined from hunter questionnaire returns for the Bitter Root Unit, however, would require an annual increase of 59.6 per cent, assuming no mortality or recruitment and maintenance of a stable population. Theoretically, a composition of 25 bulls and 76 calves per 100 cows would result in an annual increase of 60.8 per cent. Or, conversely, assuming the 26.9 per cent annual increase in the East Fork, a stable population, and no mortality or recruitment, an average annual harvest of 500 animals would require a parent herd of approximately 1860 elk. A herd of this size is more than twice as great as the average annual census for Area 27, and 48 per cent larger than the maximum count of 1958. Either aerial coverage is inefficient as a census technique or the questionnaire average harvest is greatly exaggerated. The latter is more likely to be the case. The most reliable value, though it is a known underestimate of the kill, is the harvest as recorded through the checking station.

Table 23 is a life equation table based on the spring census of 1965, a sex ratio of 97 bulls per 100 cows obtained from the aerial classification of 80 unduplicated animals in the East Fork, a calf-cow ratio of 53:100 derived from ground classification of 143 unduplicated elk in the East Fork, and checking station records of the 1964 harvest. Comparing the minimum parent spring herd of 1964, as obtained by the life equation table, with the aerial count of 536 elk in the spring of 1964, the data appear to describe the herd for this period of time.

Table 23. Life equation table from 1964 to 1965, East Fork.

Period and Gain or Loss	Cows	Calves	Bulls	Total
Winter census 1964-65	250	131	243	624
Plus total losses 1964-65	15	8	24	47[1]
Minimum summer herd 1964	265	139	267	671
Less calves		139		
Minimum parent spring herd 1964	265		267	532

[1]includes one cow killed in trapping operations

Composition, as well as total numbers, is useful in the interpretation and formulation of management practices. A 12-year harvest of 2285 animals from the East Fork, as recorded through the checking station, has been in a ratio of 105 bulls and 39 calves per 100 cows (see Table 9, page 43). We should first consider that if the calf harvest has averaged 39 calves per 100 cows over the 12-year period, the calf crop must have been substantially larger to maintain a stable herd. Classification data show an average of 56 calves per 100 cows on the winter range. This is certainly indicative of a highly productive herd.

Observed calf-cow ratios of selected elk herd are shown in Table 24. The elk population of the Bitter Root, the East Fork particularly, ranks

Table 24. Calf-cow ratios from selected elk herds.

Herd	Calves per 100 cows	Source
Montana		
Sun River	30('56-63 avg.)	Series W-74-R[1]
Gallatin	35('59-61 avg.)	Series W-73-R
S.F. of Flathead	25('58-63 avg.)	Couey 1965
Judith River	54('60-62 avg.)	Series W-74-R
Fort Peck[2]	56('56-63 avg.)	Series W-76-R
North Yellowstone	58('63-64)	McLaughlin 1964
Wyoming		
Jackson Hole	34	Straley 1961
Colorado		
White River	73	Boyd and Green 1964
New Mexico		
Pecos	36('50-59 avg.)	Gates 1960
Arizona		
Sitgreaves	50	Ariz. G.&F. Comm. 1964
Apache	53	Ariz. G.&F. Comm. 1964
Washington		
Blue Mountains	64(est.)	Urness 1960

[1]Montana Fish and Game Department, Job Completion Reports

[2]Charles M. Russell Game Range

favorably with these herds. A significant fact clearly evident in the calf-cow ratios recorded for the Fort Peck elk herd is the overall decline in calf production associated with an increasing herd on a limited range. For the years 1956 through 1963, following an introduction in 1951, the respective ratios of calves per 100 cows are 68, 67, 60, 47, 51, 50, 56, and 53.

The second consideration in the harvest composition concerns the sex ratio. Few persons will deny a desire to have more elk available to hunters in the Bitter Root. At the same time, most people would prefer not to reduce the productive capacity of the parent herd by killing too many cows. A feasible solution lies in a greater harvest of bulls. Working with the heavily exploited White River elk herd of Colorado, Harris (1963) reports a six-year (1957-62) average pre-season sex ratio of 50 bulls per 100 cows and a post-season ratio of 23 bulls per 100 cows. The proportion of one bull to two cows maintained a pre-season age ratio of 66 calves per 100 cows. Obviously, an equal sex ratio does not enhance productivity, and a larger harvest of bulls in the Bitter Root might result in increased productivity and more elk available for hunting.

In 1953 Colorado initiated a program of unlimited antlered and limited antlerless harvest seasons. In summarizing an evaluation of the elk validation system in that state, Denny (1961) reports that in validation areas the average bull kill has increased 28 per cent, the average cow and calf harvest has dropped 13 and 53 per cent respectively, statewide harvest has averaged two per cent higher, the yearling composition in the harvest has risen four per cent, and aerial trend counts have increased significantly, some as much as 100 per cent. A validation system is not suggested for the Bitter Root, but is seems apparent that the elk could be utilized at what Ciriacy-Wantrup (1963:53) calls a higher "state of conservation."

Public opinion in the Bitter Root is divided with regard to liberal harvest regulations. Although these regulations were instituted as one means of improving range conditions and reducing animal depredations, there has been strong oppostion to them, based on the belief that extended either-sex seasons cause an overharvest of elk. It is unfortunate that in the spring of 1963, following a hunting season of subnormal harvest, a complete aerial coverage was not possible. Either a confirmation of or rebuttal to common talk that the elk population was declining because of extended, either-sex seasons would have been most beneficial at that time.

As noted previously, protests following a further decline in harvest during the hunting season of 1963 led to a revocation of the liberalized seasons. The 1964 hunting season ended a month earlier than those in preceding years, in spite of the 1964 spring trend count in which elk numbers were found to be close to the average of the past 10 years. A still lower number of elk shot in 1964 brought a revival of the earlier criticism that liberal regulations had caused an overharvest. By the spring of 1965, following three harvest seasons of low intensity, the population recorded in the aerial coverage was at an all-time high. But as to the actual status of the population in the interim of imcomplete coverages, one can only conjecture.

It is entirely conceivable that the population level did decline. Study of Table 10 (page 45), particularly of 1960 and 1961 data, leads one to wonder if the harvest of adult females could have been excessive, especially in 1961 when three cows were shot for every two bulls. The abrupt rise in the ratio of calves to cows (Figure 4, page 41) in 1961 could be an expression of the degree of cow-harvest in the past season, which, as indicated by the calf-cow ratio of 1962, did not adversely affect the herd. The unbalanced sex harvest of 1961, mentioned above, resulted in a substantial decline in the total population (Figure 5, page 44) recorded in 1962. The drop of 10 calves per 100 cows in 1963 could well be a reflection of a shortage of breeding cows after the 1961 harvest.

Based on an East Fork herd composition of 100 bulls and 46 calves per 100 cows, the 1963 harvest values, and the 1964 spring census, the minimum parent spring herd of 1963 was 491 (see life equation table, page 69). Using this same technique, the calculated minimum parent spring herd of 1962 was 504. The latter value is close enough to the actual count of 522 to suggest that the derived figure for 1963 may be reliable and that a diminution of the herd did take place. This inference, however, does not alter my opinion that elk in the East Fork were more numerous than indicated by aerial coverage during 1962 through 1964 and that harvest values for these same years do not reflect actual herd numbers.

Assuming elk were sufficiently abundant to permit the modest East Fork harvest in all of the past seasons, some explanation for the extremely low harvests seems necessary. The physiography of the East Fork is unlike that of the West Fork and the west side of the Bitter Root Valley. The Bitter Root Mountains are characterized by rugged to precipitous terrain. Westward and windward of the Sapphire Mountains, they are also higher in elevation. Snowfall and accumulation and consistently lower temperatures therefore occur somewhat earlier than on the east side. Due to these factors of climate and terrain, elk move from higher to lower ranges earlier in the west side areas. Stated in another way, because elk of the east and west sides of the Bitter Root Valley are not subject to similar weather conditions concurrently, movements onto the winter range, hence accessibility to hunters, in normal years occur at different times. This phenomenon is illustrated by a breakdown of the legal harvest in relation to time periods within the hunting season (Table 26). Table 25 is a summation of harvest figures per time period from 1957 through 1963 for the either-sex portion of the seasons. The importance of the early portion in the west side and the late portion in

Table 25. Either-sex harvest per time period, 1957-63.

Time Period[1]	East Fork		Area 25	
	No.	% of total	No.	% of total
Early	115	8.0	676	37.2
Regular	617	42.8	779	42.9
Late	709	49.2	362	19.9
Total	1441	100.0	1817	100.0

[1]approximate dates of time periods--early, September 7 to October 3; regular, October 4 to November 20; late, November 21 to December 12.

the East Fork is readily apparent. About 49 per cent of the harvest from 1957 through 1963 in the East Fork has taken place in the extended or late portion of the season; about 37 per cent of the harvest for the same period in the West Fork has been accomplished during the early part of the season.

There is enough knowledge of elk movements in the East Fork to per-

Table 26. Sex and age of elk harvested by time periods.

Time Period	Year	East Fork Bulls	East Fork Cows	East Fork Calves	East Fork Total	Area 25 Bulls	Area 25 Cows	Area 25 Calves	Area 25 Total
Early	1955				NO EARLY SEASON				
Regular		129	109	48	286	81	76	39	196
Late					NO LATE SEASON				
Early	1956	NO EARLY SEASON				41	21	3	65
Regular		73	49	33	155	27	48	28	103
Late		12	19	8	39	2	3	0	5
					194				173
Early	1957	9	13	2	24	44	18	8	70
Regular		35	23	7	65	38	39	22	99
Late		40	50	19	109	21	38	22	81
					198				250
Early	1958	13	4	1	18	54	25	8	87
Regular		48	52	16	116	45	46	15	66
Late		38	49	9	96	13	11	6	30
					230				183
Early	1959	4	3	5	12	61	55	24	140
Regular		56	53	28	137	56	61	34	151
Late		22	35	24	81	7	10	1	18
					230				309
Early	1960	14	4	0	18	48	34	7	89
Regular		45	56	24	125	56	71	26	154
Late		71	81	20	172	17	37	18	72
					315				315
Early	1961	11	10	1	22	48	33	7	88
Regular		37	49	18	104	54	63	22	139
Late		41	92	29	162	10	25	15	50
					288				277
Early	1962	11	2	0	13	47	26	6	79
Regular		17	24	4	45	41	38	9	88
Late		17	26	14	57	8	11	6	25
					115				192
Early	1963	3	4	1	8	67	39	17	123
Regular		13	8	4	25	37	30	15	82
Late		11	14	7	32	15	46	25	86
					65				291
Early	1964				NO EARLY SEASON				
Regular		24	14	8	46	50	66	28	144
Late					NO LATE SEASON				

mit general statements, but information is lacking on the degree of interchange between the north and south sides of the East Fork of the Bitter Root River, the wintering habits of elk summering on the Continental Divide, and the patterns of migration over the Sapphire Range. There is even less knowledge of elk movements in the West Fork. The success of the early hunting season there has been attributed to the fact that elk summering in the high country of the West Fork drainage on the Idaho border migrate southward and winter in the Salmon River area. This pattern is hypothetical at present; more intensive management will depend on a comprehensive understanding of elk movements in the West Fork.

SUMMARY OF POPULATION CHARACTERISTICS

Early population estimates of the East Fork elk herd were obtained through ground observations of elk on their winter range. Aerial observations were first attempted as part of a cooperative ground-air coverage in 1946. In 1947 and 1951, aircraft were again used in counting game. From 1953 to date, aerial coverage has provided the data for annual trend counts. This coverage has been found most efficient when accomplished during the green-up period, when grasses begin their current-year growth. The green-up ordinarily occurs between April 15 and May 15. The best time to count is approximately one hour following dawn or one hour preceding dusk.

Herd numbers in the East Fork range from an estimated seven head in 1902 to 651 in 1958, a gradual increase at an average rate of 1.1 per cent per year, with some short term reductions. Recent management policies (1953 to date) have been based on maintenance of a stable population compatible with other resource uses. The desired level of herd numbers is 500 to 600 animals. Aerial trend counts from 1955 to date, excluding the year of 1963 for which an incomplete census exists, varied between 522 and 651 and averaged 590.

Age and sex classification based on aided-ocular ground sightings of elk on the winter range is usually accomplished during the months of March and April. Topographical conditions hinder the classification of large numbers of elk at any one observation. Ground observations from 1956 through 1965 indicate a sex ratio of 20 bulls per 100 cows and an age ratio of 51 calves per 100 cows for the Bitter Root Unit. For the years when data were recorded by separate areas, the age ratio in the East

Fork has averaged 56 calves per 100 cows. Underestimates of the adult male segment of the herd are probably, due to the isolation of mature bulls from the main herd at the time of classification.

A productivity study, as part of the total investigation, was conducted during the 1964 big-game season. The objective was determination of productivity per age class, with particular emphasis on yearling cows. Of the 14 cow elk harvested in the study area, only four usable reproductive tracts were collected. An additional tract was obtained from a cow severely injured by a bull in the midwinter trapping program. Ovaries were analyzed and uteri examined for evidence of ovulation and pregnancy. Two of the five cows were pregnant. Two other cows, including a yearling, were ovulating and quite probably would have conceived during a subsequent estrus in the breeding season. The fifth, another yearling, contained several follicles less than 5mm in diameter but had not ovulated when shot. The probability that this cow would have ovulated during the breeding season is low.

Legal harvest in the East Fork has contributed 40 per cent of the total harvest of the upper Bitter Root in the last ten seasons. In spite of low harvests in the East Fork in 1962, 1963, and 1964, the average annual harvest has accounted for 35.3 per cent of the average annual population estimate. Prior to the 1962 season, the value was 40.4 per cent. The average of 12 years' harvest data (1953 through 1964) is a composition ratio of 105 bulls and 39 calves per 100 cows. Age composition determined in the 1964 harvest shows that animals 2½ years and younger constitute 75.3 per cent of the total harvest, as recorded through the checking station. No old animals were observed in the harvest.

The complex of temperature and precipitation during the winter months directly affects the extent of winter range for elk. Limits to the winter range under mild, normal, and severe weather conditions reveal that elk are restricted to 55.6 per cent, 35.8 per cent, and 12.4 per cent respectively of the total study area. In average years, elk spend about five months on the winter range. A midwinter trapping and tagging program at two sites in the East Fork--Pasture Draw and Riemel-Tolan Ridge--indicates that some elk that summer along the Continental Divide (the Bitter Root-Bighole Divide) do not return each winter to the East Fork. Tag returns from elk originally tagged in the East Fork and later shot in the Bighole River drainage suggest intermingling of elk between the two major drainages. A tag return from the East Fork of Rock Creek, an airline distance of about 30 miles from the initial tagging site, points to movement over the Sapphire Range.

A land-use study of the East Fork by representatives of the U.S. Forest Service and the Montana Fish and Game Department, District II, in 1953 revealed that earlier unrestricted grazing by horses, cattle, and sheep and current competition between cattle and elk for available forage in the winter range had caused a downward trend in range conditions. To alleviate this condition, grazing use by domestic stock was reduced and more liberal harvest regulations to reduce game numbers were established. Livestock use on the forest ranges in the Bitter Root National Forest (Montana section) has been reduced about 39 per cent since 1953. Liberal harvest regulations of the past 10 seasons have resulted in an average annual East Fork harvest of slightly over 200 elk, while maintaining the average herd size of 590 head as determined by annual aerial trend counts.

RECOMMENDATIONS

The use of aerial coverage in obtaining annual trend counts is recommended without reservation. The elk herd of the East Fork should continue to be held at about 600 head, as determined by aerial census. The maintenance of a herd of this size in past years has resulted in high productivity, as indicated by a calf-cow ratio of 56:100, and in improved range conditions, with near negligible animal depredations on winter-range areas.

Because bull elk are in the process of dropping their antlers during spring trend counts, post-season to midwinter flights for classification only should be made to obtain data on sex and age ratios. The sex ratio of adults in particular has yet to be accurately established. Aerial classification should not replace ground observations, but would provide minimum estimates of calf crops and spike-adult bull ratios for elk concentrations in portions of the winter range that are not readily accessible.

Early and extended either-sex seasons should be reestablished. The flexibility of this type of season facilitates harvests of desired numbers regardless of the time of occurrence of weather conditions that precede elk movements onto the winter range.

The bull segment of the East Fork elk herd could provide considerably more recreational hunting than it does now. Branch-antlered bull seasons should therefore be restored. While a definite sex ratio is presently unknown, best estimates indicate that it is nearly balanced. Theoretically, one bull per four to six cows is adequate for reproductive purposes. A greater emphasis on bull harvest would result in a healthier herd and increased natality through greater availability of forage per surviving individual.

The operation of a big-game checking station at Darby should be continued. More information on age composition of the harvest as determined by dentition is desirable. The degree of branch-antlering in yearling bulls, as a reflection of the nutritional plane on which the herd subsists, needs to be evaluated.

Productivity, aside from composition data, needs further study. The continuance, or more correctly the establishment, of a program of collecting reproductive tracts from cow elk harvested during the big-game seasons would provide useful information on the reproductive performance of this herd.

In addition to aluminum ear tags, colored plastic neck bands placed on trapped elk would greatly facilitate sight records of elk movements. Periodic observations on both the winter and summer ranges could reveal patterns and routes of elk migration. A trapping program in the Bighole River drainage, in cooperation with that in the Bitter Root River drainage, is necessary to determine wintering habits of elk frequenting the Bitter Root-Bighole Divide during the summer.

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APPENDIX

Table 27. A listing of some common forbs and shrubs of the East Fork.

Forbs

Achillea spp., Yarrow
Agoseris spp., Mountain-dandelion
Allium spp., Wild onion
Antennaria spp., Pussytoes
Arenaria spp., Sandwort
Arnica cordifolia, Heartleaf arnica
Balsamorphiza sagittata, Arrowleaf balsamroot
Castilleja minata, Indian paintbrush
Delphinium spp., Larkspur
Dodocatheon pauciflorum, Shootingstar
Erigeron spp., Fleabane
Erigonum spp., Eriogonum
Fragaria spp., Strawberry
Geranium viscosissimum, Sticky geranium
Heiracium spp., Hawkweed
Lillium spp., Lily
Lomatium spp., Lomatium
Lupinus spp., Lupine
Mertensia spp., Bluebells
Penstemon spp., Penstemon
Phlox spp., Phlox
Ranunculus spp., Buttercup
Sedum spp., Stonecrop
Solidago spp., Goldenrod
Taraxacum officinale, Common dandelion
Tragapogon pratensis, Salsify
Trifolium spp., Clover
Viola spp., Violet
Xerophyllum tenax, Beargrass

Shrubs

Acer glabrum, Mountain maple
Alnus tenuifolia, Alder
Amelanchier alnifolia, Serviceberry
Arctostaphylus uva-ursi, Kinnikinnick
Ceanothus velutinus, Snowbrush
Cercocarpus ledifolius, Mountain mahogany
Cornus stolonifera, Redosier dogwood
Crataegus douglasi, Hawthorne
Mahonia repens, Creeping Mahonia
Pachistima myrsinites, Mountain-lover
Physocarpus malvaceus, Ninebark
Potentila fruticosa, Shrubby cinquefoil
Prunus virginiana var. demissa, Common chokecherry
Purshia tridentata, Bitterbrush
Ribes spp., Currant
Rosa spp., Rose
Salix spp., Willow
Shepherdia canadensis, Buffaloberry
Sorbus scopulina, Mountain-ash
Spirea spp., Spirea
Symphoricarpus alba, Snowberry
Vaccinium spp., Huckleberry

PUBLIC NOTIFICATIONS OF PRESENT STUDY

1. Newspaper Notice

To - The Western News, Hamilton, Montana.
The Ravalli Republican, Hamilton, Montana.
The Missoulian, Missoula, Montana.

ATTENTION ELK HUNTERS!

A study of the elk population of the East Fork of the Bitter Root River is being conducted during the big-game season this fall. The primary emphasis will be on herd productivity. As a means of arriving at the herd productivity or annual increase, it is important to collect as many reproductive tracts as possible from cow elk taken during the harvest season. Further, to establish the productivity per age class it is necessary to collect the jaw from the harvested cow to determine its age.

In this respect your cooperation will be appreciated. Instructions for saving the reproductive tract and jaw from cow elk harvested can be secured at the Darby checking station, which will be open throughout the big-game season.

Herd productivity is a vital consideration in establishing big-game seasons and bag limits. An important contribution to elk management in the East Fork of the Bitter Root River can be made by saving the materials mentioned above.

Your assistance is welcomed and appreciated.

Respectfully,

James Cross
Graduate Student,
University of Montana

2. Notice Disbributed to Hunters

NOTICE TO ELK HUNTERS

You can make an important contribution to elk management in the East Fork of the Bitter Root River (Management Area 27) by saving the material described below from all cow elk taken..The purpose of gathering this material is to help in the determination of herd productivity or annual increase, a factor vital to the proper management of these animals. Herd productivity is one of the prime considerations in establishing hunting seasons and harvests of game. Your assistance will be sincerely appreciated.

The Elk Collection Kit consists of a plastic bag containing powder preservative, a bottle of liquid preservative, a tag, and this instruction sheet.

1. When you are hunting, carry the plastic bag and this instruction sheet.

2. If you shoot a cow elk save the reproductive tract and the jaw-teeth from one side of the lower jaw (see diagram on back of sheet). Put these into the plastic bag.

3. When you return to camp, put the reproductive tract and the section of jaw into the bottle of preservative. On the tag attached to the bottle write the date, the drainage (or other landmark) in which you killed the elk, and your name and address.

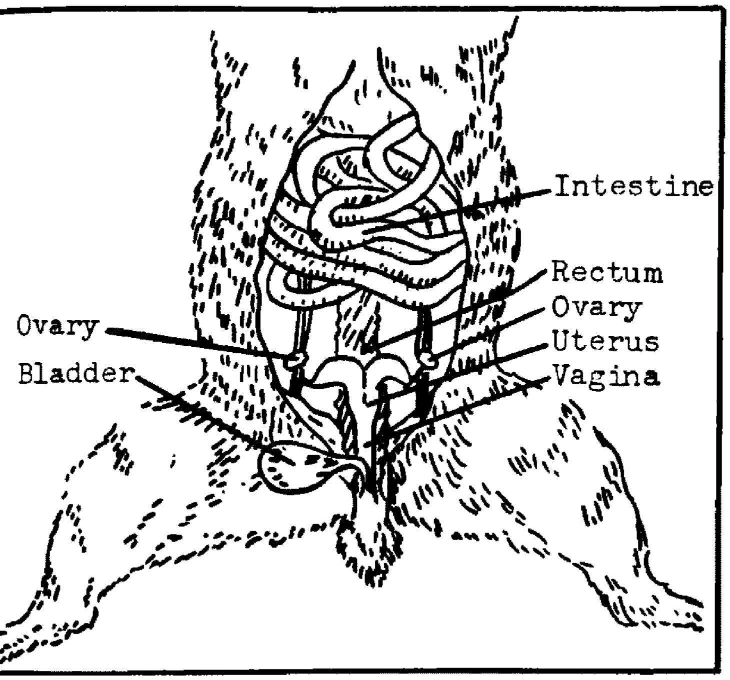
4. Turn the collected material in to the Fish and Game checking station at Darby.

Thank you.

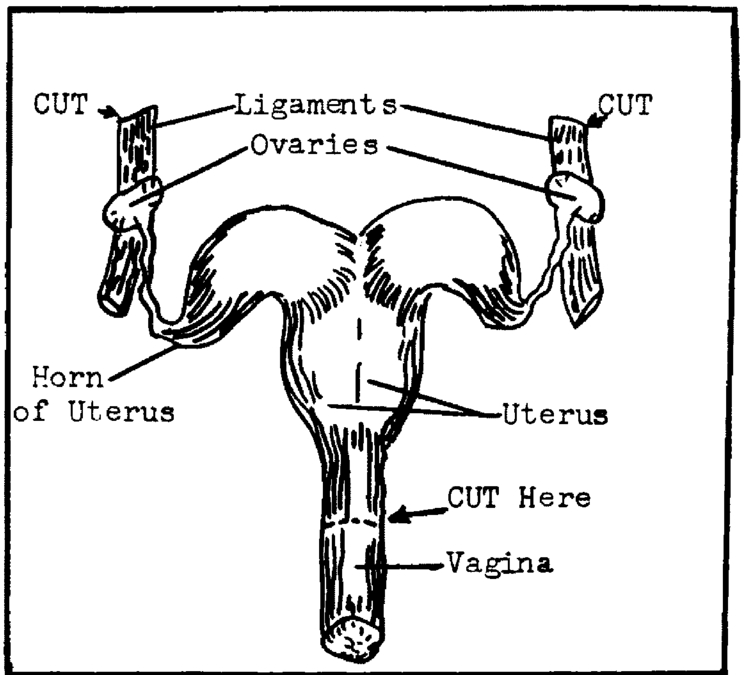
Montana Fish and Game Department
and
Montana Cooperative Wildlife Research Unit

(Back of sheet)

A. Location and removal of Elk Reproductive Tract



Reproductive organs in position



Reproductive organs removed

1. Caution is urged in field dressing the cow elk to prevent loss of or damage to the reproductive tract. Consult above diagram.

2. After removing the entrails, cut through reproductive tract (a white muscular tube) just forward of bladder.

3. Pull cut part of uterus forward, loosening with your knife the membranes which hold it back.

4. Continue this loosening process until you get forward to the ovaries (whitish, pebbled almond-shaped objects about 1" long). The ligaments attach the ovaries to the elk's body wall and must be cut. It is important to get both ovaries, one ovary at the tip of each horn.

B. Saving the tooth-row of the lower jaw.

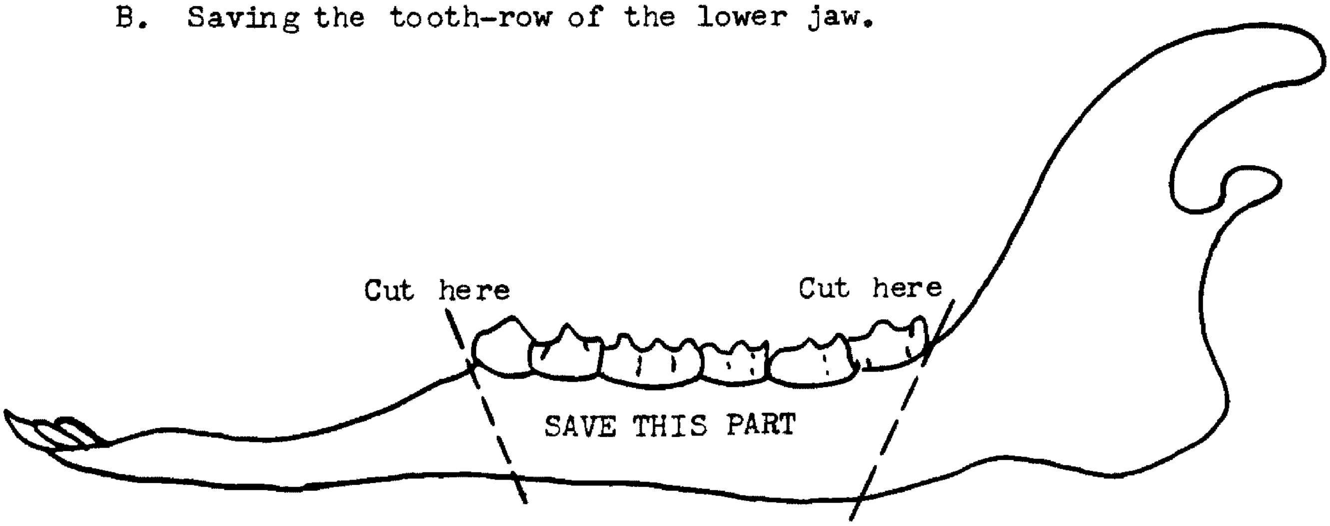


Table 28. Reproductive tract analysis.[1]

Animal	Date Coll. 1964	Age[1-2]	Corpora Lutea: Left Ovary	Corpora Lutea: Right Ovary	Uteri
EF-1	10-3	3½	-	11x14mm	Normal: no embryonic membrane
EF-2	10-3	1½	8x9mm		Normal: no embryonic membrane
EF-3	11-11	1½	-[3]	-	Normal: no embryonic membrane
EF-5	11-13	3½	-[2]	12x13mm 5x9mm	With fetus: male, F-R 47mm, HF 9.5mm
EF-6[3-4]	2-10-65	9½	OVARIES NOT COLLECTED		With fetus: male, F-R 337.5mm, HF 128.0mm
BR-4	11-6	5½		13x13mm 3x10mm	With fetus: female, C-R 16mm, Hind limb bud 2.5MM
BR-5	11-9	3½	11x13mm	-	Normal: no embryonic membrane
BR-7	11-11	3½	-	13x14mm 3x9mm	With fetus: male, F-R 41mm, HF 7mm
BR-8	11-11	3½	-	12x15mm 4x12mm	With fetus: male, C-R 21mm, Hind limb bud 3.5mm
BR-10	11-11	1½	-[4-5]	-	Undeveloped: overall size and lack of development suggestive of sexual immaturity.
BR-12	11-11	2½	12x12mm 6x8mm	-	With fetus: male, C-R 22mm, Hind limb bud 4mm.
BR-13	12-14	4½	-	-	Normal: no embryonic membrane
BR-14	12-14	2½	-	11x13mm	With fetus: male, F-R 132 mm, HF 38mm
BR-16	12-14	2½	8x8mm	14x15mm	With fetus: female, F-R 140mm, HF 43mm

[1]To compare the productivity of the East Fork elk with an intensively managed herd (about 75 head), reproductive tracts of cow elk were secured during the annual reduction program at the National Bison Range, Moiese, Montana

[2]all specimens except BR-13, BR-14, and BR-16 aged by author using Swanson (1951), Hancock and Low (1956), and Quimby and Gabb (1957) as guide. Three specimens noted aged by personnel of National Bison Range.

[3]greater part of ovary not collected

[4]critically wounded by bull in trap

[5]ovaries did contain several follicles of medium size (around 5mm in diameter)

Table 29. Weather information recorded for Sula, elevation 4,450 feet.

Period	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Temperature (in °F).							
1955-56	--[1]	--	19.7	21.3	19.9	29.9	42.6
1956-57	41.3	28.3	25.3	9.2	24.4	33.7	40.7
1957-58	40.8	27.0	23.4	20.1	32.8	30.9	39.0
1958-59	43.1	30.5	29.9	26.4	23.5	32.6	42.0
1959-60	42.1	27.6	25.0	16.3	21.4	30.5	40.3
1960-61	42.1	30.3	22.0	26.6	34.1	34.9	39.7
1961-62	41.1	28.4	21.9	14.6	24.6	29.8	43.0
1962-63	43.2	33.0	27.2	12.8	34.7	34.4	39.3
1963-64	46.8	35.5	22.2	20.3	21.8	26.8	39.1
1964-65	43.4	30.2	23.2	25.4	27.5	25.1	--[2]
Average	42.5	30.1	24.0	19.3	26.5	30.9	40.6
Precipitation (in inches)							
1955-56	--[1]	--	3.30	.77	.42	1.28	1.18
1956-57	1.52	.56	1.29	.52	.69	.98	.96
1957-58	1.35	.30	2.26	.56	.43	.92	1.85
1958-59	.77	2.83	1.40	1.08	1.06	.58	.67
1959-60	1.88	1.48	.22	.77	1.25	1.29	2.22
1960-61	.73	2.81	.64	.26	1.39	1.99	1.14
1961-62	1.68	.84	1.30	.80	1.01	.85	.99
1962-63	2.08	2.85	1.03	.83	1.22	1.01	1.58
1963-64	1.48	1.11	.56	1.93	.80	1.08	2.13
1964-65	.25	1.12	4.29	1.77	.58	.43	--[2]
Average	1.30	1.54	1.63	.93	.88	1.04	1.41

[1]Sula weather station established December 1955.

[2]information not available