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A floristic study of the Big Hole National Battlefield

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A FLORISTIC STUDY OF THE BIG HOLE NATIONAL BATTLEFIELD

By

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In 1963 the Big Hole National Battlefield was set aside to commemorate the Battle between the Non-Treaty Nez Perce and the Seventh Infantry. Because the Management of the Battlefield was interested in preserving the 1877 character of the vegetation at the site, this study was undertaken and its objectives included: a) an inventory of all the vascular plant species; b) determination of the nature of the vegetation at the time of the battle; and c) suggested management plan for the vegetation.

A total of 336 plants were collected from all noncultivated communities on the Battlefield. Of these 34 were exotic, 77 resulted in county records, and one resulted in a state record. Thirteen permanent plots were placed on the Battlefield to determine the present distribution of vegetation and permit future observations of these distributions. Utilizing the information from these plots, habitat types were assigned where appropriate, and a similarity matrix was constructed. To determine the character of the vegetation in 1877, the following sources were used: archival photographs, aerial photographs, past surveys, historical accounts, personal interviews, and field observations. These sources indicated that there was probably less sagebrush on the bench, and the gulch had no trees. On the floodplain the willow community may have been smaller and had little or no dead wood; there may have been a little more Pinus contorta and no Populus tremuloides, and little could be determined about the nature of the graminoid community except that there were probably no exotics. On the mountain slope the steppe probably did not have as much sagebrush, and the forest consisted of P. contorta with Pseudotsuga menziesii on the periphery. Regarding community dynamics, the willow community may have increased slightly in size, and the forest has increased its dominance of the mountain slope by 58 percent. To form a management plan, it was necessary to determine why these communities may have changed; thus, searches were made for edaphic changes and for fire-scarred trees. Trees invading the gulch can be related to soil disturbance. Twelve fire-scarred trees were sampled for the forest, floodplain, and steppe. Scarred trees from the forest indicated an average fire interval of 36 years between the years 1738 and 1932. A tree on the steppe displayed what may have been an eight-year average fire interval in the 1700's, and two scarred trees on the floodplain indicated that fires may have occurred in 1858 and 1861.

Management recommendations include 1) prevent new exotic species from being introduced, 2) burn the bench, floodplain, and steppe every 8 to 37 years, and 3) in the forest, remove trees or burn approximately every 37 years, or a combination of both.

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Appreciation is extended to Mr. Alfred Schulmeyer, Superintendent of the Big Hole National Battlefield, for allowing me to conduct the study and providing me with housing. I would also like to thank him for the information provided to me.

Additionally, I am grateful to the Department of Botany for providing me with a Teaching Assistantship. Special thanks go to Dr. Sherman Preece, Chairman of the Botany Department, for generously funding travel and miscellaneous expenditures.

Finally, I would like to thank my parents, William and Joann Pierce.

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CHAPTER I

INTRODUCTION

In 1877 the Nez Perce, led by Chief Looking Glass and Chief Joseph, left the Wallowa Valley of northeastern Oregon due to conflicts with the Seventh Infantry. The Seventh Infantry had been mobilized because this faction of the Nez Perce tribe had not signed nor conformed to the treaty of 1863. The route the Nez Perce took was through southwestern Montana, Yellowstone Park, then north through central Montana. Many skirmishes occurred along the way, and one of these took place in the Big Hole Valley. The Big Hole Battlefield is located at the juncture of Trail and Ruby Creeks which form the North Fork of the Big Hole River. In 1963 the area was designated as a National Battlefield to commemorate the flight of the Nez Perce and the battle that occurred there.

In 1973 Don Despain, a research biologist from Yellowstone National Park, wrote a memorandum after he had visited the area. In this memorandum Despain stated that the Battlefield embraced three land forms: a) bench, b) floodplain, and c) mountain slope.

Despain (1973) characterized the benchland as rather diverse. Areas that possessed gentle slopes had fairly deep soil that was primarily covered by a dense grassland, while the steeper slopes had shallower soils which supported a more dispersed grassland.

The floodplain, through which the North Fork of the Big Hole River flows, is situated between the bench and the mountain slope. This area is relatively flat, but since the water table is near the soil surface, small elevational changes greatly alter the moisture content of the soil. This in turn causes a great diversity of plant communities.

The two major communities found by Despain were grassland and willow bottom. The grassland was described as an abandoned irrigated hay meadow. Despain characterized the area as formerly having a shrubby cinquefoil-Idaho fescue shrubland type, but this association was no longer present because the area was being kept more moist than normal due to seepage from irrigation ditches on the bench. The moister regions of the battlefield were designated as an aquatic sedge type. Despain noted that the willow community occupied the recently abandoned river channels.

With regard to the mountain slope, Despain characterized the area as a combination of sagebrush-bluebunch wheatgrass steppe and forest consisting of lodge pole pine and Douglas fir. He also stated that the forest was invading the steppe.

Despain mentioned that more work needed to be done, especially on the bench and floodplain. He also suggested that a better description of the various communities was needed, and a plant list should be compiled.

In 1978 the superintendent of the Battlefield, Mr. Alfred Schulmeyer, in cooperation with the Cooperative Parks Research Program solicited research proposals to study the floristic and faunistic components of the Battlefield. A proposal submitted by the Botany Department at the University of Montana was not funded, yet Mr. Schulmeyer (per. comm. 1979) still expressed interest in a baseline inventory of the flora but could offer little funding. Mr. Schulmeyer wished to see the following areas investigated: a) determination of the vegetation in 1877 when the battle occurred, b) an inventory of plant species, both native and exotic, and c) formation of a management plan to return to and retain the 1877 vegetational composition of the Battlefield.

Thus, the primary objectives of my study included: a) inventory all the vascular plant species within the various plant communities found on the Battlefield, b) determine as accurately as possible the nature of the vegetation at the time of the battle, and c) suggest a possible management plan for the vegetation of the Battlefield. These objectives were achieved by the complete inventory of all vascular plants, the analysis of the various major plant communities, and elucidation of the factors that may have influenced community dynamics.

CHAPTER II

HISTORY

The history of the Battlefield is of considerable importance to this study, for one of the objectives was to determine the condition of the vegetation in 1877 when the battle occurred. Since no photographs were taken, one must analyze more indirect historical data, e.g. written and oral accounts, concerning the area. These historical accounts could yield a generalized description of the vegetation in 1877 and describe the various kinds of disturbances that potentially could have altered vegetational patterns of the area.

The Big Hole Valley first received historical mention in the journals of Lewis and Clark. When Captain Clark journeyed down Trail Creek in 1806, he noted that the timber was small and destroyed by fire in many places and that the valley was pocked with a large number of holes made by a burrowing squirrel. He also noticed old buffalo paths and some buffalo skulls. Upon reaching the valley, Sacajawea described it as a great resort of the Shoshonees, where they came to obtain camas roots (*Camassia* spp.), buffalo cows, and beaver. Captain Clark also stated that "the soil is exceedingly fertile and well supplied with esculent plants." He also noted the immense quantities of beaver in the valley (Biddle 1962).

After Captain Clark, the valley received few other outside visitors until the 1820's when trappers employed by the Hudson"s Bay Company and

several other lesser known companies began harvesting beaver and other fur-bearing animals. This activity continued until the fur business went into a general decline in the late 1840's (Toole 1959).

After the demise of the fur trade there was little activity in the valley until 1877 when the band of Nez Perce Indians became engaged in battle with the Seventh Infantry. The Nez Perce had always regarded the land between the Cascade and Bitterroot Mountains as their traditional homeland (Phillips 1962). They were highly respected by other tribes as warriors, stock breeders, and craftsmen (Spinden 1908). In 1855, the United States Government negotiated a treaty with the Nez Perce, setting aside 5,000 square miles within their ancestral land as a reservation (Kappler 1904). However, the discovery of gold and the arrival of new settlers forced the negotiation of a new treaty in 1863 (McWhorter 1952). This treaty severely reduced the size of the reservation to only one-fourth its original size (Kappler 1904). Those Indians who claimed land outside the new reservation refused to sign the treaty and became known as the Non-Treaty Nez Perce (McWhorter 1952). These tribal members continued to roam at will until the spring of 1877, when General Howard was ordered to enforce the new treaty. These efforts led to war and a 1,700 mile exodus of the Non-Treaty Nez Perce from northeastern Oregon to north-central Montana. The Battle of the Big Hole was just one of the many engagements along this route of exodus (McWhorter 1952).

The Nez Perce had a traditional campsite in the Big Hole Valley which they used when traveling to the high plains to hunt buffalo. They called this place Is-koom-tsi-la-lih or "many calves", for it was a

renowned buffalo grazing area where the buffalo cows left their calves concealed in the grass and willows in great numbers. Here the Nez Perce could obtain such necessities as tepee poles, fish, game, and camas roots for the continued trip to the east. It was to replenish their supplies once again that made them camp at this location (McWhorter 1952).

On the night of August 8, 1877, General Gibbon and his men advanced along the mountain slope to the steppe on the south side of a point of timber (Figure 1.3). From that location they could observe the Nez Perce camp of 89 tepees in a large meadow on the other side of the river (Figure 1.4). On the morning of August 9, 163 infantry and 33 volunteers advanced on the Indian Camp which contained approximately 800 Nez Perce, 125 of which were warriors. The troops caught the Nez Perce by surprise and soon occupied their camp. However, the Indians counterattacked and drove the invading force from their camp on the floodplain to a forested area on the mountain slope. This action was not accomplished without considerable loss of life on both sides (Shields 1889). The forested area to which the infantry retreated was in a point of timber at the mouth of a gulch on Battle Mountain. This area is known today as the Siege Area and corresponds to the area of Figure 1.3. Gibbon and his men were pinned down in this area until the Indians retreated. While the siege was in progress a mountain howitzer escorted by six men arrived on the south slope of Battle Mountain. The Nez Perce were able to capture the piece along with about 2,000 rounds of small-arms ammunition. The siege lasted until the next day, August

10, when the Nez Perce decided to retreat (Shields 1889). From the Battlefield the Nez Perce traveled south into Yellowstone Park and from there they went north. When they thought they had crossed the Canadian Border they stopped in some rolling hills known as the Bear Paw Mountains. They had not crossed the border, however, and were defeated by General Miles on October 5, 1877 (McWhorter 1952).

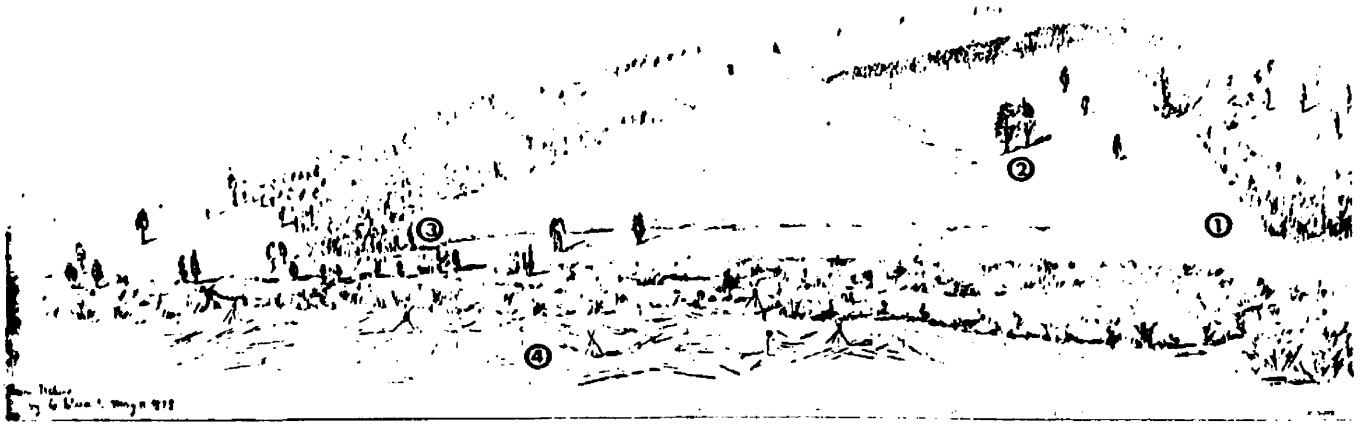


Figure 1. Field of the Big Hole Battlefield

1. Trail along which the troops were stationed waiting for daylight. 2. Large fir trees in which an Indian sharpshooter was concealed. 3. Point of timber in which General Gibbon fortified. 4. The Indian village consisting of 86 lodges and about 125 warriors. From an original pencil sketch by Granville Stuart, May 11, 1878. From the Montana Historical Society, Helena, Montana.

Domestic grazing animals were introduced in to the Big Hole Valley in the early 1880's (Noyes 1966). Actual settlement of the present Battlefield not claimed by the Government in the late 1800's probably

started in the 1890's (Beaverhead County Records Office). There was some difficulty, however, in obtaining a claim to the land at this time. In order to obtain a land patent under the homestead Act of 1862, the area had to be surveyed. Land claims in the vicinity of the Big Hole Battlefield could not be filed until 1917, when the 1915 survey was approved. Land could be claimed also under the Mining Act of 1886 as long as a mineral of value could be extracted. The Battlefield, however, lacked any extractable minerals. Finally, an individual could claim 640 acres of land under the Desert Land Act of 1877 so long as that land was irrigated within three years of the claim (Schulmeyer 1973). By the time the 1915 survey of the Battlefield was taken, three irrigation ditches drawing water from Trail and Ruby Creeks had been constructed by unknown persons.

Today the valley is used for cattle and hay production. Demand for water has increased, but the supply has not. In 1978 the Montana Department of Natural Resources and Conservation proposed that several of the mountain streams which drain into the Big Hole Valley be dammed. Water from spring runoff would be stored in these reservoirs for release during the summer when stream flow is normally inadequate. Two reservoirs on Trail Creek would have an influence on the North Fork of the Big Hole River, which flows through the Battlefield. The two sites were designated Thin Man and Fat Man and were projected to contain 11,929 and 14,320 acre feet of water, respectively. To date construction on the projects has not begun, and there has been no indication when or if it ever will.

The land within the present Battlefield has had a complex administrative history (Schulmeyer 1973). As previously mentioned, the Big Hole Valley was unsurveyed public domain under the legislative control of Congress when the battle occurred in 1877. In 1883, the Secretary of war authorized the creation of a military reserve and the installation of a granite monument on the site to honor the soldiers who had died there. At the beginning of the twentieth century, the War Department administrators of the Battlefield became alarmed that the Battlefield could be claimed under the Desert Land Act of 1877. Accordingly, the land was withdrawn from entry before claims could be filed.

In 1906 the United States Forest Service was established, and the Big Hole Forest Reserve was created. The name of the reserve was changed to the Beaverhead National Forest shortly thereafter. The only area within the present Battlefield boundaries that was included under the initial National Forest designation was a five acre parcel of land including the Siege Area with its monument and a portion of the battle area (Figure 2). In order to protect the area, the Forest Service created a 115-acre Gibbons Battlefield Administrative Site (Figure 2) and constructed a ranger station and cabin in the ravine above the Siege Area. In 1909 a caretaker's house, barn, and latrines were constructed. Then in 1910 a five acre parcel was designated the Big Hole Battlefield National Monument in accordance with the Antiquities Act of 1906 and became an administrative unit of the War Department. The Forest Service, however, still retained the Administrative Site, but did change

its name to the Big Hole Battlefield National Monument. When the 1915 survey was approved in 1917, 200 acres were set aside for the Monument, although the plat only indicated a five acre parcel.

In 1933, the five acres were transferred to the National Park Service by Executive Order; however, management funds were not available. Even though the Park Service now managed the area, the Forest Service continued to be criticized for not maintaining the site. When some funds were made available in 1938, a summer employee was hired, and only a few repairs were made. A year later, in June, the remaining 195 acres were transferred from the Forest Service to the Park Service by Presidential proclamation. For the first time, the 200-acre Monument was under the control of a single federal agency.

In 1963 another major change occurred when the name of the Monument was changed to the Big Hole National Battlefield, and the boundaries were increased to include 655.6 acres (Figure 2). This acreage was transferred from the adjoining Beaverhead National Forest and purchased from private holdings. The latter included the Indian Camp Site and the future sites for the visitor center and employee housing on the bench land.

Figure 2

Past boundaries of the Battlefield: a) five acre Military Reserve prior to about 1906; b) 115 acre Gibbons Battlefield Administrative Site from about 1906 to 1917; c) 200 acre Big Hole National Monument from 1917 to 1963; and d) 655.6 acre Big Hole National Battlefield from 1963 to present.

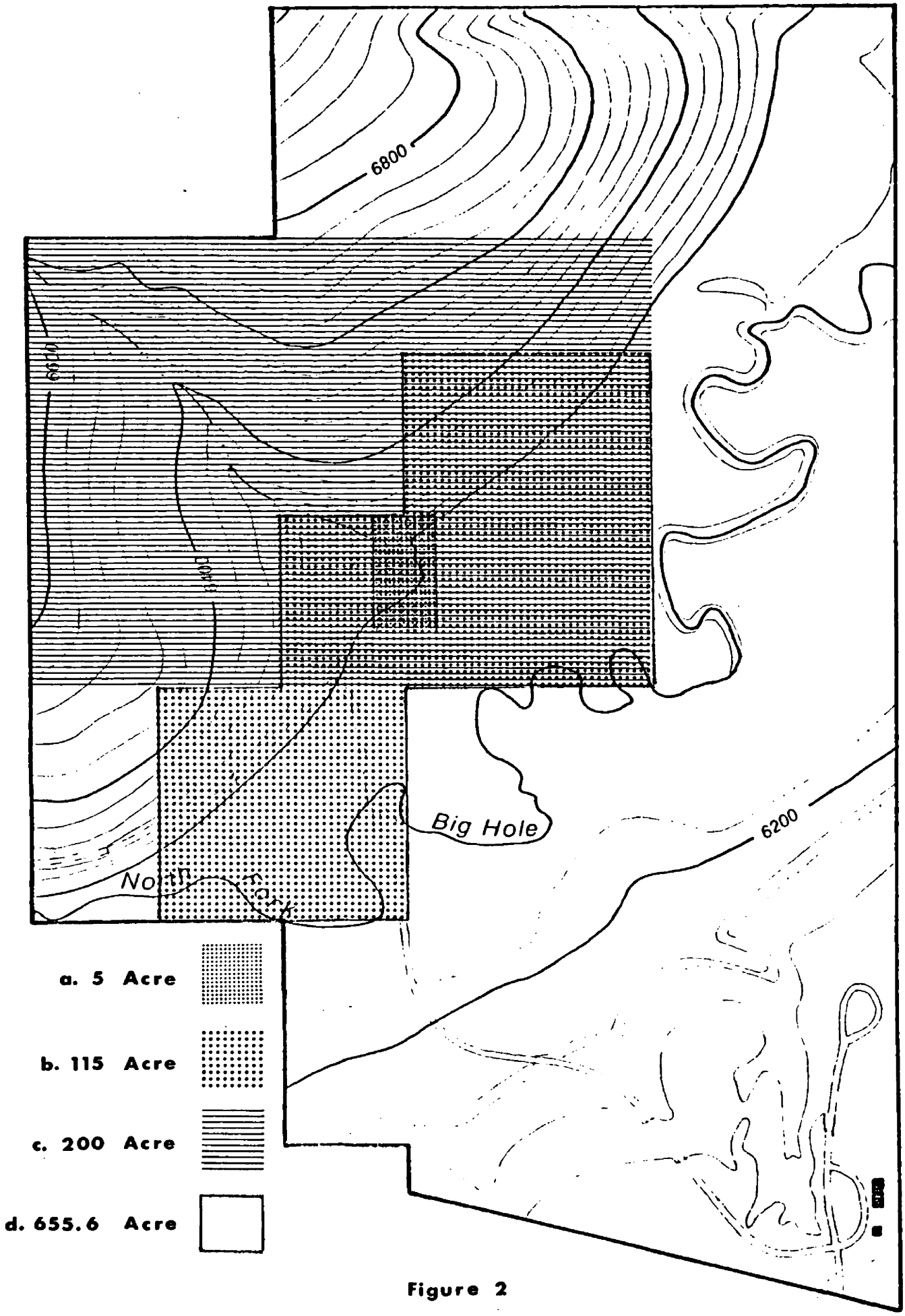

6800
6600
6400
Big Hole
6200
North
a. 5 Acre
b. 115 Acre
c. 200 Acre
d. 655.6 Acre

Figure 2

CHAPTER III

DESCRIPTION OF THE SITE

The Big Hole National Battlefield is situated in the westernmost portion of the Big Hole Valley of western Montana. This large montane valley is bounded by the Anaconda-Pintlar Range to the northwest, the Pioneer Range to the east, and the Beaverhead Range to the southwest. Draining the valley is the Big Hole River which is an upper tributary of the Jefferson River. A gravel alluvium which is as deep as 16,000 feet (Fields per. comm. 1981) has partially filled the valley. The location of the Battlefield is ten miles to the west of Wisdom, Montana on State Highway 43 (Figure 3). Near the southern boundary of the Battlefield, Trail and Ruby Creeks join to form the North Fork of the Big Hole River. While most of the Battlefield lies within Section 24 of Township Two South, Range 17 West of the Principal Meridian, Montana, the other portions are in Sections 13, 23, and 25.

The Big Hole Valley was known by the local Indian tribes as the land of the big snows (Paddock 1970). Even today the valley is considered to be unpleasant during winter. The number of frost free days at Wisdom, Montana is only 30 (Cordell 1971). A weather station has been in place at the Battlefield for ten years and monthly precipitation and temperature data from it are presented in Table 1.

Despain (1973) recognized three major land forms within the Battlefield: a) mountain slope, b) floodplain, and c) benchland

Figure 3

Map of southwestern Montana showing the location of the Big Hole National Battlefield.

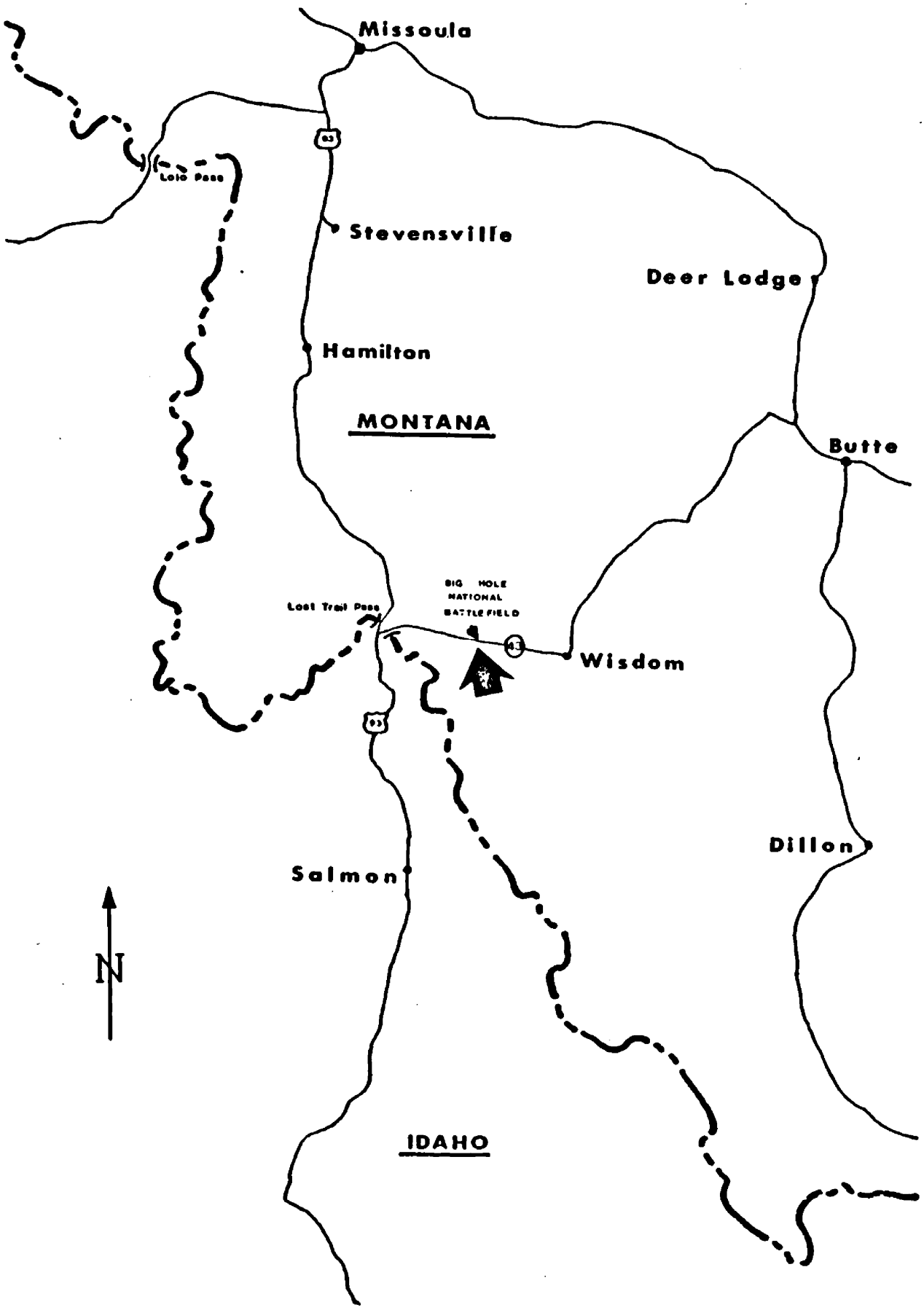

Missoula
Lolo Pass
Stevensville
Deer Lodge
Hamilton
MONTANA
Butte
BIG HOLE NATIONAL BATTLE FIELD
Lost Trail Pass
Wisdom
Dillon
Salmon
N
IDAHO

Figure 3

Table 1

Monthly temperature and precipitation readings over a ten-year period from 1972 to 1981.

	Temperature in degrees F.			Precipitation in inches
Month	Minimum	Maximum	Mean	Mean
January	3.0	25.0	14.0	1.66
February	5.38	32.69	19.04	1.55
March	10.54	38.64	24.59	.95
April	20.99	46.12	33.56	.86
May	28.80	55.39	42.10	2.01
June	34.9	67.1	51.0	1.93
July	40.0	77.1	58.0	1.42
August	37.0	74.0	55.1	1.32
September	28.1	64.9	46.6	1.20
October	22.1	53.5	37.6	.82
November	12.2	35.7	23.7	1.33
December	6.9	28.3	17.6	1.59
Mean	20.83	50.83	35.24	Total 16.64

(Figure 4). The percentage of the Battlefield occupied be each land form is 42, 34, 23, for mountain slope, floodplain, and benchland, respectively.

The mountain slope is on the southeast face of Battle Mountain of the Anaconda-Pintlar Range. The portion of the mountain slope within the Battlefield is composed primarily of Tertiary undifferentiated rocks (Ross et al. 1955). A large ravine divides the mountain slope into two portions. Through this ravine runs a small spring-fed stream which drains into the North Fork of the Big Hole River. That portion of the slope to the south of the ravine has án elevational range of 6,180 to

Figure 4

The different landforms within the Battlefield: a) mountain slope, b) floodplain, and c) bench.

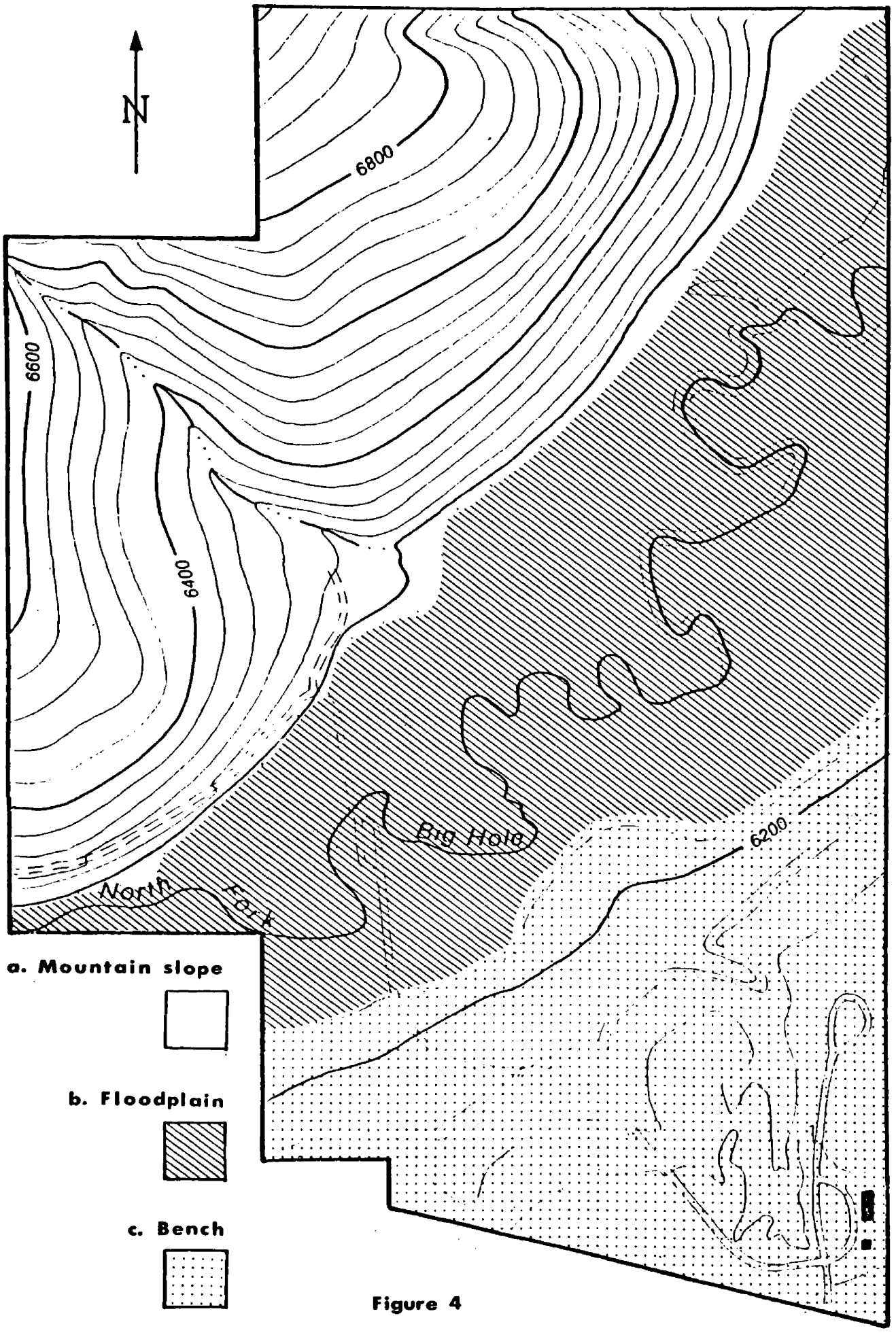

N
6800
6600
6400
6200
Big Hole
North Fork
a. Mountain slope
b. Floodplain
c. Bench

Figure 4

6,610 feet and a general slope of 30 percent. The northern portion of the mountain slope has an elevation range of 6,170 to 6,900 feet and a general slope of 40 percent.

Several types of disturbance can be identified on the mountain slope. An abandoned irrigation ditch and the remains of the old Park to Park Highway (Yellowstone to Glacier) are conspicuous on the southern portion of the slope. Within the ravine, the locations of the old ranger station and visitor center are still visible. The old access road and a portion of the parking lot for this area are still used occasionally by park personnel. Numerous rotten stumps indicate that logging has occurred in portions of the forest, and grazing by domestic stock has occurred on all portions of the mountain slope.

Three primary vegetation types, forest, forest ravine, and sagebrush steppe, are found on the slope (Figure 5). The forest portion of the slope is a Pseudotsuga menziesii / Calamagrostis rubescens habitat type, with a Calamagrostis rubescens phase (Pfister et al. 1977). The forested part comprises about 75 percent of the mountain slope and can be characterized as an uneven-aged stand of Pseudotsuga menziesii (Mirbel) Franco. (Douglas fir), Pinus contorta Dougl. (lodgepole pine), Pinus albicaulis Engelm. (white bark pine), with a small population of Pinus ponderosa Dougl. (ponderosa pine). In association with the forest is a ravine which has a spring fed stream flowing through it. Many of the plant species found here are typical of the floodplain. This constitutes three percent of the mountain slope. Situated on the more exposed sites, the sagebrush steppe covers 25

Figure 5

Vegetation types of the mountain slope; a) forest, b) forest ravine, and c) sagebrush steppe.

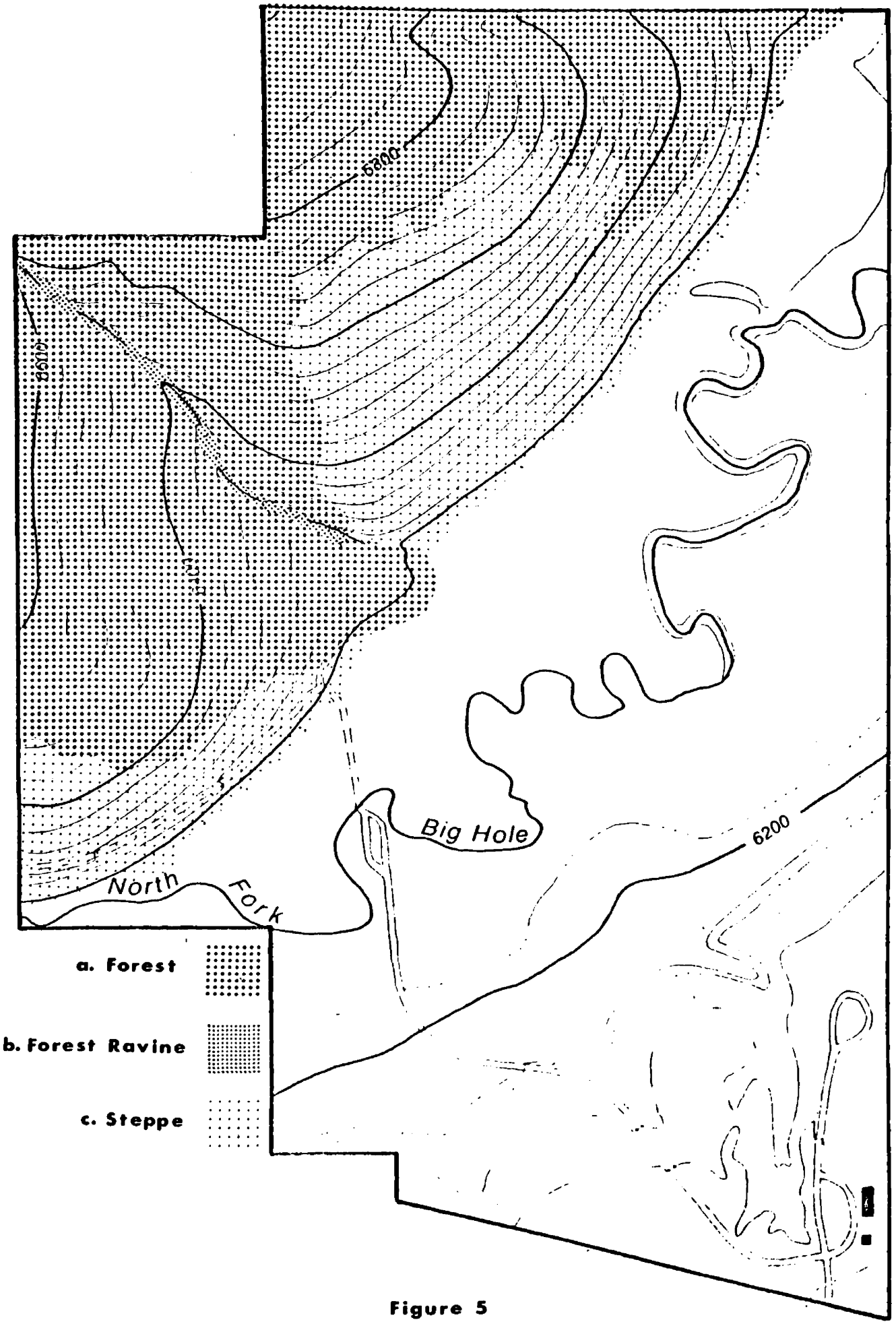

6300
6200
Big Hole
North Fork
6200
a. Forest
b. Forest Ravine
c. Steppe

Figure 5

percent of the mountain slope. The habitat type of this area is Artemisia tridentata / Festuca idahoensis (Mueggler and Stewart 1980); however, the percent cover contributed by the Artemisia tridentata Nutt. tends to decrease with an increase in elevation. Numerous young Douglas fir and lodgepole pine trees also can be found in this community as well as several Populus tremuloides Michx. (quaking aspen) groves.

Meandering through the center of the Battlefield in a northeasterly direction is the North Fork of the Big Hole River with its associated floodplain which drops only about 20 feet in elevation in a little over a mile. The surface of the floodplain is composed of a silt loam which varies in thickness (Despain 1973). Beneath the soil is a gravel alluvium (Ross et al. 1955). The water table in this area is very close to the surface, and the unevenness of the surface allows a variety of plant communities to exist in relation to changes in soil moisture.

This portion of the Battlefield also has been disturbed in places. In fact, disturbance still is occurring. Passing through the southern portion of the floodplain is the old Park to Park Highway (Figure 6). a portion of this road is now used as a footpath, and the rest has been converted into a parking lot. Acting as a dike, the road forces surface water on the west side of the road into the main river channel. The water table, however, is actually higher on the east side of the road due to the dam building activity of the beaver. In 1980 there was no beaver activity on the west side of the road; however, a dam was constructed in the fall of 1981. Another small road proceeds east from the old ranger station and stops at the river. The only traces of the

Figure 6

Approximate areas covered by the willow and graminoid communities of the floodplain.

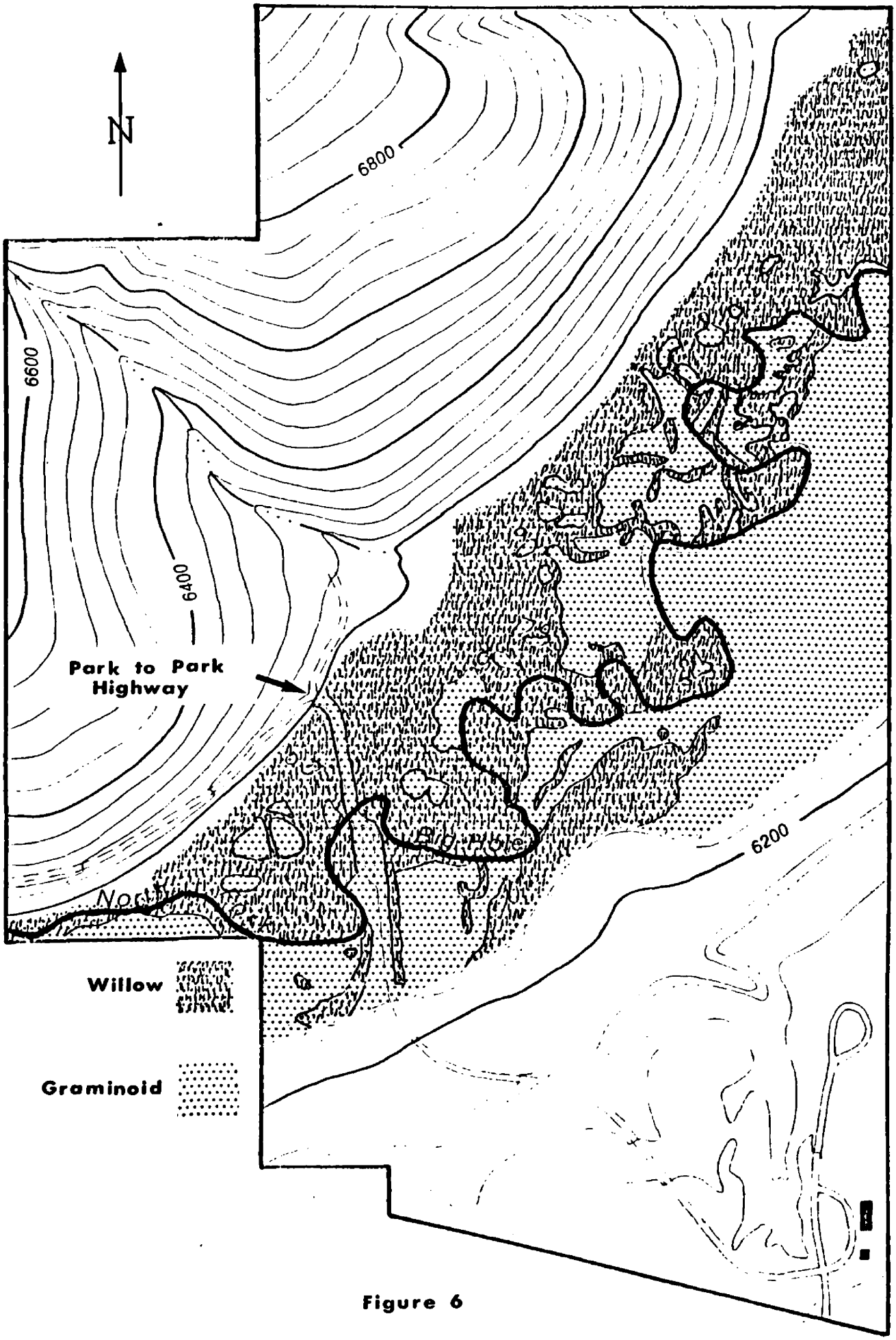


Figure 6

road now are some overgrown ruts. To the south of the present parking lot are the remains of an old irrigation aqueduct in the form of concrete footings and pieces of metal. No trace remains of a blacksmith shop which was to the north of the parking lot.

Agriculturally, the floodplain has been used as an irrigated hay meadow and was grazed by domestic stock as late as 1972 (Schulmeyer per. comm. 1980). There is, however, still a form of disturbance occurring on the floodplain. Water seeping from the lowermost irrigation ditch located on the bench is causing a portion of the floodplain to be moister than normal.

Willow, graminoid, and aquatic are the three primary communities found in the floodplain (Figure 6). The willow community comprises about 48 percent. No habitat type exists for willow communities. The graminoid community occupies about 49 percent of the floodplain. The habitat type is probably Deschampsia caespitosa / Carex spp. (Mueggler and Stewart 1980), but the species composition within this type is highly variable. This area was only tentatively habitat typed because of the high proportion of exotic species and the presence of excess water from irrigation ditches on the bench. No habitat classification has been devised for the aquatic habitat associated with the river and numerous beaver ponds. This community comprises about three percent of the floodplain and was too small to place on the map.

The bench land is situated on the eroded face of a Pleistocene alluvial terrace (Alden 1953). The aspect is primarily northwest with a slope ranging from zero to ten percent and elevation ranging from 6,170 to 6,340 feet. Soils are variable in depth and appear to be a sandy clay loam. One small ravine running primarily in a northerly direction dissects the bench.

More disturbance has occurred on the bench than on any other portion of the Battlefield. Road building has been a major contributor to this disturbance. The old Park to Park Highway is still visible, and the National Park Service has constructed several new roads. The construction of the visitor center and housing for the employees has been another contributor. In addition to the disturbance caused by this construction, the topsoil was removed from various areas on the bench for fill and landscaping. Disturbance caused by the construction of the sewage system with its associated pipeline, settling ponds, and drain field was compounded further when these areas were seeded with a mixture of exotic grasses in 1979. Four irrigation ditches are located on the bench, and three of these still transport water. These ditches, when in use, lose water to the lower lying areas, thus influencing the plant communities found there. Overflow from some of these ditches has eroded the sides of the ravine and deposited gravel in the bottom and on the floodplain. Overflow water at times still flows through the ravine. As with other areas of the of the Battlefield, past grazing by domestic stock also has influenced plant communities found here.

The bench has two primary communities, grassland and shrubland (Figure 7). The grassland comprises 60 percent of the bench and is a Festuca idahoensis / Agropyron spicatum habitat type (Mueggler and Stewart 1980). The shrubland composes about 23 percent of the bench and is an Artemisia tridentata / Festuca idahoensis habitat type (Mueggler and Stewart 1980).

Figure 7

Approximate areas covered by the grassland and sagebrush communities on the bench. This does not include disturbed areas which are occupied by exotic vegetation.

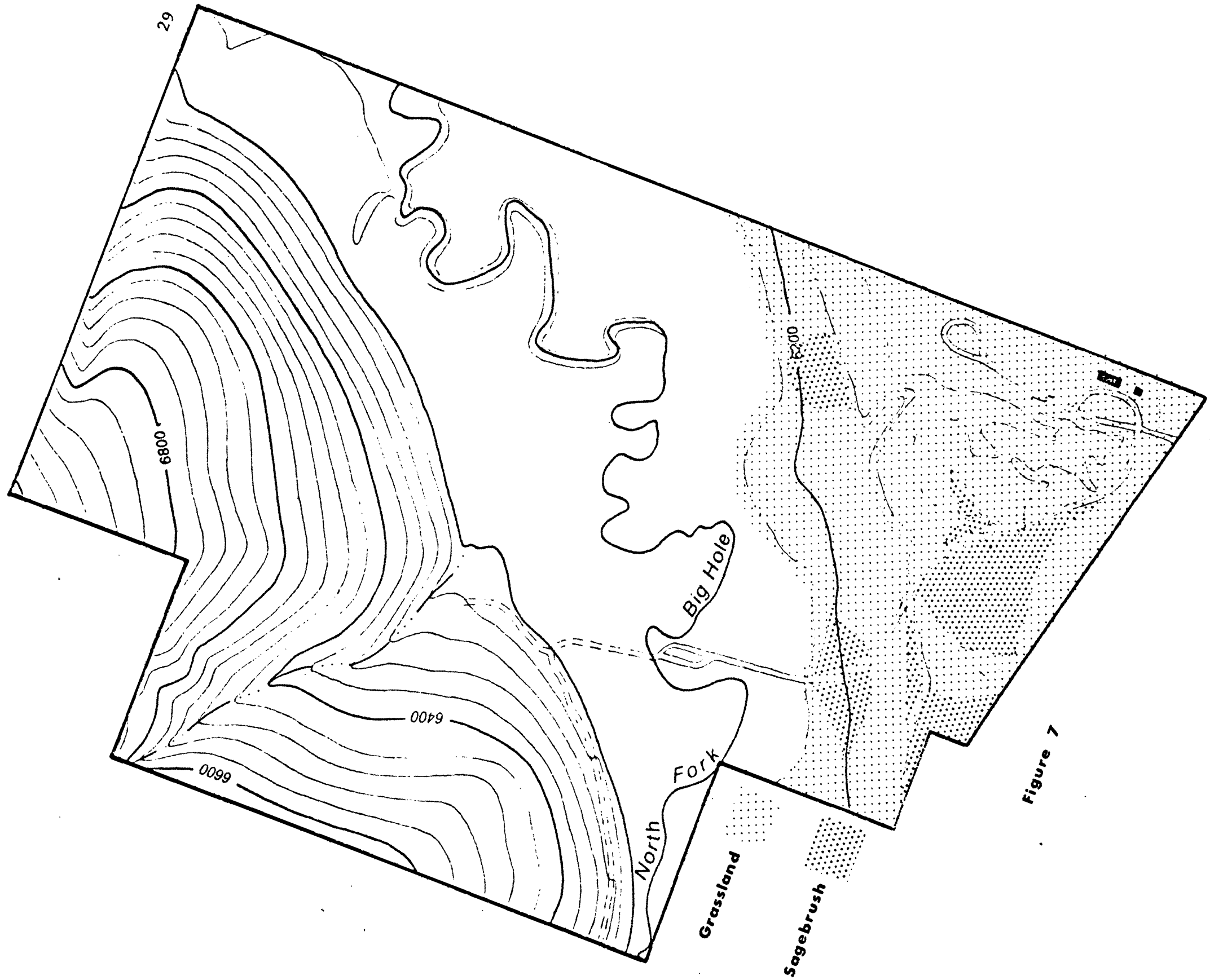


Figure 7

CHAPTER IV

MATERIALS AND METHODS

Field collections and observations at the Battlefield were made bimonthly from April to September of 1980 and on two occasions in 1981. The field work was designed to achieve the following three primary objectives: a) a complete inventory of all of the vascular plants; b) an analysis of the major plant communities; and c) an analysis of the phytosociological factors that may have influenced the dynamic relationships among these major communities.

A. Inventory of the Vascular Plants:

Representatives of all the major plant species found at the Battlefield were collected and pressed in duplicate. One set was placed in the University of Montana Herbarium (MONTU) and the other at the Battlefield. Plants were identified using Hitchcock and Cronquist (1973), Booth and Wright (1966), and Booth (1972) and species lists were compiled for each major plant community.

B. Sampling of Plant Communities:

Although the Battlefield comprises many diverse plant communities, a system of permanent plots was devised which was considered to be applicable to most them (Lyon and Stickney, per. comm. 1980). By utilizing these plots, the vegetational composition of the relatively

undisturbed areas of the Battlefield was described, and the assessment of future compositional changes could be made. Plant communities growing on greatly disturbed sites were avoided since the habitat classification used was not designed for disturbed communities (Mueggler and Stewart 1980). Three types of plots were used in this study: a) a five-meter-square plot, b) a variable plot, and c) ten half-meter-square plots nested in the five-meter-square and variable plots (Figure 8).

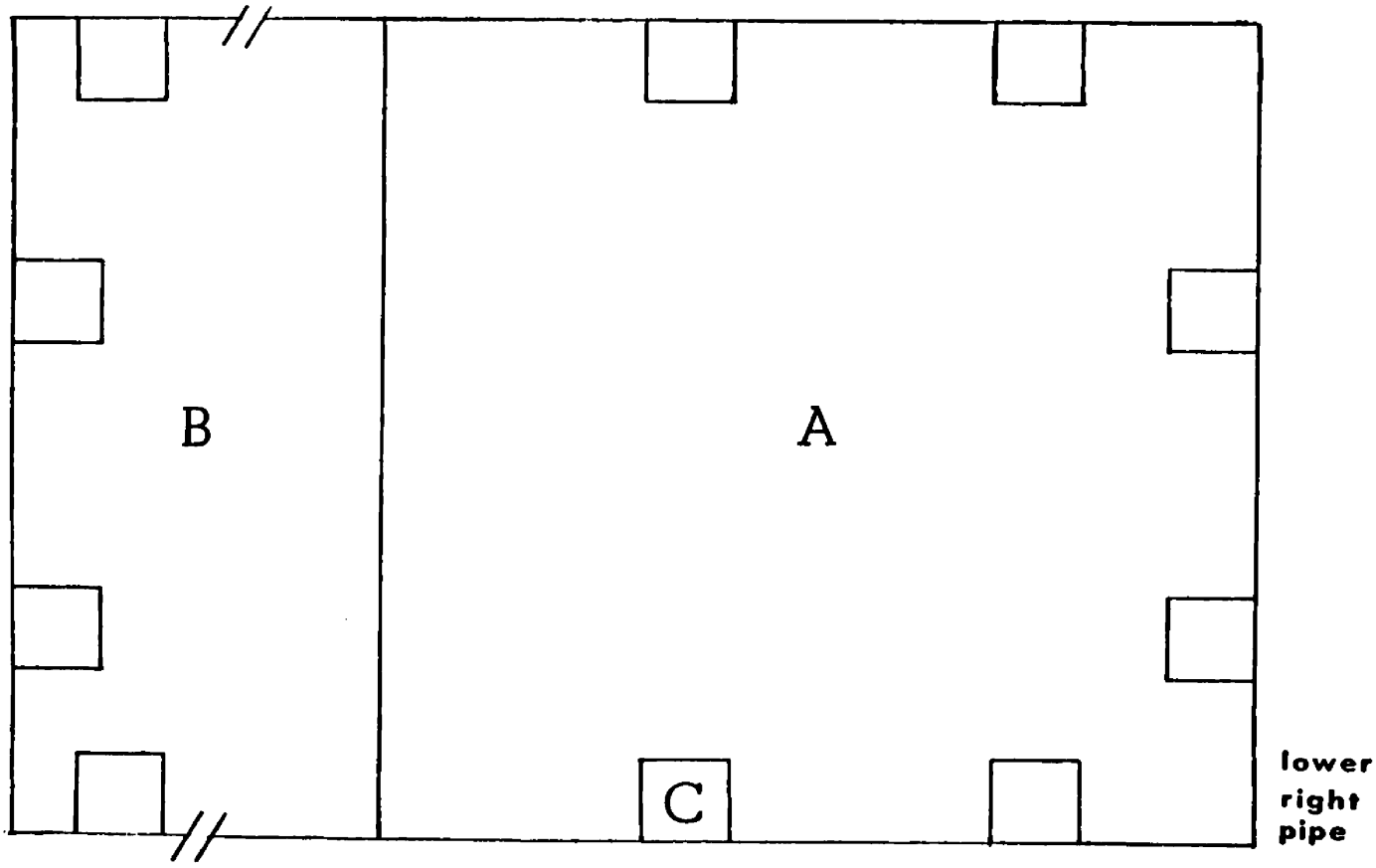


Figure 8

Three portions of the Lyon-Stickney plot. A. five-meter-square plot; B. variable plot; and C. ten half-meter-square plots placed at predetermined intervals within the five-meter-square and variable plots.

The five-meter-square plot was used exclusively to inventory woody plants 0.5 m or more in height, provided that at least ten individuals were within the plot. If the five-meter-square plot did not include the necessary number of woody species, the length of the plot was extended until it contained at least ten individuals. These variable plots ranged in area from 4.5 to 45.5 square meters. Shrub cover was determined within these plots by measuring the mean width of the canopy for each shrub even though some individuals had overlapping canopies. For the trees, the trunk diameter at breast height (d.b.h.) was recorded. Canopy coverage of the trees was not measured.

The half-meter-square plots were used to sample the herbaceous plants as well as those woody plants which did not exceed 0.5 m in height. Sampling within these plots was done by obtaining percent cover and then assigning cover classes according to Pfister et al. (1977). These classes included the following designations: t = 0-1%, 1 = 1-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%. To position these plots, a meter tape was placed on one side of the larger plot between the two corner pins. The half-meter-square plots were then positioned along this tape at predetermined intervals (Figure 8). The position of these plots was noted for relocation.

This particular combination of plots was not applicable to all of the communities sampled. Special sampling procedures were required for the Artemisia tridentata (sagebrush) communities where plants were often less than 0.5 m in height. This meant that many plants would not be considered in the five-meter-square plot, and at the same time, they

would be too small for the larger plot. Thus, all sagebrush plants in the five-meter-square plot were treated as though they were at least 0.5 m tall.

During the summer of 1980 thirteen permanent plots were placed on the three major land forms found at the Battlefield (Figure 9). These plots were in the major vegetation types, with one plot per type. A photograph of each plot was taken for a visual impression of the community composition. Of the thirteen plots, three contained variable plots. All of the plots were placed in areas which could be easily relocated using a 1972 United States Forest Service aerial photograph. One corner of each plot was referenced to a permanent object, if possible, for ease of relocation. The outside corners of the five-meter-square and variable plots were permanently marked with a seventeen-inch piece of half-inch P.V.C. pipe containing a ten-inch spike. One plot on the floodplain was marked only with ten-inch spikes, since it was located in a very conspicuous area. The top of each of these markers was driven to within one decimeter of the ground surface so as to render them inconspicuous to park visitors. All plots were reexamined during the first week of July, 1981.

Utilizing data gathered from the first thirteen plots, a habitat classification for each of the different communities was attempted according to the criteria of Mueggler and Stewart (1980), and Pfister et al. (1977). These data also were used to construct a cluster analysis and dissimilarity matrix. Both the analysis and matrix were prepared by a computer program utilizing the percent cover. This program converted

Figure 9

Location of the permanent plots on the Big Hole National Battlefield. Actual orientation of the plots is shown.

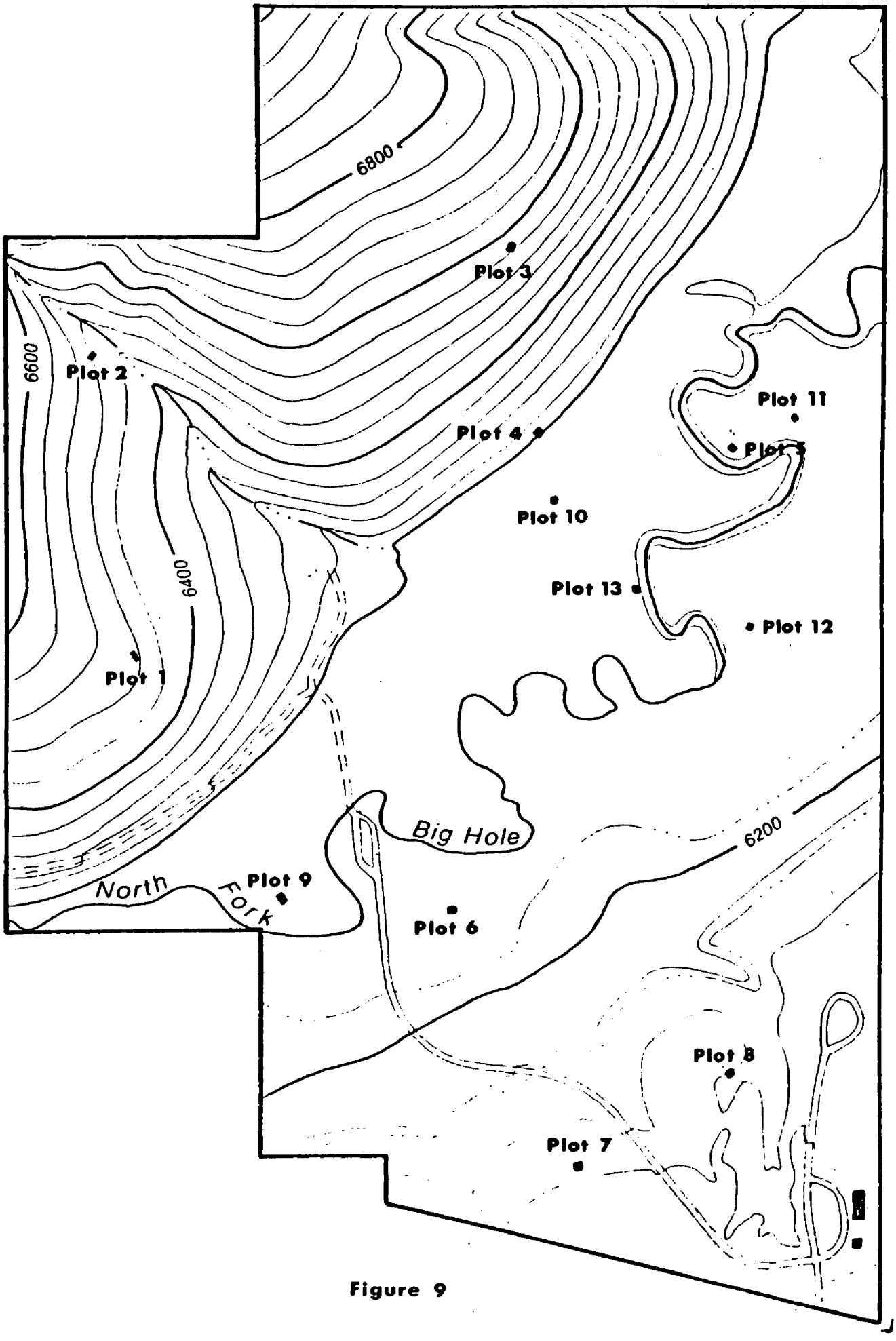

6800
6600
6400
6200
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
Plot 7
Plot 8
Plot 9
Plot 10
Plot 11
Plot 12
Plot 13
Big Hole
North Fork

Figure 9

the cover data to the cover classes of Pfister et al. (1977). The formula for the cluster analysis and dissimilarity matrix was 200W/A+B, where A is the sum of the values from one stand, B is the sum of the values from the other, and W was derived by taking the lower value of each species and summing them (Bray and Curtis 1957). The data obtained from the cluster analysis was then used to construct a dendrogram. The cluster analysis was used to quantify data and show the relatedness of the different plots (Barbour et al. 1980).

C. Synecology:

One of the objectives of the field work was to determine if any particular plant community was possibly invading another. Three different pairs of communities were investigated: a) sagebrush and grassland, b) willow and graminoid, and c) forest and steppe.

Archival photographs were used to determine the interrelationships among the members of the three pairs of communities. Fifteen photographs and one drawing were obtained from the University of Montana, Washington State University, the Big Hole National Battlefield, the United States National Archives, and the Montana State Historical Society. The oldest photograph was taken in about 1910, and the drawing was made in 1878. Each area depicted in an archival photograph or drawing was rephotographed using a 4 by 5 Speed Graphic Camera. All of the photographs and the drawing were standardized to a 5 by 7 format.

Aerial photographs for the years 1936, 1960, and 1972 were obtained from the United States Forest Service. A 1981 photograph became available in Fall, 1981 and was obtained from the Agricultural Stabilization and Conservation Service. Because the 1981 photograph was not available for field work, the 1972 photograph was used to map the location of plots. These locations were then transferred to the 1981 photograph when it became available. The 1936, 1960, 1972, and 1981 aerial photographs were studied to determine if any compositional changes had taken place in the willow and graminoid communities on the floodplain and the forest and steppe on the mountain slope. The 1936 and 1972 photographs were of special interest in regard to the willow and graminoid communities on the floodplain.[1] A line was drawn between two well-defined widely spaced land marks on the two photographs. The line which resulted extended over the entire length of the willow community. Twenty 1.33 acre plots were placed along this line at 240 foot intervals. The size of the plots was determined by two permanent objects seen in both photographs which were 240 feet apart. On each photograph the same area could be observed within these plots, and there were no shrubs on the floodplain that could be misinterpreted as willows. The only plants that might be confused with them are coniters, but these trees could be identitied by observing their shadows, or by viewing the photographs with a stereoscope. To determine if a change had taken place, a paired sample test (Wonnacott and Wonnacott 197/) was used. This method greatly reduced the variation in sampling. For the

[1]The 1981 photograph was not used since the willows were not delineated from the surrounding vegetation.

mountain slope, only changes in the forest boundary were observed.

A search was made for past descriptions of the vegetation of the Battlefield in the University of Montana Library and at the Big Hole Battlefield. The McWhorter papers at Washington State University in Pullman, Washington also were examined (Ault 1959). These papers were given to Washington State University by Lucas Mcwhorter and included all the material he collected in writing several books on the Nez Perce Indians.

Verbal descriptions of past surveys were found to be useful. Both the section and subdivision lines of the 1915 survey by the United States General Surveyor's Office were used since they provided descriptions of the vegetation encountered by the surveyor. The descriptions made by the surveyor in 1939 were then compared with the 1981 aerial photograph, and the approximate area also was observed on the Battlefield. The 1939 survey by the Department of the Interior was also useful as was a survey done in 1909. The 1909 survey, unfortunately, contained no descriptions of the vegetation.

Attempts were made to locate long-term residents of the Battlefield area in an effort to obtain firsthand information about vegetational changes. To locate these people, letters were sent to the editors of two newspapers circulated in the area. Unfortunately, these inquiries brought no response. Indeed, only Mr. Robert Scollick, a ranch hand at the Mark Clemoe Ranch provided any assistance.

To obtain a better understanding of changes in the forest, plots of trees on the Battlefield were sampled by increment boring to determine the age of the various portions of the forest and rate of growth. The growth rate was determined by dividing the circumference by the age. Eight transect lines were placed in the forested areas at 30 m contour intervals (Figure 10). At approximately every 50 m along these transect lines, trees were bored as determined by species and size class. For each of the species the following size classes were used: less than four inches, four to twelve inches, and more than twelve inches in diameter at breast height (d.b.h.). The position of each plot was marked on the 1972 United States Forest Service aerial photograph. Understory vegetation, the presence of down and rotten logs, and the number of fire scars on the trees also were recorded.

The fire history was determined by using the method of Arno and Sneck (1977), which required cutting cross sections of tree trunks near ground level. This study was conducted when the trees were aged in the forest. If a plot contained a high proportion of trees with fire scars, the tree with the greatest number of fire scars was sampled. A total of ten trees in the forest were sampled for their fire history, and their locations are shown in Figure 11. Fire scarred trees also were located on the sagebrush steppe and floodplain, but all of these trees unfortunately were dead. Four trees showing conspicuous fire scars were sampled from these areas.

Figure 10

Location of the 145 forest plots on the mountain slope.

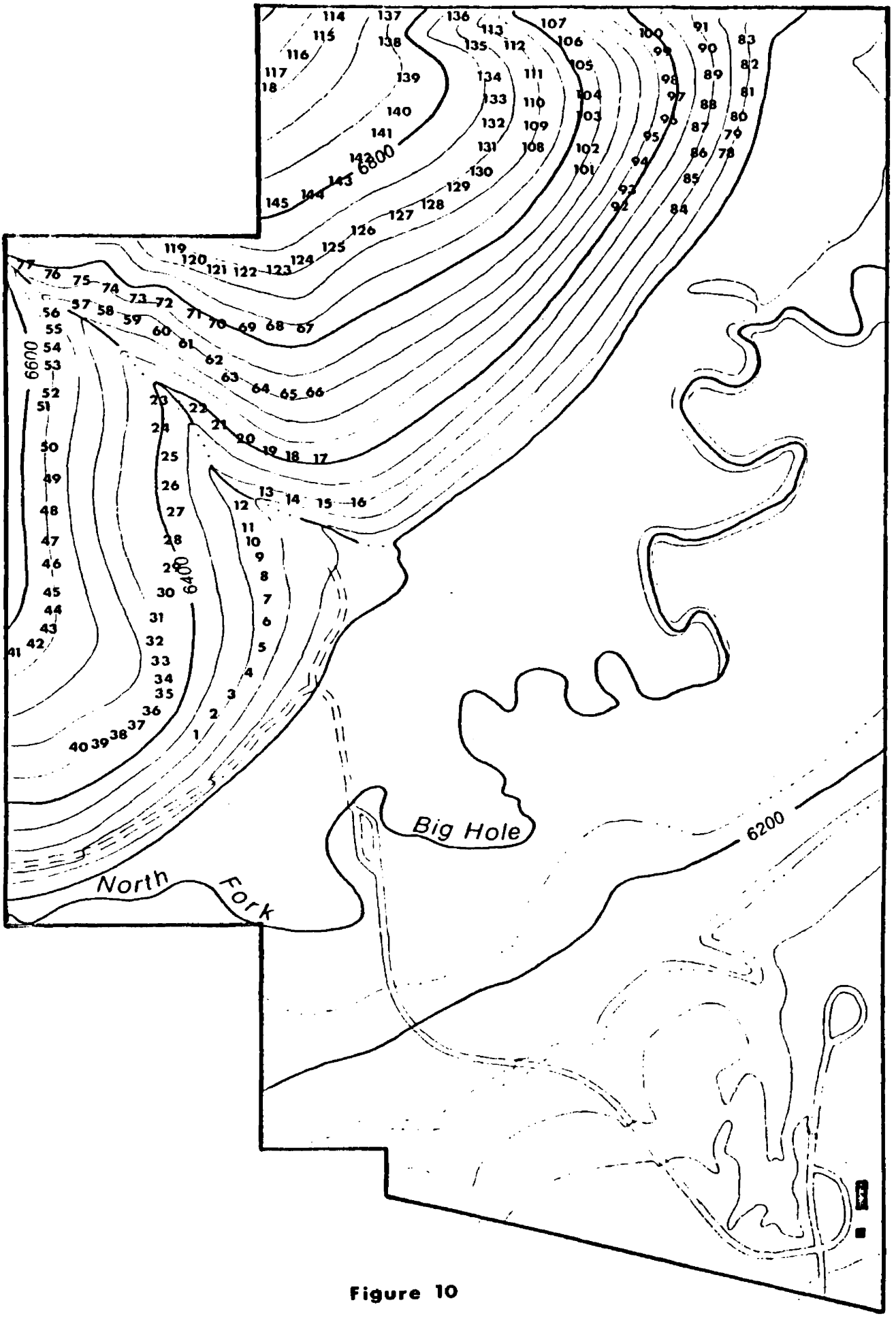


Figure 10

Figure 11

Location of scarred trees sampled for fire history on the Battlefield. The number below each triangle designates the number of trees sampled at each location.

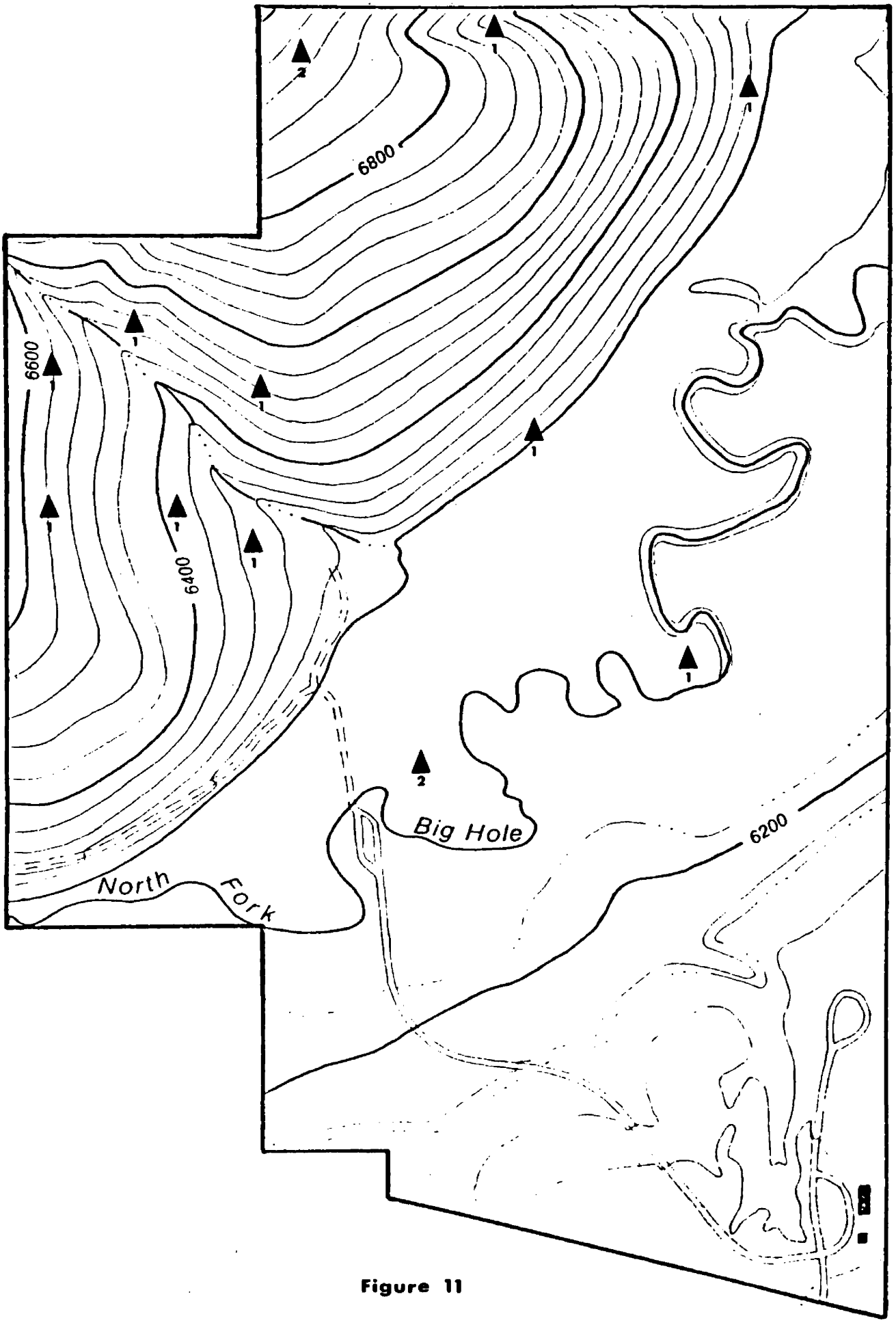


Figure 11

CHAPTER V

RESULTS AND DISCUSSION

I Inventory of the Vascular Plants:

Within the 655.6 acres of the Big Hole National Battlefield are 336 species of vascular plants representing 51 families. A list of these species appears in Appendix A. All of these species have been collected, pressed, and mounted except for Erodium cicutarium (L.) L'Her. which was encountered only as a single individual and Trisetum wolfii Vasey, Luzula campestris, and Carex praticola Rydb. which were in Plot 11, but were unfortunately overlooked in the inventory.

Items of particular interest within the inventory are: a) distinctive locations on the Battlefield where each species was observed, b) county and state records, c) non endemic species, d) native species, and e) a hybrid population.

The major regions of the Battlefield delineated in this part of the study are as follows: a) bench, b) floodplain, c) forest, d) forest ravine, and e) steppe. The last three regions are confined to the slopes of Battle Mountain. Plants growing in disturbed areas were designated in Appendix A. Disturbed areas were found within all of the previously mentioned areas. Ecotonal areas were not sampled because of their transitional nature.

Seventy-seven county records resulted from the inventory. This may be due to the lack of any previous systematic collecting having taken place in the county except for Dorn (1968). These records were determined by consulting Booth and Wright (1966), Hahn (1973), the Plant Information Network, and by examining specimens in the University of Montana Herbarium (MONTU). Within the list of county records, six species are considered of special interest and are discussed below.

On the bench by the sewage treatment plant, a single specimen each of Abies grandis (Dougl.) Lindl. and Picea engelmannii Parry were found. Both species were growing in a disturbed area and appear to be less than 20 years old. There is no seed source in the immediate vicinity, and according to Superintendent Schulmeyer (per. comm. 1980), these trees had not been planted at that location. On a moist embankment adjacent to the road leading to the trail system parking lot, Polygonum polygaloides Meisn. was collected. This plant is not commonly encountered in Montana but is found in Oregon and Washington in meadowland and vernal pools (Hitchcock and Cronquist 1976). On the floodplain Callitriche anceps Fern., an aquatic, was collected. Neither the Plant Information Network nor Booth and Wright (1966), reported this plant for Montana; thus, its occurrence at the Battlefield would be a state record. Two specimens of this species were located in the University of Montana Herbarium, however. One specimen was collected in the Anaconda-Pintlar Range, and the other is from the West Fork of the Bitterroot River. From the forest Chimaphila menziesii (R. Br.) Spreng. was collected. This species was not listed by Booth and Wright

(1966) or the Plant Information Network as being present in Montana, yet Hitchcock and Cronquist (1976) do report it for the state, I also have collected this species in 1977 during an inventory of the vascular plants of the Rattlesnake Watershed to the north of Missoula, and a specimen was deposited in the Herbarium of the Forestry Sciences Laboratory at Missoula (MRC). For another state record, Orobanche corymbosa (Rydb.) Ferris was found in association with the sagebrush on the northern and southern portions of the steppe, and its presence on the Battlefield does not appear to be threatened. The range of this species is restricted to dry lands east of the Cascades (Hitchcock and Cronquist 1976).

Thirty-four exotic plants were found on the Battlefield and of these 26 are restricted primarily to disturbed sites. The remaining eight species were found both in disturbed and undisturbed areas.

All endemic plants have been designated as such by the Plant Information Network. In order to be an endemic, the distribution of a species must be restricted to Montana, or Montana and its adjacent states and provinces of Canada. Within the Battlefield Astragalus miser var. praeteritus Barneby, Penstemon lemhiensis (Keck) Keck and Cronq., and Saxifraga oregana var. subapetala (E. Nels.) Hitchc. could be considered endemic.

On the bench in front of the staff housing area Astragalus miser var. praeteritus was found growing on the edge of a small, open, rocky windswept area. This species was not encountered anywhere else on the

Battlefield. It is restricted to southwestern Montana and central Idaho (Hitchcock and Cronquist 1976).

Penstemon lemhiensis was found on the bench as well as on the steppe. This species was considered by Ayensu and DeFilipps (1978) to be an endangered species and is listed in the December 15, 1980 Federal Register as a taxon "currently under review" for listing as a threatened or endangered species (Category 1). This means that the Fish and Wildlife Service has enough information available to support placing it on the endangered and threatened species list. This species is restricted to Lemhi County, Idaho and adjacent Montana (Hitchcock and Cronquist 1976). The population at the Battlefield on the bench is very small and is located directly below the visitor center. Most of these plants are growing on a recently disturbed bank of an irrigation ditch. However, a few individuals were found above the ditch on undisturbed land. The largest population is located on the steppe growing on the old Park to Park Highway road cut with some scattered individuals on the slope above the road cut. As long as there is an available seed source, this plant apparently can exploit disturbed sites. The presence of the plant on the Battlefield is not threatened at the present time.

Throughout the moister portions of the floodplain, Saxifraga oregana var. subapetala can be found in the graminoid communities. This species is widely scattered and is not very common on the Battlefield. According to Hitchcock and Cronquist (1976) the species can be found from central Montana to Wyoming.

In 1980 a small population of plants, putatively hybrid between Pedicularis contorta Benth. and Pedicularis parryi Gray, was found growing on the top of a road cut on the bench. Each of the two plants in this population had pink corollas with a slightly curved galea. These characteristics are intermediate between the cream-colored and curved galea of P. contorta and the purple corolla and straight galea of P. parryi. There were other features that the hybrid had in common with at least one of the parents. Basal leaves, color of the calyx, and the shape of the bracts were similar to those of P. parryi, while the cauline leaves and the inflorescence were similar to P. contorta. Under normal conditions the two parents are reproductively isolated since the prime flowering times do not overlap. Pedicularis parryi blooms in early June, while P. contorta does not bloom until late June. However, at the site where the hybrid was collected at the base of the road cut, a snow drift persists several weeks after the surrounding area becomes free of snow plus a seep keeps the soil moist throughout the summer; thus, P. parryi blooms in mid-June. As a consequence of this late melt and ready supply of moisture, the flowering period of the two parent plants overlaps for a short period of time. This overlap of flowering as well as the presence of a new possibly unexploited habitat may explain the existence of this hybrid.

In 1981 the putatively hybrid plants described above did not bloom, but two other plants growing close together in the same area did. These plants exhibited a combination of characteristics which could have resulted from a backcross between the putative hybrid and Pedicularis

contorta, yet the plants could be easily segregated from the P. contorta population. The color of the corolla was slightly pink, the terminal flowers were open while they remained closed on P. contorta, and the tip of the galea was not hidden by the lower lip as it was in P. contorta. The inflorescences of these plants were collected and mounted for future reference. There was no apparent backcross observed between Pedicularis parryi and the hybrid. Since all of the hybrid plants were found within P. contorta populations, P. contorta may be the female parent.

This portion of the study revealed that ten percent of the plant species were exotic. Of these exotic species, probably none were present in 1877, since agricultural use of the valley did not start until about 1880 (Noyes 1966). Presence of some of these species resulted from the seed mix used to revegetate disturbed land that resulted from the construction of the sewage plant. Most of the other species may be a result of past agricultural use of the land. Also the hybrid Pedicularis was probably not present prior to the construction of the Park Service road on the bench since all of the hybrids were found on the cut and not on the surrounding land.

II Analysis of the plant communities:

As previously mentioned, the Battlefield contains three main land forms: bench, floodplain, and mountain slope. Similar plant communities can be found on all three land forms, but each also contains some communities which are unique. Not all of the communities were

sampled, for some were too small, others such as the aquatic communities were too variable, and some resulted from disturbance. Plots were placed in thirteen communities, and the location and data obtained from these plots can be found in Appendix B.

A Bench

The bench, which is in the southeastern portion of the Battlefield (Figure 4), is an open grassland intermixed with Artemisia tridentata (sagebrush) communities. In the past this area was utilized as pasture for domestic stock. Currently the primary grazers are Columbia ground squirrels, deer, and elk. Minor communities not sampled were associated with the gulch. The first of these was located on a wind-swept side of the gulch in front of Park Service housing. Low growing plants such as Phlox muscoides Nutt. and Thlaspi fendleri Gray were found here and nowhere else on the Battlefield. Also, two forest communities were found in the gulch. One was a small Pinus contorta Dougl. (lodgepole pine) stand that apparently resulted from a recent disturbance. The other was a stand of Populus tremuloides Michx. (quaking aspen). According to Fowells (1965), these species have the capability of growing on disturbed sites and rocky soils. Such conditions presently exist in the gulch. In the bottom of the gulch was a community which shared many characteristics with those found on the moister portions of the floodplain. This area is currently receiving overflow water from an irrigation ditch, making it more moist than normal.

An enumeration of plots placed on the bench designating community and habitat types and the approximate percent covered by each is presented below in Table 2. A discussion of each of these communities follows.

Table 2

Plot numbers, community and habitat types, and an approximation of the percentage of the bench covered by each.

Plot number	Community type	Habitat type	Percent cover
8	Grassland	Festuca idahoensis/Agropyron spicatum	65
7	Sagebrush	Artemisia tridentata/Festuca idahoensis	19

1. Grassland Community

The grassland community covers the largest portion of the bench (Figure 7). Herbaceous plants dominate this community, but Artemisia tridentata and Amelanchier alnifolia Nutt. (serviceberry) also were present although widely scattered. The serviceberry showed strong grazing pressure since its maximum height was about five dm. This species is normally about 25 dm tall.

Plot eight was placed in this community. Twenty-six different species of herbaceous plants were recorded in the half-meter-square plots. The plant with the highest cover was Festuca idahoensis Elmer. (Idaho fescue) with a value of 24.5. Two other species had a cover value of ten or more. Antennaria microphylla Rydb. had a cover value of 18.5 and Arenaria congesta Nutt. had a cover value of 11. These species grew in the intervening spaces between the bunches of F.

idahoensis. Examination of the community indicated F. idahoensis was clearly the dominant species, and the community was designated a Festuca idahoensis/ Agropyron spicatum habitat type (Mueggler and Stewart 1980).

For these habitat types, decreaser, increaser, and invader designations can be made for some of the species. According to Dykterhuis (1949), a decreaser is a plant whose cover will be reduced when placed under grazing pressure, while an increaser will increase in cover under moderate grazing pressure, but will also decrease in cover when heavily grazed, and an invader is a plant that was not present in the area prior to grazing pressure, or it present, it made up less than 2.5 percent of the total cover in the community. Designation of these categories for the species at the Battlefield were determined by consulting Mueggler and Stewart (1980), Zacek et al. (1977), and Herman (1975 and 1970).

Among the species in the grassland community, there were four decreasers, five increasers, but no invaders (Table 3). Since decreasers made up a great deal of the cover, none of the increasers had a cover greater than ten, and there were no invaders, it can be assumed that this portion of the Battlefield may have changed little since 1877. The stunting of the serviceberry probably resulted from winter grazing pressure since this area is the grazing range for about three elk and 20 deer (Schulmeyer per. comm. 1981). Since the more palatable herbaceous material is more deeply buried in the snow, the shrubs probably receive most of this winter grazing pressure. As a result most of the shrubs are the same height.

Table 3

Decreaser, increaser, and invader species of the grassland bench community (Plot 8).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Agropyron spicatum	3.7	Achillea millefolium	6.7	None observed	0
Crepis acuminata	5.2	Arnica fulgens	4.9		
Festuca idahoensis	24.5	Geum triflorum	7.9		
Lupinus wyethii	1.8	Koeleria cristata	1.7		
		Stipa occidentalis	0.6		

2. Sagebrush Community

The other plot on the bench was placed in the Artemisia tridentata community (Plot 7) (Figure. 7). This community was restricted to the slope on the southern portion of the bench and was also in a small ravine on the north side of the road . Twenty-eight species of plants were found here with sagebrush being the only woody member. This community was classified as an Artemisia tridentata/ Festuca idahoensis habitat type (Mueggler and Stewart 1980). Of the sampled species, three were decreasers and nine were increasers. Just as with plot eight, none of the plants were invaders (Table 4).

Table 4

Decreaser, increaser, and invader species of the sagebrush bench community (Plot 7).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Agropyron spicatum	3.8	Achillea millefolium	5.4	None observed	0
Crepis acuminata	0.1	Arenaria congesta	14.9		
Festuca idahoensis	25.6	Arnica fulgens	4.6		
		Artemisia tridentata	34.5		
		Carex petasata	3.8		
		Geum triflorum	7.2		
		Koeleria cristata	2.5		
		Pedicularis contorta	1.0		
		Stipa occidentalis	1.0		

The sagebrush community had a considerably larger number of increasers with a greater percent cover as compared to the grassland community (Plot 8). Two increaser species, Artemisia tridentata and Arenaria congesta, had a cover value greater than ten. Mueggler and Stewart (1980), in their description of the Festuca idahoensis/ Agropyron spicatum habitat type, stated that A. tridentata can greatly increase in cover with grazing pressure. Perhaps signiticantly, the only decreaser in plot eight with a cover value greater than ten was F. idahoensis. Whether the two communities sampled in plots seven and eight received different grazing pressure in the past is unknown. Different external pressures seem more likely to have contributed to differences between the two communities, rather than any intrinsic physical characteristics of the sites. Indeed, no apparent physical differences between the two sites were observed. In either case, the present vegetational composition, along with extrapolation via increaser and decreaser species, indicate that in 1877 the grassland most likely occupied the entire bench.

3. Disturbed Communities

The disturbed communities, which were in all likelihood not present in 1877, are a result of excess water or alteration of the soil surface. These communities vary in relation to the type and amount of disturbance they have received. Those communities influenced by excess water are not eminently different from those found on the floodplain. This form of disturbance is responsible for the existence of a large exotic plant community on the bench. These areas could not be expected to regain

their former community structure until the presence of excess water is eliminated.

The other form of disturbance resulted from an alteration of the soil surface during construction of buildings and roads by the Park Service. These areas had a high number of exotic species. Whether the communities that existed there prior to the disturbance will be able to reestablish themselves again is not known.

B. Floodplain

The floodplain is located in the center of the reserve (Figure 2) and exhibits the greatest diversity in plant communities of the three land forms on the Battlefield. The eight communities can be traced to complex moisture gradients. Some portions of the floodplain have aquatic habitats, some are mesic, and others are quite dry as indicated by the presence of Artemisia tridentata. This complexity is due to minor fluctuations in elevation in relation to the water table.

Within the river and backwaters is an array of aquatic communities. These communities were not sampled, and no habitat classification has been previously published for them. The predominant aquatic plants were Nuphar polysepalum Engelm., Glyceria borealis (Nash) Batch., and Potamogeton epihydrus Raf.

Those areas which were transitional between the aquatic and terrestrial environments were dominated by Carex spp. This community was fairly consistent in its composition and was dominated by Carex

rostrata Stokes (Plot 10). Merging with this community was one dominated by Carex nebraskensis Dewey and Alopecurus alpinus Smith. In some areas, A. alpinus dominated the community, but these areas were very limited in size.

The next three communities in the moisture gradient appeared to be fairly similar for they all require a consistent but moderate supply of moisture. The first of these mesic communities was dominated by Juncus balticus Willd. In the second community Deschampsia caespitosa (L.) Beauv. (hairgrass) and Antennaria microphylla Rydb. were prominent components. The last of these mesic communities was dominated by Poa pratensis L. and Potentilla fruticosa L. These communities were represented by plots five, eleven, and six, respectively (Appendix B).

The last two communities were dry and quite similar to those found on the bench. One was dominated by Festuca idahoensis (Plot 13) and the other by Artemisia tridentata (Plot 14).

There are two other communities on the floodplain. A conspicuous portion of the floodplain is dominated by Salix spp. (willow) communities (Plot 9). The other community was limited to small areas dominated by Pinus contorta.

An enumeration of plots placed on the floodplain designated community and habitat types, and the approximate percent covered by each are presented below in Table 5. The following is a discussion of these communities.

Table 5

Plot numbers, community and habitat types, and an approximation of the percent of the floodplain covered by each.

Plot number	Community type	Habitat type	Percent cover
10	Sedge	Not determined	20
5	Wiregrass	Not determined	3
11	Hairgrass	*Deschampsia caespitosa/Carex* spp.	15
6	Shrubby cinquefoil	Not determined	10
13	Idaho fescue	Not determined	3
14	Sagebrush	*Artemisia tridentata/Festuca idahoensis*	1
9	Willow	Not determined	48

1. Sedge Community

The *Carex* (sedge) community (Plot 10) comprised six species, the lowest species diversity of any community that was sampled on the Battlefield. In June this community had about three dm of water on the soil surface. When examined in the late summer, this community was characterized by knee high (seven dm) sedges and the inflorescences of an occasional *Alopecurus alpinus*. This community covered about seven percent of the entire floodplain, with most of the community located to the west of the river. Of the *Carex* species found in this community, only *Carex rostrata* had a cover rating greater than ten percent, with a value of 79.5 percent. No other plant in this study had such a high cover rating. No published habitat classification was available for this community, and a habitat type will not be proposed due grazing pressure which ended as recently as 1972. According Mueggler and Stewart (1980) a habitat type is a "stable (climax) mix of plant species." At present the floodplain is still recovering; thus, this stable mix of plant species may not yet have been reached. This was also the reason why a habitat type was not designated for some of the other floodplain communities, which will be discussed in the following

sections.

According to Hermann (1970), Carex rostrata provides good forage in the spring, but only elk use it in the fall when the leaves become too tough for most foragers. In Iceland and Siberia, its forage rating is very high. Another important sedge is Carex nebraskensis which has 8.5 percent cover. According to Hermann (1970) this species can be utilized for forage and hay, especially late in the season. From this information both species could be classified as decreasers. Another plant listed as a decreaser is Alopecurus alpinus (Zacek et al. 197/). This species had a cover value of 1.5. No exotics were present. From these observations, I believe that this community has changed little in composition since the battle; however, the actual extent of this community in 1877 is unknown.

Even though the community dominated by Carex nebraskensis and Alopecurus alpinus was not sampled, lack of exotic species indicated that it probably has changed little since 1877. This community and the previous one are very similar and often intergrade when they are adjacent to one another.

2. Wiregrass Community

The Juncus balticus (wiregrass) community (Plot 5) occupies one percent or less of the floodplain. The half-meter-square plots contained sixteen species which formed a community that was denser than the sedge community (Plot 10), but the height (ca. 5 dm) was not as great. No habitat type was available for this community. Of the

sixteen plant species recorded in this community, there were two decreasers, two increasers, and five invaders (Table 6) (Mueggler and Stewart 1980, Zacek et al. 1977, and Hermann 1970,1975). The invaders, all of which are exotic, were very prevalent in this community. Three of the five exotics had a cover value of ten or more. An increaser, Juncus balticus had the highest cover value of 67. On the other hand, the highest cover exhibited by a decreaser was only 2.7 for Carex nebraskensis.

Table 6

Decreaser, increaser, and invader species of the wiregrass floodplain community (Plot 5).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Carex nebraskensis	2.7	Carex douglasii	1.2	Phleum pratense	0.3
Deschampsia caespitosa	0.4	Juncus balticus	67.0	Poa palustris	13.7
		Polygonum bistortoides	0.1	Poa pratensis	17.5
				Taraxacum laevigatum	10.5
				Trifolium repens	0.5

From this information it was apparent that this area was occupied by a plant community which did not resemble the one present in 187/. However, it may have been a Deschampsia caespitosa/ Carex spp. habitat in the past, as the former species is found in the vicinity of this community.

3. Hairgrass Community

The Deschampsia caespitosa (hairgrass) community in plot eleven was similar to the wiregrass community of plot five. Plants in this community grew very close together forming a tight sod, and the height of the community was above five dm. Thirty plant species were located in the half-meter-square plots, and this was the highest number of

species recorded for any plot on the Battlefield. Within the half-meter-squares, three species were decreasers, nine were increasers, and three were invaders (Table 7) (Mueggler and Stewart 1980 and Zacek et al. 1977). This community was classified as a *Deschampsia caespitosa/Carex* spp. habitat type (Mueggler and Stewart 1980).

Table 7

Decreaser, increaser, and invader species of the hairgrass floodplain community (Plot 11).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Agropyron caninum	2.7	*Achillea millefolium*	14.2	*Poa pratensis*	17.8
Camassia quamash	2.9	*Carex pachystachya*	1.0	*Taraxacum laevigatum*	10.7
Deschampsia caespitosa	9.5	*Carex praticola*	7.7	*Trifolium repens*	0.2
Trisetum wolfii	3.0	*Danthonia intermedia*	11.4		
		Juncus balticus	2.4		
		Polygonum bistortoides	3.7		
		Potentilla diversifolia	6.2		
		Senecio integerrimus	9.1		

A comparison of the wiregrass community (Plot 5) and hairgrass community (Plot 11) indicated that the cover contributed by the decreasers in the community represented by plot eleven was a little greater than in plot five but the increasers and invaders were still prevalent. However, the invaders did exhibit less cover and had a lower species diversity in plot 11. Since these invaders are exotic, they were probably not present at the time of the battle. This community is found in isolated portions of the floodplain and in some areas which I classified as being disturbed due to water seeping from irrigation ditches on the bench. At the time of the battle, *Deschampsia caespitosa* probably had a higher percent cover than it has now.

4. Shrubby Cinquefoil Community

Plot six represented one of the communities on the floodplain which contained a woody species, Potentilla fruticosa L. (shrubby cinquefoil). Twenty-three species of herbaceous plants were recorded in this plot, and about ten percent of the floodplain was occupied by this community. The plants were spaced closely together and formed a good sod. No habitat classification for this area was available. From information gathered from the halt-meter-squares, one species was a decreaser, seven were increasers, and four were invaders (Table 8) (Mueggler and Stewart 1980, Zacek et al. 1977, and Hermann 1970). Three species had a cover value greater the ten. Achillea millefolia L. was an increaser and Phleum pratense L. was an invader (Mueggler and Stewart 1980), and the third, Potentilla fruticosa, may be an increaser. Like the three previous communities, there was a high number of increasers and invaders in this community. These areas have apparently received a great deal of grazing pressure in the past, and their original composition cannot be determined. Whether they can return to their original state is unknown since many exotic species may be better adapted to the conditions that exist in these communities than the species that they displaced.

5. Idaho fescue Community

The community in plot 12 could not be habitat typed. The only habitat type that could have been applied to it was Festuca idahoensis/Agropyron spicatum with a Stipa occidentalis phase (Mueggler and Stewart 1980). However, the latter two species were missing. Of 23

Table 8

Decreaser, increaser, and invader species of the shrubby cinquefoil floodplain community (Plot 6).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Camassia quamash	2.7	Achillea millefolium	14.2	Phleum pratense	14.6
		Carex douglasii	4.8	Poa pratensis	2.6
		Danthonia intermedia	1.2	Taraxacum laevigatum	2.4
		Juncus balticus	2.7	Trifolium repens	2.2
		Polygonum bistortoides	2.9		
		Potentilla diversifolia	6.6		
		Solidago canadensis	1.5		

species recorded in the half-meter-square plots, one was a decreaser, seven were increasers, and one was an invader (Table 9) (Mueggler and Stewart 1980). The dominant in this community was Festuca idahoensis. In fact, it was the only species that had a percent cover greater than ten. It is interesting to note that for basically the same habitat classification, Zacek et al. (1977) designated F. idahoensis as an increaser, not a decreaser. This may be related to its current dominant role in the community. Grazing pressure on this community ceased in 1972 as with the rest of the floodplain. Due to the number of increasers and the presence of the invader, the condition of this community cannot be classified as pristine.

The area of the floodplain occupied by this community is about one percent. However, much of the land that is presently affected by excess water from the irrigation ditches probably was occupied by this community. This wet area is presently covered by Carex spp., Juncus balticus, and Deschampsia caespitosa communities, similar to those in Plots ten, five, and eleven, respectively. If water from these irrigation ditches were prevented from flowing onto the floodplain, the

Table 9

Decreaser, increaser, and invader species of the Idaho fescue floodplain community (Plot 12).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Festuca idahoensis	62.0	Achillea millefolium	6.8	Taraxacum laevigatum	0.2
		Arnica fulgens	5.8		
		Carex petasata	0.7		
		Cerastium arvense	0.7		
		Danthonia intermedia	9.0		
		Koeleria cristata	1.7		
		Potentilla diversifolia	3.9		

area covered by the Festuca idahoensis/Agropyron spicatum habitat type (Plot 13) probably would increase to about twenty percent of the floodplain.

In 1973, Don Despain stated that the floodplain was probably a Potentilla fruticosa/Festuca idahoensis habitat type. In my study it was a rare occasion when these two species were observed together on the Battlefield. The potentilla community lacked F. idahoensis and P. fruticosa. However, the possibility that these two communities could have been one habitat type before there was grazing pressure from cattle cannot be ruled out.

6. Sagebrush Community

The driest community occupies a smaller area than any other community on the floodplain. The only woody member in this community is Artemisia tridentata, and the community has been classified as an Artemisia tridentata/Festuca idahoensis habitat type (Mueggler and Stewart 1980). This community was located to the west of the river.

Of the 22 species, two were decreasers, ten were increasers and none were invaders (Table 10) (Mueggler and Stewart 1980). Only three species had cover values greater than ten: Festuca idahoensis, a decreaser, Artemisia tridentata, an increaser, and Eriogonum umbellatum, which could not be designated. Primary grazers in this community were Columbia ground squirrels, moose, deer, and elk.

Table 10

Decreaser, increaser, and invader species of the sagebrush floodplain community (Plot 13).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Agropyron spicatum	5.6	Achillea millefolium	1.3	None observed	0
Festuca idahoensis	16.9	Arenaria congesta	7.6		
		Arnica fulgens	2.1		
		Artemisia tridentata	18.0		
		Carex petasata	2.2		
		Danthonia intermedia	3.0		
		Geum triflorum	2.0		
		Koeleria cristata	3.7		
		Potentilla gracilis	5.8		
		Stipa occidentalis	0.8		

7. Willow Community

The Salix spp. (willow) community of Plot nine covers the largest portion of the floodplain with a value of about 50 percent. This community appears to be associated with old river channels and fill banks that the river has abandoned. No willow habitat types exist. Of the ten herbaceous species recorded in the half-meter-square, Carex nebraskensis with 10.5 percent cover was a decreaser, Carex petasata with 0.3 percent cover was an increaser, and Poa palustris with 45.5 percent cover was an invader. The species displaced by P. palustris cannot be determined at this time.

This community appeared to be impenetrable to human travelers; however, deer, moose, elk, and bear are able to hide in it during the day. It was interesting to note that the only place where young willows were observed was on the new fill banks of the river. In the old fields, abandoned channels, and backwaters, the only willows observed were quite old and well established. In all likelihood the willows represent a seral species on the Battlefield, and in time they would be expected to be replaced by one of the other communities previously mentioned on the floodplain.

The communities with Pinus contorta were very small and too inconsistent in their composition, and no plots were placed in these areas.

C. Mountain slope

The mountain slope is situated in the northwestern portion of the Battlefield and can be divided into sagebrush steppe and forest (Figure 3).

An enumeration of plots placed on the mountain slope, designated community and habitat types and the approximate percent covered by each are presented below in Table 11. Following is a discussion of each of these communities.

Table 11

Plot numbers, community and habitat types, and an approximation of the percentage of the mountain slope covered by each.

Plot number	Community type	Habitat type	Percent cover
3,4	Sagebrush steppe	Artemisia tridentata/Festuca idahoensis	
1,2	Forest	Pseudotsuga menziesii/Calamagrostis rubescens	

1. Sagebrush Community

Two plots were located on the steppe even though it appeared to be one community type. Plot three was placed on the upper portion of the steppe. Two woody species, Amelanchier alnifolia and Artemisia tridentata, were present. Twenty-nine species were recorded, and of these four were decreasers, five were increasers, and none were invaders (Table 12) (Mueggler and Stewart 1980). One of the decreasers, Festuca idahoensis, had a cover value of 17.9, the highest cover of any of the species found in this plot. Other species with cover values above ten were Artemisia tridentata with a cover value of 13.7 of the five meter square plot and Balsamorhiza sagittata (Pursh) Nutt. with a cover value of 10.7 in the half-meter-square plots.

Table 12

Decreaser, increaser, and invader species of the upper sagebrush steppe community (Plot 3).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Agropyron spicatum	11.0	Achillea millefolium	1.1	None observed	0
Crepis acuminata	2.9	Arenaria congesta	7.7		
Festuca idahoensis	17.9	Artemisia tridentata	13.7		
Lupinus wyethii	1.9	Koeleria cristata	4.0		
		Pedicularis contorta	1.5		

Plot four had 24 species, of which four were decreasers, five were increasers, and one was an invader (Table 13) (Mueggler and Stewart 1980). However, the single invader was Taraxacum laevigatum which had a cover value of only 0.2 percent. Of the plants with a cover value of ten percent or more, two were decreasers and one was an invader.

Table 13

Deacreaser, increaser, and invader species of the lower sagebrush steppe community (Plot 4).

Decreaser	% Cover	Increaser	% Cover	Invader	% Cover
Agropyron spicatum	11.0	Achillea millefolium	1.1	Taraxacum laevigatum	0.2
Crepis acuminata	0.7	Arenaria congesta	4.6		
Festuca idahoensis	12.0	Artemisia tridentata	48.4		
Lupinus wyethii	4.3	Carex petasata	0.2		
		Koeleria cristata	3.5		

When viewing the sagebrush steppe from a distance, the lower portion of the slope appears to have more sagebrush than the upper portion. A comparison of plots three and four shows that this is indeed the case. The sagebrush on the lower portion had a cover value of 48.4, while on the upper portion of the steppe the cover value was 13.7. Other differences include the fact that Balsamorhiza sagittata is present in plot three but not apparent in plot four. In spite of these differences both communities can be classified as an Artemisia tridentata/Festuca idahoensis habitat type (Mueggler and Stewart 1980). This community appears to be relatively unchanged since 1877. Primary grazers that use this area now are Columbia ground squirrels, deer, moose, elk, and domestic cattle. The cattle are present on the steppe only in the fall of the year when they are driven from the top of Battle Mountain by cooler temperatures to the lower elevations of the

Battlefield. Due to grazing pressure, Artemisia tridentata may have invaded a Festuca idahoensis/ Agropyron spicatum habitat type, but the information gathered from this study does not allow such a determination with any certainty.

2. Forest Community

The forest covers the remainder of Battle Mountain within the reserve. As with the steppe, two plots were placed in this community because of the observed differences existing in the stands.

Plot one was placed in a stand that contained a few old Pseudotsuga menziesii (Mirbel) Franco (Douglas fir) trees whose height was greater than the surrounding trees. However, most of the younger trees in this area were Pinus contorta intermixed with P. menziesii (Appendix B). The understory was almost a pure stand of Calamagrostis rubescens Buckl. intermixed with a few other species of herbaceous plants. There were no conspicuous woody shrubs in the area, and the young trees were predominantly Douglas fir. There were several downed trees that probably resulted from the 1925 beetle kill. During the beetle infestation, the mature trees in and around the siege area were attacked and killed (Anonymous 1935). Within the half-meter-squares there were thirteen understory species. Only two species exhibited a cover value greater than ten, including Calamagrostis rubescens with a value of 75 and Arnica cordifolia Hook. which had a value of 15.1. This community was classified as a Pseudotsuga menziesii/Calamagrostis rubescens habitat type, with a Calamagrostis rubescens phase (Pfister et al.

1977).

Plot two was placed in a Pinus contorta stand. In this area there were few Douglas fir trees. The trees were more closely spaced than those of the previous stand (compare the sizes of the variable plots in Appendix B). Downed logs also were much more conspicuous in this stand. The understory was a mixture of Calamagrostis rubescens and Vaccinium scoparium Leiberg, and there were no conspicuous woody shrubs in the stand other than V. scoparium. Young trees in the understory consisted of a few Douglas fir and some widely spaced Pinus albicaulis Engelm (white bark pine). This plot was classified as a Pseudotsuga menziesii/Calamagrostis rubescens habitat type. This designation was given because in time, without disturbance, Douglas fir will dominate the overstory.

The forest represented by these plots has changed from its 1877 condition. None of the trees in plot one were alive at the time of the battle, and apparently, only three downed trees may have been alive in 1877. In plot two, on the other hand, one living tree was present at the time of the battle, and at least four downed trees may have been standing in 1877.

D. Summary of Plant Community Analysis

An analysis was conducted to determine how closely the various communities were related to each other. A dendrogram was then constructed to illustrate these relationships (Figure 12).

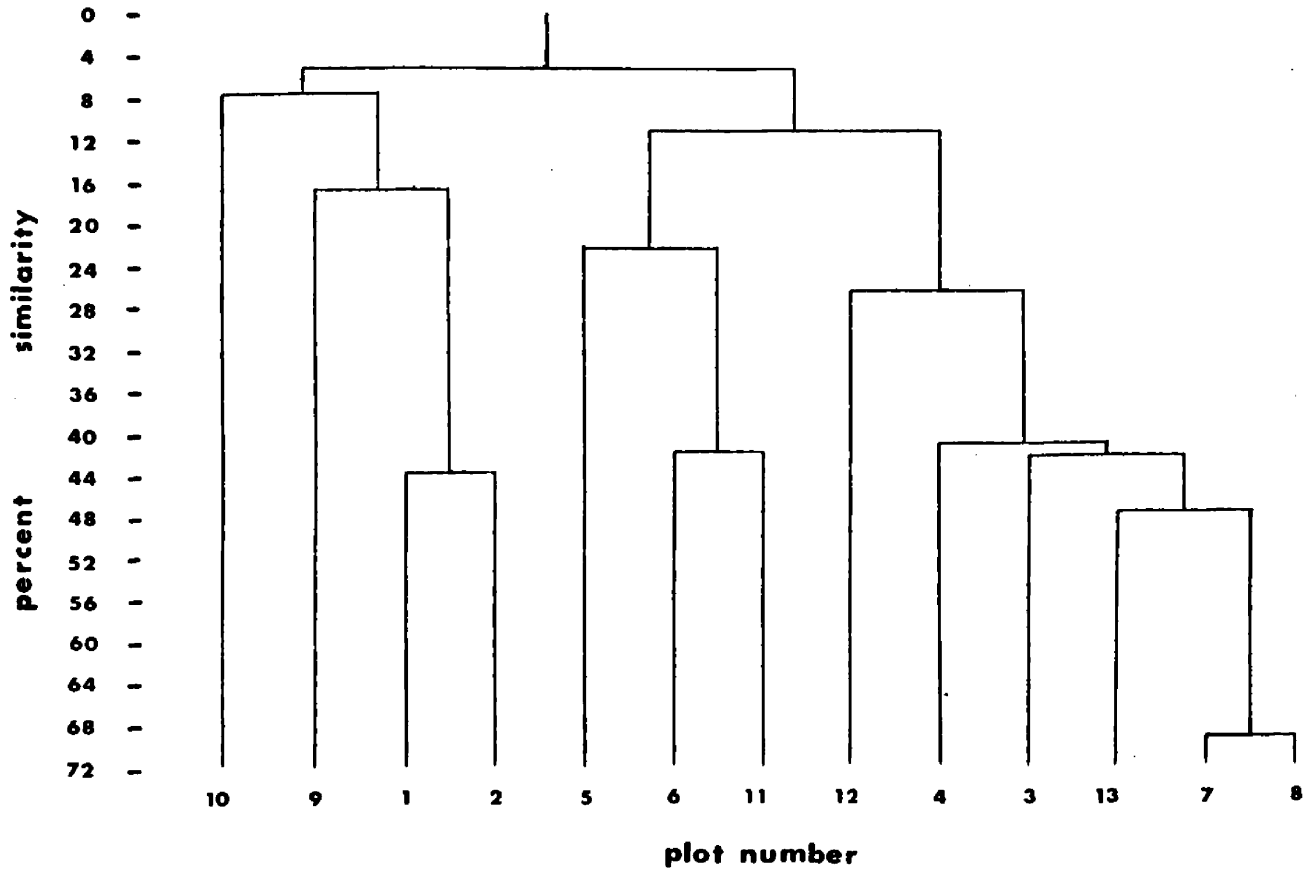


Figure 12

Plot similarity dendrogram constructed from cover data obtained from each plot.

The two plots which were the most similar were plots seven and eight with a similarity of 69 percent. Both plots were from the bench area and these plots had been classified as separate habitat types, these being Artemisia tridentata/ Festuca idahoensis for plot seven and Festuca idahoensis/ Agropyron spicatum for plot eight. Thus, the dendrogram lends support to their being reclassified as one habitat type, this being Festuca idahoensis/ Agropyron spicatum (Mueggler and Stewart 1980). Sagebrush may have invaded the community of plot seven

due to some form of disturbance in the past.

There was then a group of plots which clustered together between 48 and 41 percent. In the forested area, the understory of plots one and two showed a 43.6 percent similarity. There were many differences between the two communities, but they are, nevertheless, the same habitat type. In this percentage range three plots containing sagebrush also clustered together, these being three and four from the sagebrush steppe and thirteen from the floodplain. All three had been classified as a Artemisia tridentata/Festuca idahoensis habitat type (Mueggler and Stewart 1980). The difference between these plots was the presence or absence of minor species and differences in cover values of plants they had in common. When viewed in the field, the plots appeared similar with regard to their major components which were Artemisia tridentata, Festuca idahoensis, Arenaria congesta, and Antennaria microphylla.

The only other plots to show a similarity in this percentage range were six and eleven from the floodplain. On a moisture gradient the communities represented by these plots were adjacent to one another. Plot eleven was a Deschampsia caespitosa/Carex spp. habitat type while plot six could not be typed. It was primarily the native plants which made these two plots similar, but Taraxacum laevigatum and Poa pratensis also made a minor contribution. However, these two communities were not designated as the same habitat type since their field appearance was very different.

There is one more piece of information in Figure 12 which is of use. It should be remembered that Don Despain (1973) designated the grassland communities as a shrubby cinquefoil/Idaho fescue type. Only plot six contained Potentilla fruticosa while the only plots on the floodplain to contain Festuca idahoensis were 12 the 13. These two groups of plots only had a similarity of eleven percent. In fact it was uncommon to see P. fruticosa and F. idahoensis together. This indicates that the shrubby cinquefoil/Idaho fescue type designated by Despain apparently does not exist on the Battlefield.

When the undisturbed portions of the Battlefield are compared, the area that seems to have changed the most since 1877 is the floodplain. Here a higher amount of cover is contributed by exotic species than in other areas of the Battlefield. These exotics have probably invaded areas formerly occupied by the native species which have been reduced in number or eliminated. It is due to the high number of exotic species that no habitat type was applied to many of the floodplain communities.

The bench is probably in the best condition of the landforms. This is reflected by the absence of invaders. With regard to the sagebrush on the bench, evidence from the dendrogram suggests that sagebrush may have invaded the grassland community.

The mountain slope also is in reasonably unaltered condition. Whether sagebrush was on the steppe in 1877 cannot be determined utilizing these methods. In the forest, the stand measured by plot one may be more dense than it was at the time of the battle. The stand

represented by plot two probably has not changed significantly since 1877.

III Synecology:

Since the battle in 1877, some plant communities may have invaded areas previously occupied by other communities. The purpose of this section is to determine the range of some of these communities at the time of the battle.

There are several general historical descriptions which pertain to the valley and may which have included the Battlefield. Captain William Clark, during the Lewis and Clark Expedition, visited the valley during July 6 and 7, 1806. He referred to the area as a beautiful plain with exceedingly fertile soil covered with esculent plants (Biddle 1962). One of the names the Nez Perce gave to the area was Iskumtselalik Poh, or place of the the ground squirrels (McWhorter 1940). This probably referred to the Columbia ground squirrels which are still abundant on the Battlefield. An early settler to the area, Alva Noyes, stated in his description of the evacuation of General Gibbon's men to Deer Lodge after the battle (1966), that there was quite a bit of high sagebrush in the area. Another description that probably dealt with the Battlefield itself was made by Shields (1889), a participant in the battle. He described the valley as rich in bunch grasses. Such apparently conflicting descriptions resulted from the fact that these accounts merely described different portions of the valley.

The three land forms, bench, floodplain, and mountain slope, will again be used as a framework to report results for this portion of the study. The primary advantage of these designations is that no undisturbed community of one land form extends into a community of another. This is primarily due to differences in soil moisture.

A. Bench

Little documentation was found regarding the past vegetational composition of the bench. Perhaps this situation results from the fact that the bench area was not involved in the battle; hence there has been little historical research. At present there are two communities which may have existed at the time of the battle, grassland and sagebrush. Information used for the bench has been gathered from the following sources: a) archival photographs, b) aerial photographs, and c) the 1915 survey.

Four archival photographs showed portions of the bench with enough clarity to be of use. Three of these were taken from the bench and show only a small portion of it, and the fourth was from the mountain slope (Appendix D). Plates 1 and 2 were taken from what is presently the sagebrush community. The archival photograph in Plate 1 was taken in October 1925, 48 years after the battle, and reveals some striking changes that have occurred in the vegetation on this portion of the bench. The archival photograph shows some low growing dark plants which appear to be Potentilla fruticosa. In the lower left corner and near the right edge, there also appears to be sagebrush. In the 1981 retake

there was only one P. fruticosa plant in the area covered by the photograph, but it was hidden by the sagebrush. Herbaceous plants appear to be grazed in the 1925 photograph. The archival photograph in Plate 2 was taken in 1935 and shows the southern portion of the bench. This sector of the bench appears to be heavily grazed, judging from the height of the vegetation, and there is also very little sagebrush. The 1980 photograph shows that the vegetation is much taller now, and there is considerably more sagebrush. The photographs in Plate 3 were taken from the present grassland community. The archival photograph was taken in July 1951, 74 years after the battle. Of primary interest is the lack of sagebrush and the low stature of the vegetation. This same area in 1980 had scattered sagebrush and much taller herbaceous vegetation. Only one archival photograph showed the gulch (Plate 9) and indicates that trees were in the gulch in 1937.

Since the archival photographs were taken, the sagebrush definitely has increased in cover. The grassland community of 1925 and 1935 (Plates 1 and 2) is now a sagebrush community. The archival photographs in Plates 2 and 3, taken in 1935 and 1951 respectively, indicate that the vegetation was presumably closely grazed during this 16-year period. With regard to the disappearance of Potentilla fruticosa during the 56 year interval between the photographs in Plate 1, the archival photograph was taken below an irrigation ditch which was operating in 1925 (Scollick per. comm. 1980), but was abandoned by 1935 (Anonymous 1935). This ditch may have leaked water which increased the surface soil moisture, thus allowing the P. fruticosa to become established.

The abandonment of this ditch eliminated the supply of water. Above this ditch there was and still is a second ditch which operates and leaks water. The amount of water contributed by this ditch apparently is not great enough to maintain the P. fruticosa community. According to Mueggler and Stewart (1980) P. fruticosa requires 20 to 30 inches of precipitation per year, but Park Service records indicate that the Battlefield only gets 16 inches per year. Thus, without some moisture contributed by the ditches, it is unlikely that P. fruticosa could have become established.

Aerial photographs used to study the changes in vegetational composition of the bench were taken in 1936 and 1981 (Appendix E, Plates 17 and 20). An arrow in the lower right center on the 1936 photograph indicates a fence line and an associated enclosure. This enclosure was identified by Dr. Melvin Morris of the University of Montana Forestry Department (per. comm. 1981) as a holding pen for livestock. Another view of this enclosure can be seen in the archival photograph in Appendix D, Plate 2. Livestock was probably shipped from this pen primarily in the spring and fall of the year (Morris per. comm. 1981). The area around the pen may have been more heavily grazed during these times of the year than the surrounding area. Today much of this area has sagebrush.

When the two aerial photographs are compared, it is apparent that the large ravine on the bench has undergone some changes. The two arrows on the 1981 photograph indicate two quaking aspen groves in a fresh washout within the ravine. These communities were very small in

1936. The other trees in the ravine are lodgepole pine communities that have greatly increased in size since 1936. Erosion of the side of this ravine also can be seen at the ends of several irrigation ditches in the 1936 photograph (Appendix F, Plate 17). This disturbance appears to have provided a suitable habitat for the lodgepole pine and quaking aspen.

Two lines of the 1915 survey crossed the bench within the present Battlefield (Figure 13 and Appendix F, Plate 22). The line between sections 24 and 25 included no mention of the vegetation encountered by the surveyor. However, some other interesting observations could be made. The old Park to Park Highway (Glacier to Yellowstone), as seen in the 1936 aerial photograph (Appendix E, Plate 17), was not at that location in 1915. Instead, it went through a small ravine on the southwest portion of the bench. This ravine can be seen in Appendix E, Plate 17 and is located just below the white arrow. The irrigation ditch that currently traverses the middle of the slope on the bench was apparently not present in 1915. On the other hand, the large erosional gulch was present, as was the ditch that presently crosses the south-east boundary of the Battlefield. The north-south subdivision line through the center of section 24 (Figure 13) described the vegetation found along the line as scattered sagebrush. Today there is very little sagebrush along this line, and the vegetation is similar to that seen in the 1980 photograph in Appendix D, Plate 3. There were also no irrigation ditches encountered along this line. Presently there are three irrigation ditches, of which two are still in operation.

Figure 13

Approximate locations of the section and subdivision lines surveyed in the 1915 survey.

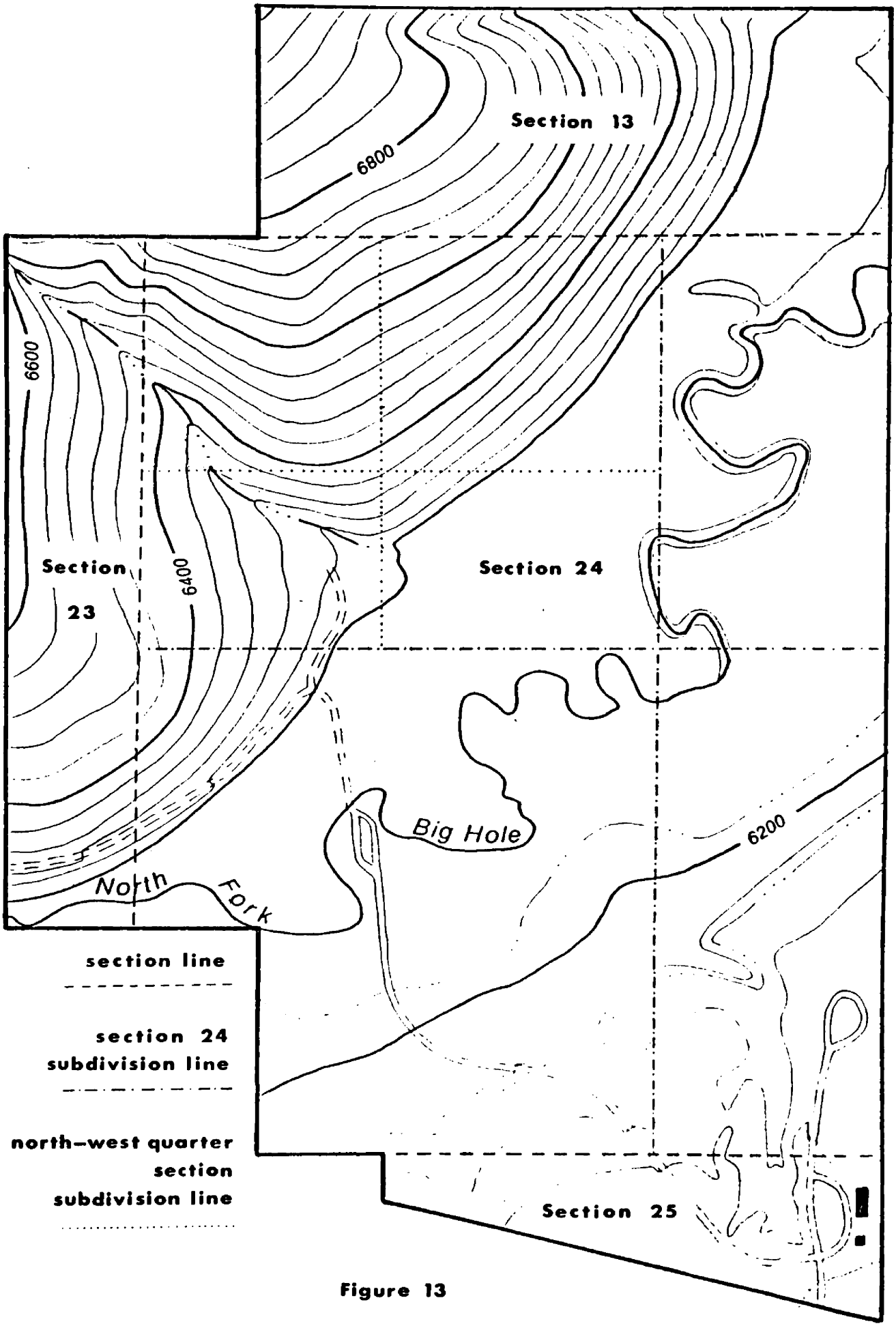

Section 13
6800
6600
6400
Section 23
Section 24
Big Hole
6200
North Fork
section line
section 24 subdivision line
north-west quarter section subdivision line
Section 25

Figure 13

This rather sketchy historical evidence presents an inconsistent view of the vegetational composition of the bench. Some sources indicated the presence of sagebrush, while others such as the photograph on Plate 1 (Appendix D) suggested that it was absent. The first description which actually refers to the bench within the Battlefield is the 1915 survey taken 38 years after the battle and 35 years after domestic animals were introduced to the valley. One disadvantage of this survey is that one does not know what the surveyor meant by "scattered sagebrush". Thus, no definitive conclusions can be made from the evidence presented here about the extent of the sagebrush and grassland communities on the bench in 1877, although the Potentilla fruticosa probably was not present. However, it is probably true that the large ravine probably had no quaking aspen and lodgepole pine in it. Also, the fresh gravel currently visible on portions of the sides and in the bottom of the ravine was probably not present in 1877.

B. Floodplain

The early stages of the battle occurred around the Indian Village on the floodplain. Because of the historical importance of the floodplain, Superintendent Schulmeyer was interested in determining if the willow community was invading the graminoid communities and if the number of trees was decreasing. Information concerning the floodplain was taken from the following sources: a) archival photographs, b) aerial photographs, c) past descriptions, d) the 1915 survey, e) personal interviews, and f) field observations.

Twelve archival photographs were used to evaluate the vegetational changes on the floodplain. Of these, only two, both from 1916, were taken from the floodplain (Appendix D, Plates 4 and 5). In both of the archival photographs it appears as though the herbaceous sector of the meadow had been mowed. This is evident in the archival photograph in Plate 4, where the vegetation is shorter in the foreground than in the background. If the reduction in height were due to grazing pressure from domestic animals, the vegetation in both areas would have been the same height. The 1981 photograph shows that the unmowed area is now a dense stand of Deschampsia caespitosa, and the darker grasses in what was the mowed portion are primarily Phleum pratense, Poa pratensis, and Poa palustris, all of which are introduced. Also, one willow to the right in the archival photograph is now dead with only a rotten root crown remaining, and no new willows appear in the 1981 photograph. The archival photograph in Plate 5 again shows that this portion of the floodplain appears to be mowed, for the height of the vegetation in the depression is about even with that around the depression. The archival photograph in Plate 1, which was taken nine years later, lends further support to this observation by showing numerous hay stacks in the same general area.

All of the other archival photographs were taken either from the bench or the mountain slope. Some of these photographs showed an increase in the number of willows, for what appeared to be open fields at one time now contain scattered willows (Appendix D, Plates 2, 6, 7, 8, and 9). Trees are also a conspicuous component of the floodplain

vegetation, as seen in the photographs. About five Populus trichocarpa Torr. and Gray (cottonwood) trees are present on the floodplain at the mouth of the ravine on the bench. This species was apparently not present at the time the archival photographs in Plates 9 and 10 were taken. The opposite is the case for the conifers, as shown by Plates 6, 8, and 11. These archival photographs show that the number of Pinus contorta trees has been reduced.

Aerial photographs were very useful in the assessment of possible changes in the distribution of the willow community and for the observation of past agricultural practices. To determine if the willow community had changed its percent cover in relation to the graminoid community, twenty 1.33 acre plots were laid along a line drawn over the same portion of the floodplain on the 1936 and 1972 photographs (Appendix E, Plates 17 and 19). From these plots it was found that between 1936 and 1972 the willow community had increased in cover by 3.2 percent with a confidence interval of ± 2.4. This slight increase may be a result of an increase in the size of the willows and/or an increase in their numbers. Another population of willows is located at the mouth of the ravine on the bench. This population was too small to be sampled, but comparison of the two photographs shows that the cover contributed by this community has been considerably reduced. The 1936 photograph does not show any past agricultural use of the floodplain. By 1960, however, (Plate 18) agricultural use is evident by comparison of the vegetation on either side of a fence line running through the floodplain. The east side of the fence had lighter vegetation cover as

compared to the other side, even in the willows. This difference resulted from heavier grazing on the east side of the fence.

In 1806, Captain Clark traveled down Trail Creek and noted that there were numerous old buffalo paths and great quantities of Camassia quamash in bloom (Biddle 1962). Upon reaching the open plain, Sacajawea stated that she had traveled here often during her childhood (Biddle 1962). It was here that her tribe, the Shoshonees, gathered C. quamash, buffalo cows, as well as beaver which were common on the plain (Biddle 1962). One of the names which the Nez Perce had for the area was Is-koom-tsi-la-lih, or many calves, for this was where the buffalo cows left their calves concealed in the grass and willows. There was also a large buffalo wallow in the area (Ault 1959). Descriptions of the floodplain at the time of the battle are numerous, and of all, General Gibbon (1877) probably produced the most accurate. He stated that "the intervening space between the camp" (Nez Perce) "and the foot of the slope upon which we stood was almost entirely covered with a dense growth of willow brush, in the grassy spaces between which herds of ponies were grazing. A deep slough with water in places waist deep wound through this bottom from right to left, and had to be crossed before the stream itself could be reached." He then stated that his men "pushed forward in perfect silence" through this bottom land. General Woodruff (1910) described this area as covered by large willows, and Shields (1889) stated that it had dense thickets of willows. In the McWhorter papers (Ault 1959), one description stated that there was "a dense copse of willows spreading from the stream to the hill, hiding in

places swamp land and lagoons of water." These descriptions prior to and at the time of the battle can be easily applied to this area today, except for the portion of General Gibbon's description stating that his troops advanced "in perfect silence". The willows now contain a considerable amount of dead wood, and it is impossible to walk through these communities without rattling or breaking these dead branches.

The 1915 survey yielded some interesting information about the floodplain (Figure 13 and Appendix F, Plate 22). The description of the line between sections 23 and 24 contained no mention of the vegetation. It did, however, indicate the location of Trail Creek and this creek has not subsequently changed its course. The description of the line between sections 13 and 24 did mention the presence of willows. From the river, which is still in the same location, the surveyor mentioned that he had encountered the willow community 1353 feet later and this community continued for another 330 feet when the mountain slope was encountered. Today this area between the river and the steppe is completely covered by the willow community, except for some occasional openings. The descriptions of the lines for the subdivision of section 24 contained some interesting, but perhaps inaccurate information. The description of the north-south line through the center of this section indicated that the Big Hole River flowed on the lower portion of the bench near the the mouth of the ravine. However, this area is about 50 feet above the present floodplain; thus the river could not have been located there. Also, what is now an old willow community on the alluvial fan was described as meadowland. This willow community

presently contains the largest individuals on the average of any at the Battlefield and, furthermore, is shown in a 1910 archival photograph (Appendix D, Plate 6). Thus the 1915 survey was inaccurate in stating that the area was meadowland. The rest of the present willow community appears to have changed little. The east-west line through the center of section 24 revealed that the river may not have had as many bends as it now has.

One informant was able to supply useful information concerning the floodplain. Mr. Robert Scollick worked at the Battlefield Ranger Station between 1910 and 1930. He stated that the hay meadow, to his knowledge, had never been plowed. He also mentioned that there were beaver present during this time and that their dams were dynamited occasionally. After the dams had been dynamited, flues were placed at the base of the dam. Apparently, the beavers would rebuild the dam but not plug the flue if it were placed properly.

Field observations were made of the living and standing dead conifer trees on the floodplain. Two groups of dead trees were studied. The group to the north of the present parking lot had about six trees, each with two fire scars, one of which was on the east and the other of which was on the west side of the trees. The other group of trees was by the Indian village and contained one scarred tree. Since these trees were dead when they were sampled, the time of death had to be determined in order to ascertain when the scars occurred. These times were determined by using archival photographs and the fire history from the forest on the mountain slope.

The grove of trees by the parking lot is identified by arrows on the photographs (Appendix D, Plates 2 and 6). In 1910 the trees were alive, as seen in the archival photograph in Plate6, but by 1935 they had died as shown in Plate 2. The trees in Plate 2 also appear to have many fine branches, indicating that they may have died in the mountain pine beetle epidemic which began in 1925. Such an epidemic can persist for numerous seasons.

The fire history of at least a portion of the floodplain can be inferred by examination of the fire scars present on trees of the lower mountain slope. In 1861 a fire occurred on the lower portion of the mountain slope (Figure 18 A). Trees scarred from this fire were observed in the lower southern and northern portions of the forest. By taking into account that a fire scar will most likely occur on the leeward side of a tree (Arno per. comm. 1981) then the most recent of the two fire scars, which was on the west or mountain slope side of the trees, was probably caused by a fire coming from the east. Since the northern portion of the forest burned, it can be assumed that the northern portion of the floodplain also burned. During this fire, much of the dead wood and even some of the living wood of the willows would have been removed. No other scarred trees on the Battlefield indicated the occurrence of the 1858 fire so the area it burned cannot be determined.

Knowledge of the fire history of the floodplain also helps to interpret the time of death of the floodplain trees shown in certain archival photographs. Thus, if the last fire scar on the floodplain

trees is a result of the 1861 fire, then one of the trees in Appendix D, Plate 2 died in 1934. This may explain why the trees appear to have many fine branches on them. The other tree would have died in 1937. This tree was on the west side of the grove and is not visible in the 1935 photograph in Plate 2.

Willows can resprout from their root crown (Stickney per. comm. 1980). Since the battle occurred in 1877 they would have had 16 years to regrow after the 1861 fire. It is not known how large the willows would have been in that time interval, but it could be assumed that they would not be as large and contain as much dead wood as they did in 1980 and 1981. This may explain why the troops were able to advance through the willows without alerting the Indian village, as indicated by General Gibbon (1877). It should be remembered that one could not even walk through these areas at the time of the study.

The group of trees near the Indian village was different. Here only one scar was found on one tree. Assuming that the tree died at about the same time as the group discussed above, as it was in the same state of decomposition, then the tree received its scar in about 1890. Yet the fire history of the mountain slope does not indicate a fire in or near this date. Also if a fire had gone through the area it is likely that other trees in the group would have been scarred. Thus, fire was ruled out as a probable cause of the scar and other types of agents were considered. A wedge of wood which appeared to have been removed by an ax was missing from the middle of the scar. Whether the wedge was removed when the tree was scarred could not be determined.

Other agents could have created the scar. New settlers may have removed bark from the tree to mark the boundaries of their land. Alternately, this tree was near an east-west subdivision line and it may have been marked by surveyors when the boundaries of the military reserve, created in 1883, were determined. The 1848 and 1861 fires did not scar this tree because it did not germinate until the 1870's.

All of the dead trees sampled on the floodplain had a blue stain in the outer portions of the wood. This stain is caused by the hyphae of the fungus, Ceratocystis, a pathogenic species, which is carried by the mountain pine beetle (Strobel and Mathre 1970). Besides scarred trees, there were burned stumps and pieces of wood in many places. Unfortunately, no fire history could be obtained from this material because the trees were already dead when the fires occurred. The trunk of a living tree may have its cambium killed in a fire, but the wood is wet and in most cases will not burn. When burned wood is encountered it means that that wood was dead when the fire occurred.

The information presented for this landform indicates that the willow community may occupy some of the area that was formerly a portion of the graminoid community. Not much weight can be placed on the 1915 survey since the subdivision lines were improperly surveyed, and the descriptions of vegetation along the section lines appear to be inaccurate. Surveys from 1909 and 1939 were found for the Battlefield (Appendix F, Plates 21 and 23). These surveys were used as a comparison for placement of the subdivision lines and the location of the North Fork of the Big Hole River. It was found that the 1915 survey placed

the river in a completely different location than what is indicated by the 1909 and 1939 surveys which were in agreement. The 1915 survey, along one section line, also indicates that the willow community has extended its range 1,353 feet into the graminoid community. It is interesting to note that between 1936 and 1972, a 36 year span, aerial photographs showed only a slight increase in willow cover, while between 1915 and 1936, a 21 year span, the area covered by the willow community quadrupled along one survey line. At the time of the battle the willow community contained little or no dead wood and was probably not as large as it is today.

Descriptions of the graminoid community at the time of the battle could be easily applied to the present graminoid communities in 1980 and 1981. The Nez Perce referred to the grass in these communities as being tall enough to hide a buffalo calf. A buffalo calf when lying down is about four to five dm tall (Morris per. comm. 1981). The sedge and hairgrass communities average seven dm tall, thus buffalo calves could certainly hide in these communities. However, much of this area has been used as a hay meadow and pasture in the past and now contains many exotic species.

In reference to the Indians collecting Camassia spp., Camassia quamash is presently well represented on the floodplain. This species is not found in either the sedge or sagebrush community, but it is in the other graminoid communities on the floodplain. Lodgepole pine has declined in number since 1877, and this appears to be due to the 1925 mountain pine beetle epidemic. Present lodgepole pine populations on

the floodplain are healthy and exhibit some regeneration.

Special mention should be made regarding the status of the beaver communities. In July 1981, there were three beaver families on the Battlefield and one beaver dam on the river, all of which were to the east of the old highway through the floodplain. Since dam building activity may influence the level of the water table, it would be helpful to determine if there were any beaver present at the time of the battle. Examination of 1936 and 1960 aerial photographs (Appendix E, Plates 17 and 18) revealed that two beaver dams were located in the river in 1936 and three in 1960. Robert Scollick mentioned that there were beaver present during his tenure at the Battlefield. From a taped conversation on April 9, 1980 (Wiesner 1980), Lawrence Humbel, a trapper, stated that as many as 90 beaver a day were taken out of the Big Hole at the turn of the century. Also General Gibbon stated that there was a waist deep slough to cross before the river was encountered. In 1981 there was a knee to shoulder deep slough along the foot of the mountain slope. Beaver dams at certain locations in the Big Hole River may have had an influence on the level of this slough. This information suggests that beaver may have been present on the floodplain at the time of the battle.

C. Mountain slope

Forest and sagebrush steppe are the two major communities on Battle Mountain. The interaction between these communities provides the greatest potential for producing changes in the vegetation on the

Battlefield. Sources of information dealing with these communities included: a) archival photographs, b) aerial photographs, c) past descriptions, d) the 1915 survey, e) personal interviews, and f) field observations within the forest community. Nine archival photographs show various portions of the mountain slope (Appendix D, Plates 2, 3, 6, 9, 10, 12, 13, 14, and 15). Six of these photographs were taken from the mountain slope.

Within the siege area (Plate 12) a comparison of the photographs reveals that there has been a significant change within this portion of the forest. Only three trees are seen in common between the 1925 and 1981 photograph. These older trees can be easily identified in the 1981 photograph, since they have fewer lower branches as compared to those trees which have appeared since 1925. This difference in age structure could be explained by considering the fact that in 1925 many lodgepole pine trees were killed by the mountain pine beetle and its associated fungus (Anonymous 1935). The 1937 photograph (Plate 9) shows dead trees within the siege area being cut and burned, creating an opening in the forest. Young trees that subsequently became established in this opening can be seen in Plate 13 (Appendix D). As shown in the 1981 photographs (Plates 9 and 13), these openings have been reclaimed by the forest.

Plate 15 illustrates the invasion by the forest into what was previously a grassland community with scattered sagebrush. The grassland also has more sagebrush than it did in 1916, when the archival photograph was taken. Plate 14 shows the same trend except the tree

that has invaded the steppe is Pinus contorta while in Plate 15 it is Pseudotsuga menziesii.

Plate 6 shows the sagebrush and forest communities on the mountain. The archival photograph, which was taken in about 1910 indicates that there was less sagebrush than there was in 1981. The forest, on the other hand, appears not to have changed much. Three photographs were taken from either the bench or the floodplain toward the mountain. The archival photograph in Plate 10 was taken forty-three years after the battle. Sixty-one years later, the steppe to the right of the ravine has considerably more trees, and the open areas above the steppe are now forest. One conspicuous element in both of the photographs is the aspen community to the right of the ravine. Plate 2 shows this same area after the 1925 beetle infestation. By comparing the two photographs in Plate 3 one can see once again the invasion of the steppe by conifers, especially on the left side of the ravine.

One drawing prepared by Granville Stewart in 1878, a year after the battle, was accurate enough to be useful (Plate 16A). Comparison of the north end of the mountain in 1878 with its present condition (Plate 16B) shows that the forest boundary has moved extensively to the south. On the other hand, the upper forest boundary appears to be approximately the same, as does the southern boundary to the right of the ravine. The slope to the left of the ravine also has undergone considerable change. The scattered trees near the top of the slope have now been enclosed by forest and the opening below them now has trees in it.

The aerial photographs again show that the forest has invaded the sagebrush steppe (Appendix E, Plates 17 and 20). These changes can be seen easily by comparing the locations of some large trees scattered throughout what in 1936 was steppe. These trees are indicated by arrows on the photographs.

Descriptions of the mountain slope, as with the other land forms, began with the Lewis and Clark Expedition in 1806. Traveling down Trail Creek, Captain Clark noted that the forest on both sides of the Creek, had been destroyed by fire in many places (Biddle 1962). There are also several descriptions of the mountain at the time of the battle. General Gibbon (1877) mentioned that his troops passed through a point of timber which is now known as the siege area. Shields (1889) wrote the following description of the steppe to the north of the gulch. "Down the side of this steep bluff, thoroughly overgrown with sagebrush, mountain laurel, and jack pines; over rocks, and through break-neck ravines and washouts, the soldiers and citizens picked their way with all the skill and adroitness of trained hunters, until at last they reached a position overlooking the Indian camp, and within 150 yards of the nearest tepees." In 1927 Yellow Wolf stated, as he tried to retrace his route from the site where the cannon was captured to where the Ranger Station stood, indicated by a circle on Appendix E, Plate 17, "I can not recognize every place as then. Young trees have grown up, changing looks of woods and land." When he took this route during the battle he stayed within the forest to escape being shot by the soldiers (McWhorter 1940 and Ault 1959). In a letter, Mr. Ben Stein (per.

comm. 1981) stated that he had an unpublished biography written by Andrew Garcia of Barret Wilkerson, one of the volunteers in the battle. Wilkerson stated in 1934 that "this gulch all down below us (with the exception of the small grove of good sized lodgepole pine trees in the mouth of the gulch)... was then open grassy country that only contained a few large straggling trees on it. And that since then the lodgepole forest from above has encroached on what was then open... making Battle Gulch a different looking place."

The 1915 survey was helpful in analyzing the sagebrush-forest interrelationship. Six lines were surveyed on the mountain slope (Figure 13 and Appendix F, Plate 22). The description of the section line between sections 23 and 24 revealed that the presently unused irrigation ditch on the steppe had been built, as had the Park to Park Highway. No mention was made of the vegetation on the open steppe along this line except for the presence of trees. From this information, the forest boundary has moved approximately 335 feet into the steppe community since 1915. The edge of the forest began at the center of this section line, and two trees were blazed to mark the location. The closest tree to this area was a four-inch pine 40 feet to the east and the second was an eight-inch pine 19 feet to the west. The line between sections 13 and 24 again had no mention of the vegetation on the steppe. With regard to the forest boundary, it was in approximately the same location in 1915 as it was in 1979. The north-south subdivision line through the center of section 24 traversed the steppe to the north of the ravine for only 330 feet. The vegetation along this line was

described as scattered sagebrush. The description of the east-west subdivision line revealed that the forest boundary had moved 198 feet east into the steppe community. The vegetation on the steppe was described as sagebrush. The remaining two lines passed through the center of the northwest quarter section of section 24. The description of the north-south line revealed that the steppe contained scattered sagebrush and the forest began at approximately the same place as it does today. The east-west line, however, described the south slope to the right of the ravine as grassy. In 1980 this slope possessed sagebrush and some widely spaced trees. Apparently, the rest of the line was also grassy even though it crossed the previously mentioned north-south quarter section line which had scattered sagebrush along it.

Robert Scollick (per. comm. 1980) mentioned that there was not so much sagebrush on the steppe during the 1910 to 1930 period because of sheep grazing. He also recalled that one fire did occur in the beetle-killed trees in about 1927.

I studied the forest utilizing 145 plots, (Appendix G). These plots helped determine the range of the forest and open forest boundaries in 1877 as well as its fire history. No plots were placed in the siege area per the request of the Superintendent of the Battlefield.

Plot data supplied four lines of evidence which were used to determine the dimensions of the forest at the time of the battle. These lines included tree age, presence of rotten logs, tabulation of the predominant plant species constituting the understory vegetation, and

tree growth rates.

Figure 14A shows what the forest may have looked like using the age of the trees to delineate the boundary. If a plot had a tree which was at least 103 years old, then that area was considered to be within the forest at the time of the battle. A major problem with this method is that many of the lodgepole pines which existed at the time of the battle died in the mountain pine beetle epidemic which started in 1925.

Figure 14B shows the hypothetical dimensions of the forest through observation of rotten logs which were in a state of decomposition such that they could be kicked apart. No age could be obtained from these trees, but they probably died prior to 1925. Trees which died in the 1925 mountain pine beetle epidemic have not yet decomposed to this stage. Those trees which are now rotten and even some killed by the beetle may represent a portion of the 1877 forest overstory. A problem with this method exists in the vicinity of the old ranger station and visitor center. These buildings were likely heated with wood which may have come from the surrounding area and as the trees died and fell they were probably used for fire wood. Furthermore, barbecues and camp fires were encouraged in and around the siege area by the forest service between 1910 and 1930 (Scollick per. comm. 1980).

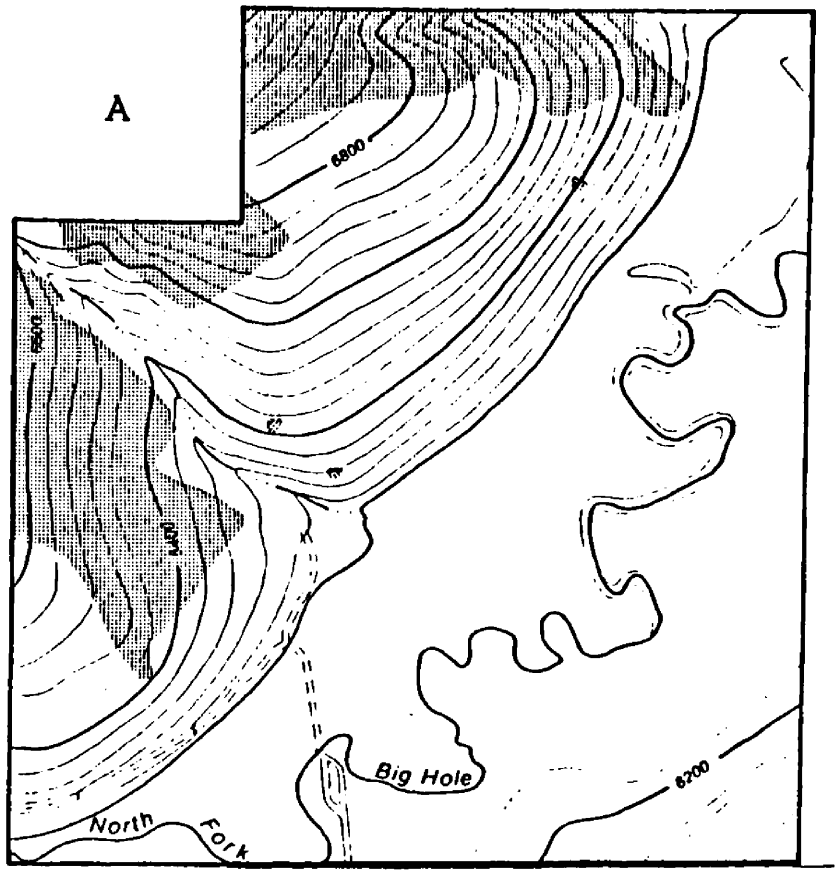
The steppe and the dense old growth forest were very different in their respective plant species compositions. The dense forest had a great deal of Calamagrostis rubescens and Vaccinium scoparium, while the steppe consisted primarily of Artemisia tridentata and Agropyron

Figure 14

Probable boundaries of the forest in 1877 as determined by tree age and the presence of rotten logs.

A. Probable boundaries of the forest in 1877 as determined by tree age.

B. Probable boundaries of the forest in 1877 as determined by the presence of rotten logs.


A
6800
6600
6400
Big Hole
6200
North Fork

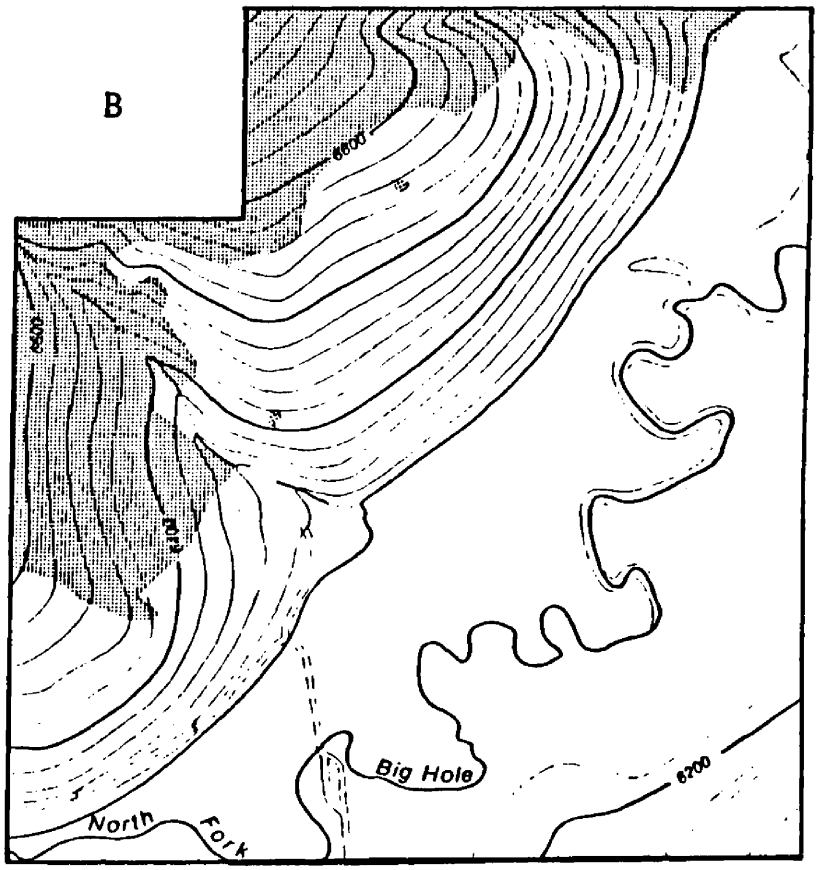

B
6800
6600
6400
Big Hole
6200
North Fork

Figure 14

spicatum. As the forest continues to invade the steppe C. rubescens and V. scoparium are replacing A. tridentata and A. spicatum. In most cases, V. scoparium was observed only in areas which had rotten logs and living trees which were old enough to be alive at the time of the battle. Figure 15A shows what the dimensions of the forest may have been using understory vegetation. Any area having V. scoparium was considered forest at the time of the battle. Any area containing A. tridentata either living or dead was considered to be outside the forest at the time of the battle. There were many areas where neither A. tridentata nor V. scoparium was growing. Rather, C. rubescens was the primary understory species. Since it could not be definitely determined by the present vegetation whether these areas were forest or steppe, such areas were divided uniformly so that half was considered within the forest at the time of the battle.

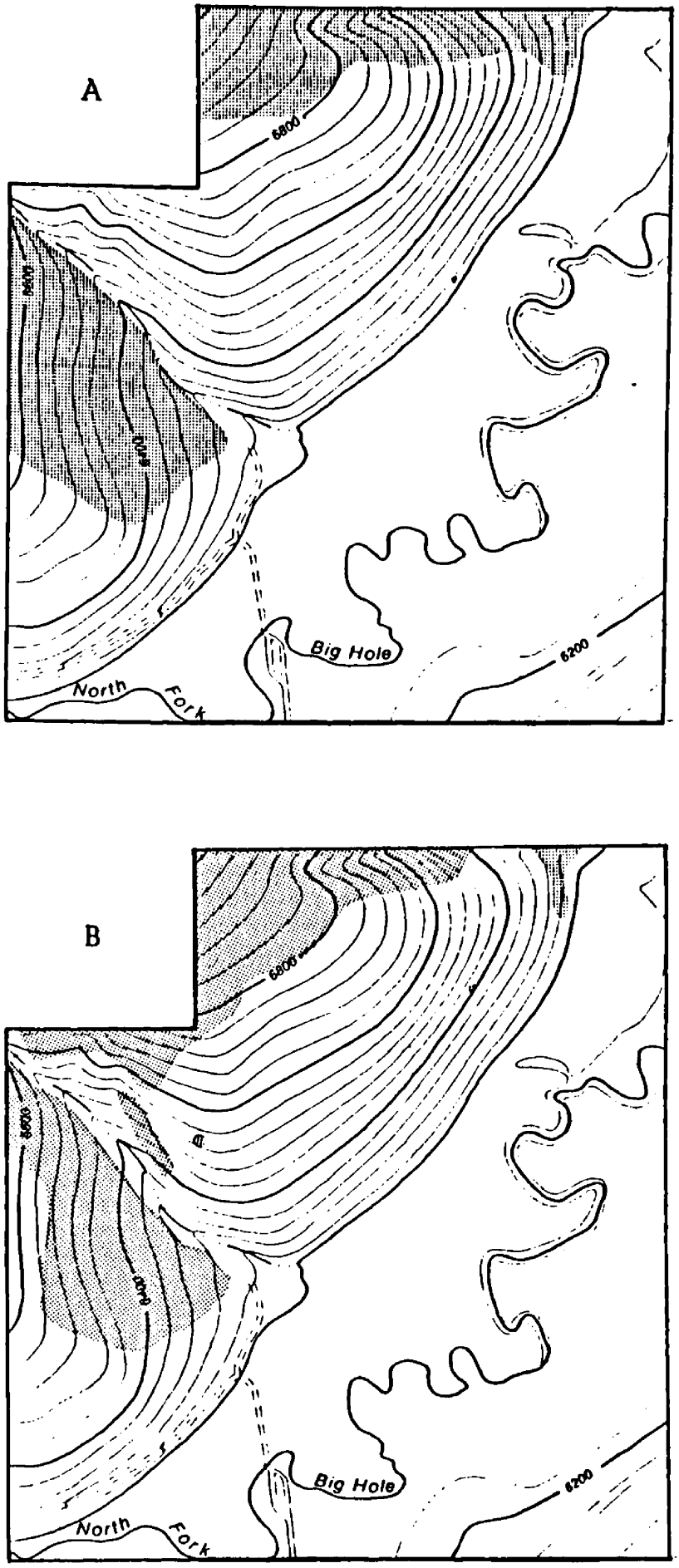
The last method used to determine the extent of the forest at the time of the battle involved studying the growth rate of the dominant tree in a plot (Figure 15B). Growth rate of trees was obtained by dividing the diameter at breast height by the age. A growth rate of less than 0.13 inches per year was determined as indicative of a tree which spent at least a portion of its life, primarily its initial years, as a part of the understory in the forest. A series of these plots (40 to 31) (Appendix G) which proceed from the edge of the steppe near the southern park boundary north into the forest helps to illustrate this. In plots 40 through 38, there was at least one tree which had a growth rate of 0.2 inches per year or greater. These relatively rapid growth

Figure 15

Probable boundaries of the forest in 1877 as determined by the understory vegetation and the overall growth of the dominant tree.

A. Probable boundaries of the forest in 1877 as determined by the understory vegetation.

B. Probable boundaries of the forest in 1877 as determined by the overall growth rate of the dominant tree.


A
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Big Hole
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North Fork

Figure 15

rates are indicative that these trees, which are at least 37 years old, began growth in an open habitat; thus, the area represented by plots 40 through 38 was probably also an open steppe at the time of the battle. In plots 39 and 38 the tree with the greatest growth rate was also the oldest. The oldest tree in Plot 40, a Pinus contorta, did not have the greatest growth rate since it was growing next to the Populus tremuloides grove and was shaded by it. The next oldest tree in that plot was not shaded by the grove and had the greatest growth rate in that plot, or 0.25 inches per year. The understory of these plots was in part Agropyron spicatum and Artemisia tridentata.

Plots 37 and 36 had the same understory vegetation as plots 40 through 38, but contained dead trees that probably died in the mountain pine beetle infestation which began in 1925. At the time of the battle, this area may have been primarily a steppe community with some scattered trees in it. In Plot 37, the oldest living tree in 1980, a Douglas fir at 96 years, had a growth rate of 0.15 inches per year while the slowest growing tree, a Douglas fir at thirteen years, had a growth rate of 0.02 inches per year. Plot 36 had a 115-year-old Pinus ponderosa with a growth rate of 0.24 inches per year, while the youngest tree, a Pinus contorta at 57 years, had the slowest growth at 0.06 inches per year. All of the stands so far mentioned are very open, as indicated by the presence of Agropyron spicatum and Artemisia tridentata, both shade intolerant species (Patten 1969).

A change in the understory is seen in Plot 35, for the Agropyron spicatum has been replaced by Calamagrostis rubescens, a shade tolerant grass (Patten 1969). The Artemisia tridentata is begining to be shaded out in the area of Plot 35, as indicated by the presence of dead shrubs. The dominant living tree is a Pinus contorta at 42 years, having a growth rate of 0.13 inches per year, while the youngest tree, also a P. contorta, had a growth rate of 0.06 inches per year. This stand was probably open forest at the time of the battle but all the trees of that time have died, as indicated by the presence of dead trees and stumps.

All traces of the steppe community have disappeared in the area of Plot 34, but there are no rotten logs or Vaccinium scoparium, and there are three trees with a growth rate greater than 0.1 inches per year. Plots 33 and 32 may have been open forest or forested at the time of the battle for there was no strong evidence to place them in either category.

The area of Plot 31 was probably forested at the time of the battle, as this plot has a Calamagrostis rubescens and Vaccinium scoparium understory. There were also dead trees and rotten logs, and the maximum growth rate displayed by the dominant tree, a lodgepole pine at 150 years, was 0.06 inches per year.

I have discussed the validity of my growth rate estimation technique with Dr. Sidney Frissell and Dr. James Faurot of the U of M Forestry Department (per. comm. 1981). They agreed that a tree growing under an existing canopy would have a slower growth rate than a

tree growing on the open steppe. However, they advised that it would be better to use only the first ten years of growth of the dominant tree. This would provide a more accurate picture of the condition of the environment experienced by the tree when it started to grow. During the entire life of a tree many more factors come into play which could have a bearing on the overall growth rate of that tree (Faurot and Frissell per. comm. 1981). Some of these factors include removal of the overstory, insect predation, and fire.

The several lines of information discussed above for the mountain slope have been synthesized to construct a map (Figure 16) which shows the approximate boundaries of the forest at the time of the battle. In its compostion the forest was similar to what was recorded for Plot 2 (Appendix C), which is a permanent plot. The open forest on the other hand had widely spaced trees with Festuca idahoensis and Agropyron spicatum as the dominant understory vegetation. Not one line of evidence indicated that the forest in 1877 was larger than it is now. However, the various sources of evidence did not always appear to agree as to the limits of the forest at the time of the battle. Because of this, certain lines of evidence were given more weight than others. Determination of the boundaries for the southern portion of the forest in Figure 16 will be discussed first.

The siege area was probably isolated from the main portion of the forest as indicated by the descriptions of Yellow Wolf (Ault 1959) and Wilkerson (Stein per. comm. 1981) and the 1936 aerial photograph (Appendix E, Plate 17). Most significantly Wilkerson described the area

Figure 16

Probable boundaries of the forest and open forest in 1877 with the 1981 forest boundary designated by a dark line.

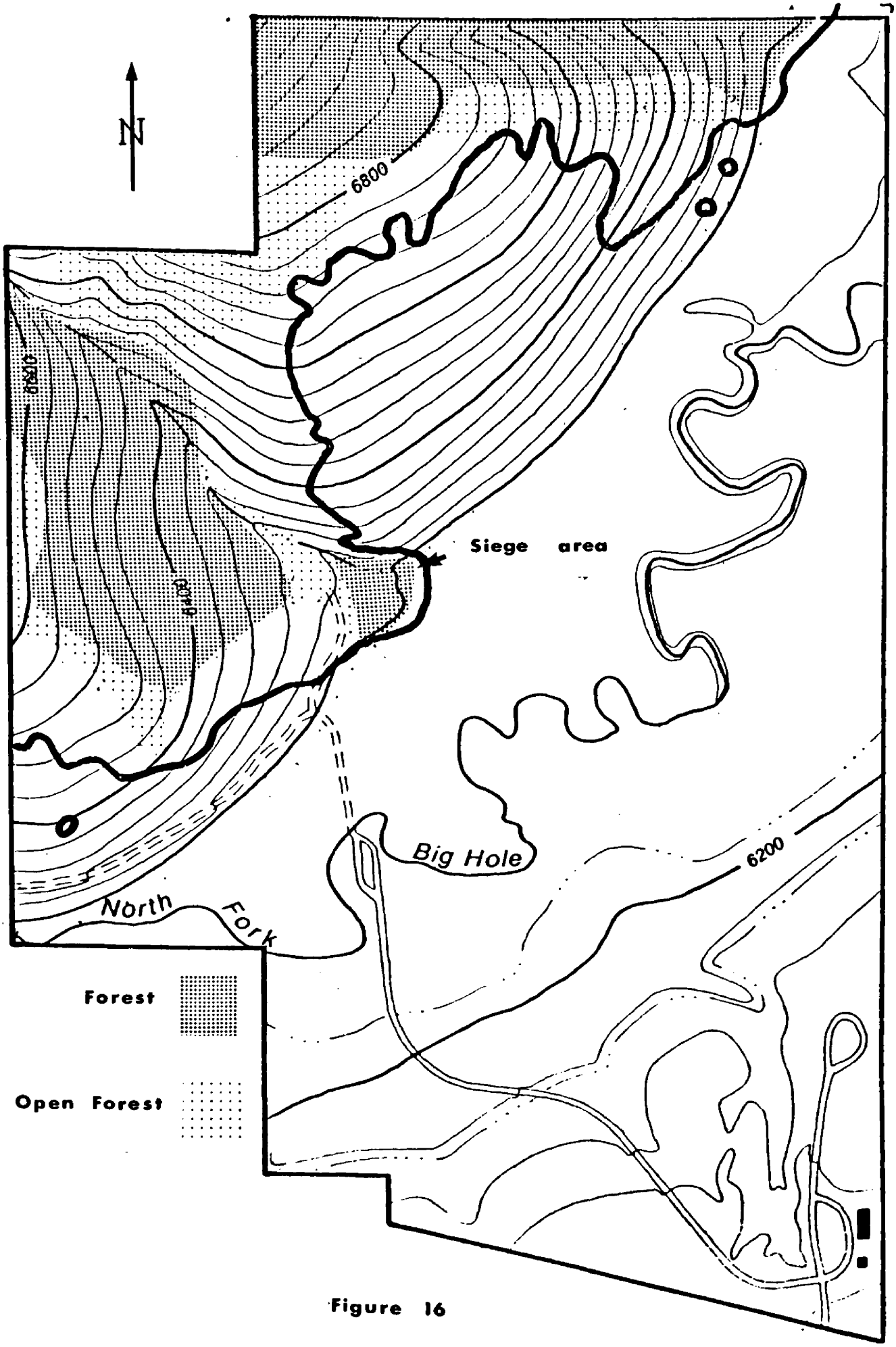
N
6800
6600
6400
Siege area
Big Hole
6200
North Fork
Forest
Open Forest

Figure 16

between the forest and the siege area as open forest.

The southeast boundary of the forest was determined by study of the archival photographs in Appendix D, Plates 2 and 14, the aerial photograph in Appendix E, Plate 17, and Figures 14A, 15A, and 15B. The southwest boundary was resolved by consulting Figure 15B, Stewart's drawing (Appendix D, Plate 16), and the 1936 aerial photograph (Appendix E, Plate 17). The northwest boundary was drawn according to information from Appendix D, Plate 2; Appendix E, Plate 17; and Figures 14B and 15B. With regard to the northern portion of the forest, its southern boundary was determined by consulting Stewart's drawing (Appendix D, Plate 16), the 1936 aerial photograph (Appendix E, Plate 17), and Figures 15A and 15B. The boundaries of the open forest were decided upon by consulting figures 14A, 14B, and 15B; Appendix D, Plates 2, 10, and 16; and Appendix E, Plate 17).

Several of the information sources also indicated that there may have been less sagebrush in 1877. This is supported by the photograph in Appendix D, Plates 14 and 15. Robert Scollick (per. comm. 1980) also indicated that there was less sagebrush.

To determine why the vegetation is changing on the mountain slope, previous research and the fire history were studied. Eleven miles to the west of the Battlefield, Mehringer et al. (1977) sampled the sediment in a bog at the top of Lost Trail Pass. From the pollen analysis of these sediments, it was determined that an Artemisia tridentata steppe dominated this area 12,000 to 11,500 years ago. There

were some conifers in association with this community, but they were primarily spruce and prostrate juniper. This community, which may have been a cold steppe or tundra, was replaced by Pinus albicaulis and possibly Pinus contorta 11,500 years ago. The climate during the period when P. albicaulis dominated this area was probably cooler than it is today.

Even though there are similarities, the present conditions at the Battlefield are probably not a continuation of the changes which occurred on Lost Trail Pass. The steppe on the Battlefield does not contain elements of juniper and spruce, and Pinus albicaulis is not the primary tree invading the area. Thus, the communities were probably different.

One factor which may have led to the vegetation change on the mountain is a reduction in the fire frequency. In the study cited above, Mehringer et al. (1977) found that fires appeared to increase in frequency during the last 2,000 years. They thought that this may have been due to changes in aboriginal land-use. Barrett (1981), in a study of Indian burning practices, including those of the Flathead tribe, found the "Indian fires were very influential in modifying grasslands and forest in lower-elevation habitat zones" in western Montana before the 1880's. He then stated that "Indians apparently set fall and spring underburns primarily for hunting purposes, food-plant stimulation, and, after about 1730, to increase the growth of forage for horses." He found that in heavily used areas, the mean fire interval was 7.5 years, while in remote stands which received little aboriginal use, the interval was

13.5 years. Schulmeyer (per. comm. 1981) stated that the Battlefield area was a traditional campsite for several tribes, including the Flatheads.

Information from fire scarred-trees on the Battlefield indicated that numerous fires had occurred in the past (Appendix H). Ten fires were recorded in the forest between 1738 and 1981. The most recent fire occurred in 1932 (Figure 17A). This fire may have started near the ranger station and is probably the fire Robert Scollick thought occurred in 1927 (per. comm. 1980). In 1904, a fire burned on the northern boundary of the reserve near the floodplain (Figure 17A). Figure 17B shows a major fire which in 1902 burned just about all of the forested portions of the Battlefield, except the northern portion which then burned in 1904. Six years before the battle, in 1871, another fire occurred on the upper portions of the forest and a fire burned the lower portion of the slope in 1861 (Figure 18A). Since this fire was recorded only in the forest ravine and on the northern boundary, it may have originated on the floodplain where scars from it also were found. The last fire for which there was a record from a living tree occurred in 1841 (Figure 18B). This burn covered the entire forest in the ravine, but only the lower portion of the forest burned on the northern boundary. This fire may also have burned the floodplain.

The three earliest fires recorded from the forested portion of the Battlefield were from a dead tree on the northwestern boundary. These fires probably occurred in 1801, 1761, and 1738.

Figure 17

Probable boundaries of the 1932, 1904, and 1902 forest fires.

A. Probable boundaries of the 1932 and 1904 forest fires.

B. Probable boundaries of the 1902 forest fire.

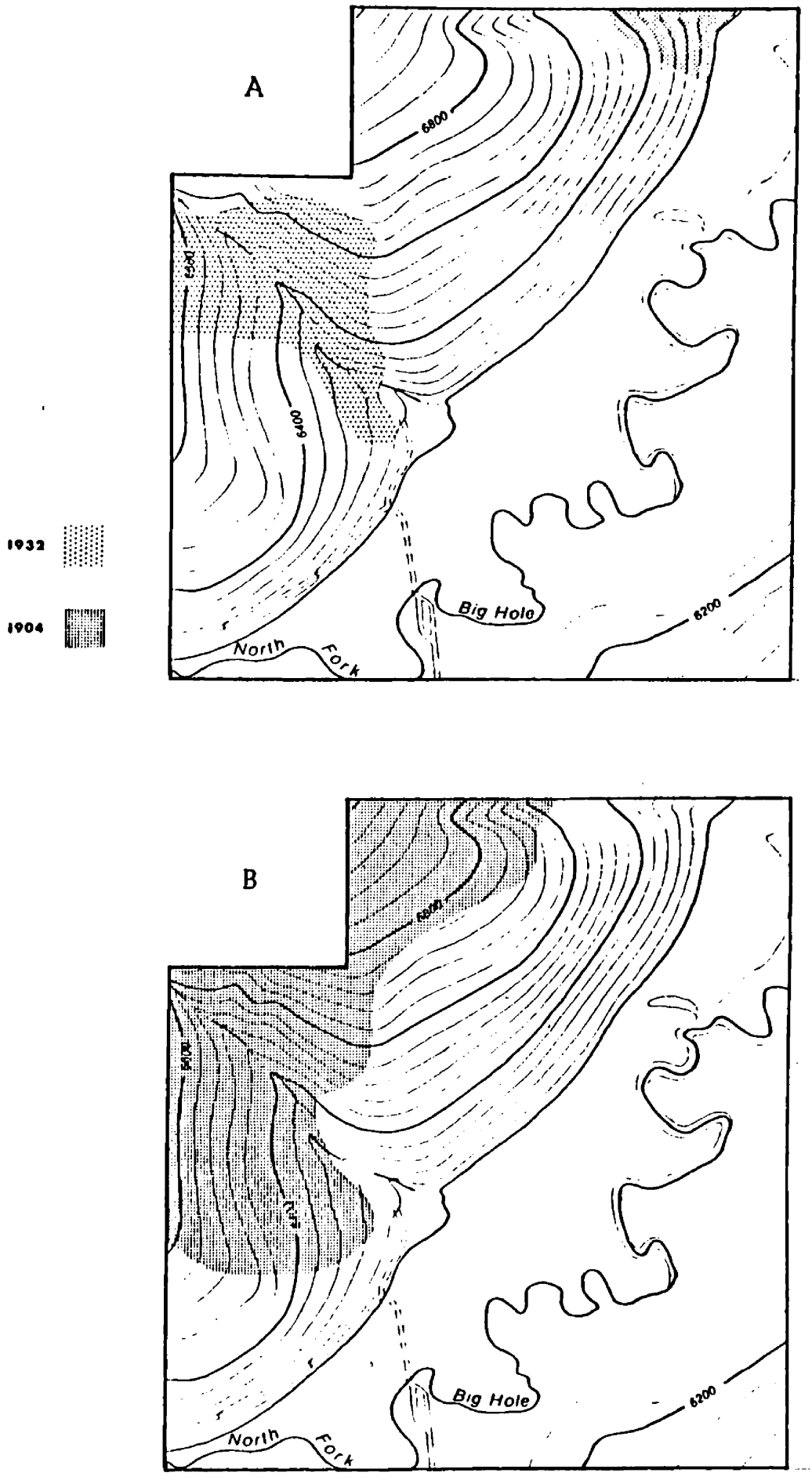
A
6800
6600
6400
1932
1904
Big Hole
6200
North Fork
B
6000
5800
6400
Big Hole
6200
North Fork

Figure 17

Figure 18

Probable boundaries of the 1871, 1861, and 1841 forest fires.

A. Probable boundaries of the 1871 and 1861 forest fires.

B. Probable boundaries of the 1841 forest fire.

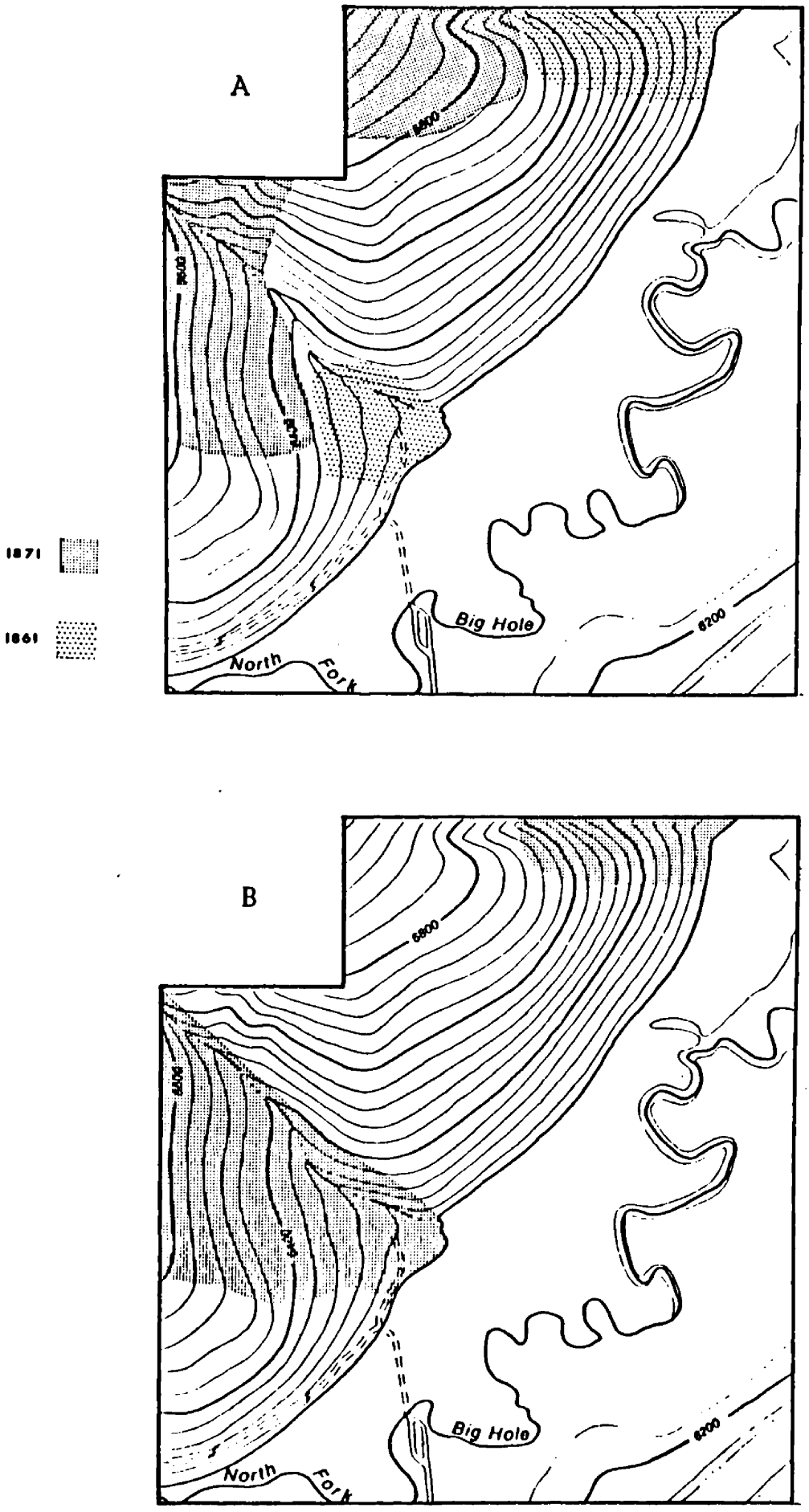
A
6600
6400
6200
Big Hole
North Fork
1871
1861
B
6600
6400
6200
Big Hole
North Fork

Figure 18

None of the fires described above killed the trees from which this information was obtained. Thus, it can be assumed that these fires were mostly restricted to the ground and tended not to burn in the forest canopy which could have killed the trees.

The mean fire interval (Stokes and Dieterich 1980) in the forest area can be calculated in two ways. One can average all the intervals which occurred in the forest between 1932 and 1738. However, this method would produce a mean interval which does not reflect the different fire histories for the different portions of the forest, i.e. not all the fires burned all of the forest. A more accurate calculation of the mean fire interval (Stokes and Dieterich 1980) is to average the fire intervals of all the trees sampled. By using this method only the intervals between those fires which burned the same portion of the forest were averaged. This method produced a mean fire interval (Stokes and Dieterich 1980) of 36.8 years with a standard deviation of 14 years between 1932 and 1738. There have been no fires on the Battlefield for the last 49 years.

In 1981 a dead tree was found at the base of the mountain slope in the middle of the steppe. Stewart showed this tree as being alive, and it was one of two closely spaced trees identified by an arrow on his 1878 drawing (Appendix D, Plate 16). A 1936 aerial photograph, however, showed that this tree was dead though still standing (Appendix E, Plate 17). In 1981 this tree was located, and it had fallen down. Six probable fire scars were observed. All of these scars occurred in the 1700's, probably in 1754, 1738, 1734, 1733, 1726, and 1716 which gives a

mean fire interval (Stokes and Dieterich 1980) of 7.6 years. Since the tree was dead, the years when the tree was scarred had to be estimated. The fire years chosen were the only ones for which two of the years correlated with those from the forest, these being 1738 and 1716 (Appendix H). By using this combination of years the tree would have died in 1927. This would indicate why the tree was still standing and capable of casting a shadow as seen the the 1936 aerial photograph. Since there was only one other tree in the vicinity of this one, all of these fires were probably sagebrush of grass fires. Fires in the 1800's probably did not leave visible scars due to the extremely slow growth of this tree during that time and weathering along with decay after death which removed some of the most recent growth.

In a study conducted in 1981, Arno and Gruell (unpublished data) sampled fire-scarred trees near the southern boundary of the Battlefield. Two Douglas firs displaying a total of seven fire scars were included in their sample. These fires occurred between 1902 and 1662 giving a mean fire interval of 34 years. Three of these fires correlated with those previously mentioned in this study, the 1902, 1841, and 1761 fires. Other years obtained by Arno and Gruell were 1791, 1756, 1716, 1695, and 1662.

Organized fire suppression at the Battlefield probably began about 1906 with the building of the ranger station. Since that time only the fire of 1932 has occurred. Arno (1976), from a study on Tolon Creek, located about 15 miles from the Battlefield on the East Fork of the Bitterroot River, found a similar reduction of fires in the 1900's. He

found that there had been 16 fires in the drainage in the 1800's, while there had been only two in the 1900's.

All of the fires which are recorded for the Battlefield probably had an effect on the vegetation. Fire has the ability to kill sagebrush (Harniss and Murray 1973 and Blaisdell 1953). Taking into account that fires may have occurred about every eight years on the steppe during the 1700's, then the sagebrush frequency on the landscape probably would have been limited. Fires in the 1800's, even though they may not have occurred as frequently, would also have restricted the presence of sagebrush on the steppe. With regard to trees invading the steppe, Patten (1969), in a study at Yellowstone Park, noticed that "areas once appearing to be pure sagebrush stands now support young lodgepole pine". This is currently occurring on the steppe to the south of the siege area, as seen in Appendix D, Plates 2 and 14. Patten (1969) indicated that sagebrush may be an early seral stage which terminates in a mixed conifer forest in the absence of fire. In another study by Sindelar (1971), the invasion of grasslands by Douglas fir was very closely associated with sagebrush. He observed that the sagebrush stands were 10 to 25 years old when the Douglas fir became established and that there "was a strong positive association between individual Douglas-fir saplings and big sagebrush plants." This may explain the recent invasion of the northern portion of the steppe by Douglas fir. Appendix D, Plate 15 shows that the upper steppe had very little sagebrush in 1916 and a few large Douglas fir. The archival photograph in Appendix D, Plate 3 shows this area in 1951 and indicates that there were still very few

conifers on the steppe. Unfortunately, the exact amount of cover contributed by the sagebrush in this photograph cannot be determined. The 1980 photographs in Plates 3 and 15 show that there was a great deal of sagebrush on the slope and also many young Douglas fir. Apparently, as indicated by Sindelar (1971), sagebrush protects young Douglas fir from the elements. The presence of young Douglas fir as the predominant understory tree in many portions of the forest also could probably be explained by the reduction in the occurrence of fire.

IV Evaluation of Various Synecological Methods:

There were many sources of information used in the synecological studies, and some appear to be more reliable than others. The archival photography is the most accurate; however, many photographs could not be dated properly. The photographs taken by Wood (Plates 6 and 7) have no date on them, but the women's clothing would indicate that they were taken about 1910. Two photographs were reportedly taken in 1916, but an aqueduct is present in one, but not in the other (Plates 8 and 11).

Drawings posed another problem. Of the approximately five drawings examined, only one had enough detail to be of any use (Plate 16). To determine the accuracy of this drawing, some of the lone trees on the steppe were sought to determine if they indeed were at that location. Arrows on the drawing indicate several trees which were used for this purpose. All of the trees to the left of the twin Douglas firs are now dead but could still be found, while those trees to the right were still alive in 1981.

The aerial photographs were very helpful. However, the first of these was taken 59 years after the battle, and many changes may have occurred by then.

Regarding the 1915 land survey, many errors were encountered. The survey lines in Figure 13 were drawn from information given in the description of the lines. The subdivision lines were drawn off center because that is where the descriptions placed them. Another problem with the survey was in the interpretation of the surveyor's description of the vegetation, especially the term "scattered sagebrush". To decipher this, a 1916 photograph was used (Plate 15). This photograph showed the steppe community encountered by the surveyors. The sagebrush distribution was similar to that seen in the present grassland or sagebrush communities on the bench. Because of these problems, the 1915 survey was not considered of value.

Written descriptions could contain misrepresentations. Shields's highly dramatized publication in 1889 is a good example. However, Gibbon's description in 1877 was highly regarded since it was written during the same year as the battle. Also, the works of McWhorter and information from Stein were highly regarded since they recorded the recollections of actual participants in the battle when they revisited the Battlefield after an absence of many years.

Interviews brought mixed results. Robert Scollick misplaced the date of the 1932 fire by five years, and there was no way to determine the accuracy of the statements of Lawrence Humbel (Wiesner 1980). On

the other hand, information from field observations was very helpful.

Other lines of evidence which could be used in the synecology section were the inventory of vascular plants and habitat typing. As mentioned before, many of the species designated as being exotic were probably not present on the battlefield in 1877.

Habitat typing proved to be of no use. This method has the potential of determining the stable (climax) blend of plant species for a community despite the successional status of the community. However, numerous fires (Appendix H) have disrupted the successional status of the Battlefield communities in the past; thus, they were probably not in a stable climax state.

CHAPTER VI

CONCLUSIONS AND MANAGEMENT

A. Conclusions

On the Battlefield I found 336 species of vascular plants of which 77 resulted in county records and one a state record. Of particular interest was *Penstemon lemhiensis* which is listed by the Federal Register (Anonymous 1980) as a possible rare and endangered species. Additionally, I located a probable hybrid swarm between *Pedicularis contorta* and *Pedicularis parryi*. Within the list of species, 34 were considered to be exotic and were probably not on the Battlefield at the time of the battle.

Since 1877 the bench, floodplain, and mountain slope appear to have changed. All of these landforms have been subjected to disturbance caused by construction, and the bench and the floodplain have also been receiving excess water from irrigation ditches. With regard to the undisturbed areas, the bench appears to be the least changed, though the sagebrush may have increased in cover. Trees also were probably not present in the gulch portion of the bench at the time of the battle.

On the floodplain the willow community probably contains more dead wood than it did at the time of the battle, and it probably increased slightly in cover since 1936. There also may be fewer lodgepole pine trees than at the time of the battle, and no definite conclusions can be made regarding the graminoid community other than that some portions have a high number of exotic species.

The steppe on the mountain slope appears to have more sagebrush than it had in 1877 and is being invaded by the forest. Within the forest young Douglas fir constitutes most of the understory and has the potential of replacing lodgepole pine as the dominant tree. Indeed, the open forest of 1877 now could be classified for the most part as forest comprised of lodgepole pine and Douglas fir.

Fire probably had an influence on the communities at the time of the battle, and its elimination may be responsible for many changes that have occurred since. Sixteen years before the battle a fire may have burned all of the willow community and removed much of the dead wood and maybe some of the living wood.

A fire scarred tree on the steppe shows that the mean fire interval during a portion of the 1700's was eight years, which might indicate deliberately set fires western Montana Indian tribes deliberately set fires (Barrett 1981). In the forest, fires between 1738 and 1932 indicated a mean fire interval of 37 years.

Absence of fires on the steppe during recent times may explain the probable increased dominance of sagebrush, a fire intolerant species (Harniss and Murray 1973; Blaisdell 1953). Absence of fire may also explain why the forest has invaded portions of the steppe and open forest and why the Douglas fir has increased.

B. Suggested Management Procedures

Management concerns for the Battlefield included the presence of exotic plant sagebrush, excess water from the irrigation ditches, the distribution and maintenance of the sagebrush, willow, graminoid, and forest communities, and the continuation of the natural flow patterns in the North Fork of the Big Hole River.

Many of the exotic species were probably purposely introduced to the Battlefield to improve hay production on the floodplain and prevent possible soil erosion resulting from the construction of the sewage works. Most of these plants are now presumably a permanent part of the Battlefield flora. If an effort were made to eliminate the exotic species, one would risk elimination of many of the native species. Thus, preventing the introduction of additional exotic species seems to be the most fundamental course of action.

Excess water appears to have made portions of the bench and floodplain more mesic than they were in 1877. Since ranchers depend on water from these ditches, it would be impractical to eliminate them even though it would be the best solution. Instead, the ditches should be lined to prevent water leakage from them.

The extent of the grassland, sagebrush, willow, and forest communities in the past was apparently controlled by fires started by lightning and Indians. Periodic burning every 8 to 37 years of the grassland, sagebrush, and willow communities would probably help to restore these communities to their 1877 condition. Three possible

methods could be used to force the forest back to its 1877 boundaries. The safest method would be to remove trees which were not in the forest at that time. This also would entail removing Douglas fir from beneath the lodgepole pine understory. The most ecologically sound method would be to burn the forest understory approximately every 37 years. The last method is a combination of the previous two, in other words removing trees to preserve the 1877 boundaries and burning to inhibit Douglas fir from dominating the forest. These methods should also be considered for the trees in the gulch on the bench. Regardless of which method is used, it should be done as quickly as possible since the forest community appears to be changing rapidly. All burning should be conducted by qualified personnel.

Dams at the Fat Man and Thin Man sites on Trail Creek should be discouraged from development. These would reduce spring flooding and increase summer stream flow (Anonymous 1978).

Permanent plots should be read after the management options have been executed and approximately every 20 years thereafter to determine if the vegetational composition has changed. Also, since these are permanent plots, care should be taken so that they are not disturbed. Further work should be done on fire-scarred trees in the forest, especially in the siege area. As trees die, those displaying scars which appear to be a result of fire should be sampled to obtain the age of the trees and years of past fires. The location of these trees should then be indicated on a map.

CHAPTER VII

SUMMARY

The primary objectives of this study included: a) an inventory of the vascular plant species within the various plant communities found on the Battlefield, b) to determine as accurately as possible the nature of the vegetation at the time of the battle, and c) to suggest possible management options for the vegetation on the Battlefield.

From field work during the summer of 1980 and 1981, 336 species of vascular plants were observed. All but five of these were collected, mounted, and deposited at the University of Montana Herbarium (MONTU) and the Big Hole National Battlefield. Of these, 77 resulted in new county records and one, Orobanche corymbosa resulted in a new state record. Of interest in the inventory was Penstemon lemhiensis, a proposed threatened and endangered species (Anonymous 1980) and a population of putative hybrid crosses between Pedicularis contorta and Pedicularis parryi. Thirty four of the 336 species were determined to be exotics and were probably not on the Battlefield in 1877.

Thirteen permanent plots were placed on the Battlefield to determine the existing condition of the various major vascular plant communities and provide a method to analyze future changes which may occur. These plots contained three parts: a) five-meter-square plot for woody material over 0.5 m tall, an exception being that all sagebrush in this plot was measured regardless of its height; b) a variable plot for woody material which could be extended until ten woody

plants were in both the five-meter and variable plots; and c) ten half-meter-square plots nested within the five-meter-square and variable plots. Information obtained from these plots was used to assign habitat types when possible and construct a similarity matrix. Habitat typing was not used to ascertain the composition of the vegetation in 1877.

Other methods used to determine the composition of the vegetation in 1877 were archival photographs, aerial photographs, past surveys, historical accounts, personal interviews, and field observations. The undisturbed portions of the bench were likely very similar to their 1877 appearance except that there was probably not as much sagebrush. There were also probably no trees in the gulch. On the floodplain the willow community appears to have slightly increased its size at the expense of the graminoid community. However, the exact composition of the graminoid community could not be determined due to recent disturbance from grazing. On the mountain slope the steppe probably has more sagebrush than it did at the time of the battle. Trees also are invading this community, reducing it in size. The expanded forest also has changed. Areas which probably were once pure lodgepole pine in 1877 now contain numerous young Douglas fir. What was open forest in 1877 with mostly a few large Douglas fir or lodgepole pine is now mostly forest.

To determine why these communities had probably changed, edaphic modifications, past agricultural practices, and fire-scarred trees were studied. On the bench, trees have invaded the recently disturbed portions of the gulch and the increase in sagebrush could be related to

past grazing pressure. On the floodplain increases in the cover contributed by willows could be related to the elimination of fire. One tree on the steppe which contained six possible fire scars was sampled. These scars indicated that the mean fire interval for a part of the 1700s' may have been eight years. Fires could have restricted the occurrence of sagebrush on the steppe. Ten fire-scarred trees in the forest indicated a mean fire interval of 37 years between 1738 and 1931. Many of these fires probably limited the spread of the forest into the steppe community and also tended to eliminate Douglas fir from the forest.

In light of this information a management plan was proposed for the Battlefield. Control of exotic species of plants would simply require preventing the introduction of new species. Concerning control of community interactions, the sagebrush and willow could be controlled by fire, while the forest could be controlled by fire, removing trees, or a combination of both.

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APPENDIX A

List of Vascular Plant Species Found at the Big Hole National Battlefield

Below is a list of species arranged alphabetically by family, genus, and species. The nomenclature is according to Hitchcock and Cronquist (1973). After each name is a code designating the portion of the Battlefield where each species grows and if it constitutes a county record, an exotic, or an endemic species. The code is as follows: B, bench; Fp, floodplain; F, forest slope; Fr, forest ravine; S, steppe; D, disturbed; Cr, county record; Ex, exotic; and En, endemic. Plants found in transitional zones between these portions of the Battlefield were not considered. The endemic species had been previously determined by the Plant Information Network. To be considered as an endemic a plant had to be restricted in its distribution to Montana, or Montana and adjacent states and Canadian provinces. After each endemic designation, the states or provinces where it has been observed have been listed.

Berberidaceae								
Berberis repens Lindl.			F		S			
Boraginaceae								
Amsinckia menziesii (Lehm.) Nels. and Macbr.			F		S			
Cryptantha torreyana (Gray) Greene			F		S		Cr	
Lappula echinata Gilib.						D		Ex
Lithospermum ruderale Dougl.	B	Fp	F		S			
Mertensia ciliata (Torr.) G. Don		Fp	F					
Mertensia viridis A. Nels.	B							
Myosotis micrantha Pall.						D	Cr	Ex
Plagiobothrys scouleri var. penicilatus (Greene) Cronq.						D		
Callitrichaceae								
Callitriche anceps Fern.		Fp					Cr	
Callitriche verna L.		Fp						
Campanulaceae								
Campanula rotundifolia L.	B	Fp			S			
Caprifoliaceae								
Lonicera caerulea L.		Fp					Cr	
Lonicera involucrata var. involucrata (Rich.) Banks		Fp	F					
Symphoricarpos albus var. laevigatus Fern.		Fp	F				Cr	
Symphoricarpos oreophilus var. utahensis (Rydb.) A. Nels.			F					
Caryophyllaceae								
Arenaria congesta var. congesta Nutt.			F					
Arenaria congesta var. lithophila Rydb.	B	Fp	F		S			
Arenaria lateriflora L.		Fp						
Cerastium arvense L.	B	Fp						
Cerastium vulgatum L.			F					
Silene douglasii var. douglasii Hook.	B						Cr	
Silene menziesii var. viscosa (Greene) Hitchc. & Mag.				Fr				
Spergularia rubra (L.) Presl.						D		Ex
Stellaria calycantha var. bongardiana Fern.		Fp		Fr			Cr	
Stellaria longipes var. altocaulis (Hulten) Hitchc.		Fp						
Chenopodiaceae								
Chenopodium album L.						D		Ex
Monolepsis nuttalliana (Schultes) Greene						D		

Compositae									
Achillea millefolium ssp. *lanulosa* var. *lanulosa* (Nutt.) Piper	B	Fp			S	D			
Agoseris aurantiaca var. *aurantiaca* (Hook.) Greene				Fr					
Agoseris glauca var. *dasycephala* (T. & G.) Jeps.		Fp				D			
Agoseris glauca var. *glauca* (Pursh.) Raf.		Fp							
Anaphalis margaritacea (L.) B. & H.	B		F						
Antennaria anaphaloides Rydb.	B								
Antennaria dimorpha (Nutt.) T. & G.					S		Cr		
Antennaria microphylla Rydb.	B	Fp			S				
Antennaria racemosa Hook.			F						
Arnica chamissonis ssp. *chamissonis* var. *interior* Maguire		Fp							
Arnica cordifolia var. *cordifolia* Hook.			F						
Arnica fulgens Pursh	B	Fp				D	Cr		
Artemisia firgida Willd.	B				S				
Artemisia ludoviciana var. *latiloba* Nutt.		Fp				D			
Artemisia tridentata Nutt.	B	Fp	F		S	D			
Aster chilensis ssp. *adscendens* (Lindl.) Cronq.		Fp							
Aster conspicuus Lindl.			F						
Aster foliaceus var. *lyallii* (Gray) Cronq.	B				S		Cr		
Aster integrifolius Nutt.	B	Fp			S				
Aster occidentalis var. *occidentalis* (Nutt.) T. & G.	B	Fp			S				
Aster stenomeres Gray	B				S				
Balsamorhiza sagittata (Pursh) Nutt.	B		F		S				
Carduus nutans L.						D	Cr	Ex	
Centaurea maculosa Lam.	B	Fp			S	D		Ex	
Chrysothamnus nauseosus var. *albicaulis* (Nutt.) Rydb.					S		Cr		
Chrysothamnus viscidiflorus var. *viscidiflorus* (Hook.) Nutt.	B				S				
Cirsium arvense var. *horridum* Winn. & Grab.						D	Cr	Ex	
Cirsium hookerianum Nutt.			F						
Cirsium scariosum Nutt.		Fp		Fr		D	Cr		
Cirsium vulgare (Savi) Tenore						D		Ex	
Crepis acuminata ssp. *acuminata* Nutt.	B				S				
Crepis runcinata ssp. *runcinata* (James) T. & G.	B	Fp							
Erigeron compositus var. *glabratus* Macoun	B								
Erigeron corymbosus Nutt.	B	Fp			S				
Erigeron divergens var. *divergens* T. & G.	B				S		Cr		
Erigeron speciosus var. *speciosus* (Lindl.) DC.		Fp			S				
Eriophyllum lanatum var. *integrifolium* (Hook.) Smiley			F						

Compositae								
Grindelia squarrosa var. serrulata (Rydb.) Steyerm.					D			
Haplopappus integrifolius Gray	B							
Haplopappus lanuginosus var. andersonii (Rydb.) Cronq.	B							
Haplopappus uniflorus (Hook.) T. & G.	B							
Hieracium albiflorum Hook.			F		S			
Hieracium cynoglossoides Arv.-Touv.		Fp	F		S			
Madia glomerata Hook.	B							
Matricaria matricarioides (Less.) Porter	B	Fp	F			D		
Microseris nigrescens Henderson	B	Fp					Cr	
Microseris nutans (Gray) Schultz-Bip.	B				S			
Senecio integerrimus var. exaltatus (Nutt.) Cronq.	B	Fp	F		S			
Senecio serra Hook.			F					
Senecio triangularis var. triangularis Hook.				Fr				
Solidago canadensis var. salebrosa (Piper) Jones	B	Fp	F		S			
Solidago missouriensis var. missouriensis Nutt.			F		S			
Tanacetum vulgare L.		Fp						Ex
Taraxacum laevigatum (Willd.) DC.	B	Fp			S	D		Ex
Tetradymia canescens DC.					S			
Tragopogon dubius Scop.	B					D		Ex
Crassulaceae								
Sedum lanceolatum var. lanceolatum Torr.	B				S			
Sedum stenopetalum Pursh	B					D	Cr	
Cruciferae								
Alyssum alyssoides L.						D	Cr	Ex
Alyssum dessertorum Stapf.						D		Ex
Arabis glabra (L.) Bernh.	B						Cr	
Arabis holboelii var. retrofracta (Grah.) Rydb.	B				S			
Arabis nutallii Robins.	B							
Arabis sparsiflora var. sparsiflora Nutt.	B						Cr	
Barbarea orthoceras Ledeb.						D		
Berteroa incana (L.) DC.						D	Cr	Ex
Cardamine pensylvanica Muhl.		Fp				D	Cr	
Descurainia richardsonii var. sonnei (Robins.) Hitchc.						D	Cr	
Descurainia sophia (L.) Webb						D		Ex
Draba nemorosa L.						D		Ex
Draba stenoloba Ledeb.		Fp						

Cruciferae							
Erysimum asperum (Nutt.) DC.	B						
Lepidium perfoliatum L.					D		Ex
Lepidium ramosissimum Nels.	B						
Rorippa islandica var. *islandica* (Oed.) Borbas		Fp			D		
Sisymbrium altissimum L.					D	Cr	Ex
Thlaspi arvense L.					D		Ex
Thlaspi fendleri var. *glaucum* (Nels.) Hitchc.	B						
Cupressaceae							
Juniperus communis var. *montana* Ait.			F				
Cyperaceae							
Carex aurea Nutt.		Fp		Fr			
Carex concinnoides (L.) Bart.			F			Cr	
Carex douglasii Boott	B	Fp			D		
Carex filifolia Nutt.	B	Fp			S		
Carex geyeri Boott			F		S		
Carex lanuginosa Michx.		Fp					
Carex microptera Mack.	B				D		
Carex nebraskensis Dewey		Fp		Fr	D		
Carex pachystachya Cham.		Fp					
Carex petasata Dewey	B	Fp			S	D	Cr
Carex praegracilis Boott		Fp					
Carex praticola Rydb.		Fp				Cr	
Carex rossii Boott.	B				S		
Carex rostrata Stokes		Fp		Fr		D	
Eleocharis acicularis (L.) R. & S.						D	
Eleocharis palustris (L.) R. & S.		Fp				D	
Elaeagnaceae							
Shepherdia canadensis (L.) Nutt.			F				
Ericaceae							
Arctostaphylos uva-ursi (L.) Spreng.	B		F				
Chimaphila menziesii (R. Br.) Spreng.			F			Cr	
Chimaphila umbellata var. *occidentalis* (Rydb.) Blake			F				
Hypopitys monotropa Crantz.			F			Cr	
Menziesia ferruginea var. *glabella* (Gray) Peck			F				
Pyrola asarifolia var. *asarifolia* Michx.			F				
Pyrola chlorantha Sw.			F				

Ericaceae								
Pyrola secunda var. secunda L.			F				Cr	
Vaccinium caespitosum Michx.	B							
Vaccinium globulare Rydb.			F					
Vaccinium scoparium Leiberg			F					
Equisetaceae								
Equisetum arvense L.		Fp		Fr				
Gentianaceae								
Frasera albicaulis var. albicaulis Dougl.	B				S			
Gentiana affinis Griseb.	B	Fp						
Geraniaceae								
Erodium cicutarium (L.) L'Her.						D	Cr	Ex
Geranium viscosissimum var. viscosissimum F. & M.	B							
Gramineae								
Agropyron caninum ssp. majus (Vasey) Hitchc.	B	Fp					Cr	
Agropyron cristatum (L.) Gaertn.						D		Ex
Agropyron elongatum Host						D	Cr	Ex
Agropyron spicatum (Pursh) Scribn. & Smith	B		F		S			
Agrostis alba var. alba L.						D	Cr	Ex
Agrostis diegoensis Vasey	B							
Agrostis idahoensis Nash						D		
Agrostis scabra Willd.				Fr		D		
Alopecurus aequalis Sobol.						D		
Alopecurus alpinus Smith		Fp						
Alopecurus pratensis L.						D	Cr	Ex
Beckmannia syzigachne (Steud.) Fern.		Fp				D		
Bromus carinatus var. linearis Shear.		Fp				D	Cr	
Bromus inermis var. pumpellianus (Scribn.) Wagnon		Fp				D	Cr	
Bromus japonicus Thumb.						D	Cr	Ex
Bromus tectorum L.						D	Cr	Ex
Calamagrostis canadensis var. canadensis (Michx.) Beauv.		Fp						
Calamagrostis inexpansa var. inexpansa Gray		Fp						
Calamagrostis rubescens Buckl.			F					
Danthonia californica Boland.	B	Fp					Cr	
Danthonia intermedia Vasey	B	Fp			S			
Danthonia unispicata (Turb.) Munro	B				S	D	Cr	

Gramineae								
Deschampsia caespitosa var. *caespitosa* (L.) Beauv.		Fp				D		
Elymus cinereus var. *cinereus* Scribn. & Merr.	B							
Elymus glaucus var. *glaucus* Buckl.						D	Cr	
Festuca idahoensis Elmer.	B	Fp	F		S	D		
Festuca ovina var. *rydbergii* St. - Yves	B	Fp	F		S			
Festuca pratensis Huds.		Fp				D	Cr	Ex
Festuca scabrella Torr.	B							
Glyceria borealis (Nash) Batch.		Fp				D		
Glyceria grandis Wats.						D		
Hesperochloa kingii (Wats.) Rydb.	B							
Hierochloe odorata (L.) Beauv.		Fp						
Hordeum brachyantherum Nevski	B	Fp						
Hordeum jubatum L.						D		
Koeleria cristata Pers.	B	Fp			S			
Muhlenbergia richardsonis (Trin.) Rydb.						D		
Phleum pratense L.		Fp				D		Ex
Poa glaucifolia Scribn. & Will.	B						Cr	
Poa juncifolia Scribn.						D	Cr	
Poa palustris L.		Fp				D		Ex
Poa pratensis L.		Fp				D		Ex
Poa sandbergii Vasey	B							
Sitanion hystrix var. *brevifolium* (Smith) Hitchc.						D		
Stipa occidentalis var. *minor* (Vasey) Hitchc.	B	Fp			S			
Stipa richardsonii Link	B						Cr	
Trisetum wolfii Vasey		Fp					Cr	
Grossulariaceae								
Ribes cereum var. *inebrians* (Lindl.) Hitchc.			F					
Ribes hudsonianum var. *petiolare* (Dougl.) Jancz.				Fr				
Ribes inerme Rydb.		Fp						
Ribes lacustre (Pres.) Poir.				Fr				
Ribes viscosissimum var. *viscosissimum* Pursh			F					
Haloragaceae								
Myriophyllum spicatum var. *exalbescens* (Fern.) Jeps.		Fp						
Hydrophyllaceae								
Hesperochiron pumilus (Griseb.) Porter						D		

Hydrophyllaceae									
Hydrophyllum capitatum var. *capitatum* Dougl.						D			
Nemophila breviflora Gray		Fp					Cr		
Phacelia franklinii (R. Br.) Gray						D			
Phacelia heterophylla var. *heterophylla* Pursh		Fp			S	D			
Iridaceae									
Iris missouriensis Nutt.		Fp							
Sisyrinchium angustifolium Mill.	B								
Juncaceae									
Juncus balticus var. *montanus* Engelm.		Fp				D			
Juncus ensifolius var. *ensifolius* Witst.				Fr					
Juncus longistylis Torr.		Fp				D			
Luzula campestris var. *multiflora* (L.) DC.		Fp					Cr		
Labiatae									
Agastache urticifolia (Piper) Heller					S				
Mentha arvensis L.		Fp							
Leguminosae									
Astragalus canadensis var. *mortonii* (Nutt.) Wats.		Fp				D			
Astragalus miser var. *praeteritus* Barneby	B								En (Mt., Wy., Id.)
Lupinus argenteus var. *stenophyllus* (Rydb.) Davis			F						
Lupinus lepidus var. *utahensis* (Wats.) Hitchc.						D			
Lupinus polyphyllus var. *burkei* (Wats.) Hitchc.		Fp							
Lupinus sericeus var. *sericeus* Pursh	B		F		S				
Lupinus wyethii Wats.	B				S				
Melilotus alba Desr.						D		Ex	
Melilotus officinalis (L.) Lam.						D		Ex	
Trifolium longipes var. *reflexum* Nels.		Fp				D			
Trifolium repens L.		Fp				D		Ex	
Lentibulariaceae									
Utricularia vulgaris L.		Fp							
Liliaceae									
Allium geyeri var. *tenerum* Jones		Fp							
Calochortus nuttallii T. & G.	B	Fp			S				
Camassia quamash var. *quamash* (Pursh) Greene		Fp				D			
Fritillaria pudica (Pursh) Spreng.	B						Cr		

Liliaceae									
Smilacina stellata (L.) Desf.		Fp							
Veratrum viride Ait.				Fr					
Zigadenus venenosus var. gramineus (Rydb.) Walsh	B		F		S				
Loranthaceae									
Arceuthobium americanum Nutt.			F				Cr		
Nymphaeaceae									
Nuphar polysepalum Engelm.		Fp					Cr		
Onagraceae									
Epilobium angustifolium L.	B	Fp	F						
Epilobium glandulosum var. glandulosum Lehm.						D			
Epiloboum paniculatum var. paniculatum Nutt.					S	D	Cr		
Epilobium watsonii var. parishii (Trel.) Hitchc.		Fp		Fr		D	Cr		
Gayophytum ramoisissimum Nutt.						D			
Oenothera subacaulis (Pursh) Garrett.		Fp				D			
Orchidaceae									
Corallorhiza mertensiana Bong			F				Cr		
Corallorhiza trifida Chat.		Fp							
Goodyera oblongifolia Raf.			F						
Habenaria dilatata var. albiflora (Pursh) Hook.				Fr					
Spiranthes romanzoffiana var. romanzoffiana Cham.		Fp							
Orobanchaceae									
Orobanche corymbosa (Rydb.) Ferris.	B				S		Cr		
Orobanche fasciculata Nutt.	B				S		Cr		
Pinaceae									
Abies grandis (Dougl.) Lindl.						D	Cr		
Picea engelmannii Parry						D			
Pinus albicaulis Engelm.			F						
Pinus contorta Dougl.	B	Fp	F		S	D			
Pinus ponderosa Dougl.			F		S		Cr		
Pseudotsuga menziesii (Mirbel) Franco.			F		S				
Plantaginaceae									
Plantago major var. major L.						D		Ex	
Polemoniaceae									
Collomia linearis Nutt.		Fp				D			
Gilia aggregata var. aggregata (Pursh) Spreng.	B				S				

Polemoniaceae								
Linanthus septentrionalis Mason			F					
Microsteris gracilis var. *gracilis* (Hook.) Greene		Fp						
Phlox longifolia Nutt.	B				S			
Phlox muscoides Nutt.	B							
Polygonaceae								
Eriogonum strictum Benth					S			
Eriogonum umbellatum var. *subalpinum* (Greene) Jones	B	Fp			S			
Polygonum bistortoides Pursh	B	Fp						
Polygonum douglasii var. *douglasii* Greene						D		
Polygonum polygaloides Meisn.						D	Cr	
Rumex acetosella L.		Fp	F					
Rumex crispus L.	B	Fp			S			
Rumex paucifolius Nutt.		Fp				D		
Polypodiaceae								
Woodsia oregana D.C. Eat.	B						Cr	
Portulacaceae								
Claytonia lanceolata var. *lanceolata* Pursh			F		S			
Lewisia pygmaea var. *pygmaea* (Gray) Robins.	B							
Lewisia rediviva Pursh	B				S			
Montia chamissoi (Ledeb.) Robins & Fern.		Fp						
Montia linearis (Dougl.) Greene		Fp					Cr	
Potamogetonaceae								
Potamogeton berchtoldii Fieb.		Fp					Cr	
Potamogeton epihydrus Raf.		Fp						
Primulaceae								
Androsace filiformis Retz						D	Cr	
Dodecatheon conjugens var. *viscidum* (Piper) Mason	B				S			
Dodecatheon pulchellum var. *pulchellum* (Raf.) Merrill		Fp						
Ranunculaceae								
Actaea rubra (Ait.) Willd.				Fr				
Delphinium bicolor Nutt.	B							
Delphinium depauperatum Nutt.		Fp						
Delphinium occidentale Wats.	B	Fp						
Myosurus aristatus Benth.						D	Cr	
Ranunculus flammula L.		Fp					Cr	

Ranunculaceae									
Ranunculus glaberrimus var. ellipticus Greene	B	Fp							
Ranunculus gmelinii var. hookeri (G. Don) Benson		Fp							
Ranunculus macounii var. macounii BRitt.		Fp					Cr		
Ranunculus subrigidus Drew		Fp					Cr		
Ranunculus uncinatus var. uncinatus D. Don		Fp					Cr		
Thalictrum occidentale Gray		Fp		Fr					
Rosaceae									
Amelanchier alnifolia var. alnifolia Nutt.	B				S				
Fragaria virginiana var. glauca Wats.		Fp	F			D			
Geum macrophyllum var. macrophyllum Willd.				Fr					
Geum triflorum var. ciliatum Fassett	B	Fp	F		S				
Ivesia gordonii (Hook.) T. & G.	B								
Potentilla diversifolia var. diversifolia Lehm.	B	Fp							
Potentilla fruticosa L.	B	Fp							
Potentilla glandulosa var. intermedia (Rydb.) Hitchc.	B								
Potentilla gracilis var. elmeri (Rydb.) Jeps.	B	Fp			S				
Potentilla gracilis var. flabelliformis (Lehm.) Nutt.	B								
Potentilla gracilis var. permollis (Rydb.) Hitchc.	B	Fp			S				
Potentilla norvegica L.						D			
Prunus virginiana var. melanocarpa (Nels.) Sarg.			F		S				
Rosa woodsii var. woodsii Lindl.	B				S	D			
Spiraea betulifolia Pall.			F						
Rubiaceae									
Galium bifolium Wats.		Fp		Fr			Cr		
Galium boreale L.	B								
Galium triflorum Michx.				Fr					
Salicaceae									
Populus tremuloides Michx.			F		S	D			
Populus trichocarpa T. & G.		Fp				D			
Salix drummondiana Barratt		Fp				D			
Salix geyeriana var. geyeriana Anderss.		Fp			S	D			
Salix lasiandra var. caudata (Nutt.) Sudw.		Fp					Cr		
Salix rigida var. mackenzieana (Hook.) Cronq.	B	Fp				D			

Saxifragaceae									
Saxifraga arguta D. Don				Fr			Cr		
Saxifraga oregana var. montanensis (Small) Hitchc.				Fr					
Saxifraga oregana var. subapetala (E. Nels.) Hitchc.		Fp							En (Mt., Wy.)
Scrophulariaceae									
Castilleja cusickii Greenm	B				S	D	Cr		
Castilleja miniata var. miniata Dougl.		Fp		Fr					
Collinsia parviflora Lindl.	B	Fp			S	D			
Mimulus guttatus var. guttatus DC.				Fr					
Mimulus moschatus var. moschatus Dougl.				Fr			Cr		
Orthocarpus tenuifolius (Pursh) Benth.	B	Fp			S	D			
Pedicularis contorta var. contorta Benth.	B	Fp			S	D			
Pedicularis groenlandica Retz.		Fp				D			
Pedicularis parryi Gray	B	Fp			S	D			
Penstemon albertinus Greene	B	Fp							
Penstemon lemhiensis (Keck) Keck & Cronq.	B				S				En (Mt., Id.)
Penstemon procerus var. procerus Dougl.	B	Fp							
Penstemon rydbergii A. Nels.		Fp							
Veronica americana Schwein.		Fp				D			
Veronica peregrina var. xalapensis (H.B.K.) St. John & Warren						D			
Veronica serpyllifolia var. humifusa (Dickson) Vahl		Fp							
Selaginellaceae									
Selaginella densa var. scopulorum (Maxon) Tryon	B						Cr		
Solanaceae									
Hyoscyamus niger L.						D		Ex	
Sparganiaceae									
Sparganium angustifolium Michx.		Fp							
Umbelliferae									
Angelica arguta Nutt.				Fr					
Heracleum lanatum Michx.				Fr					
Ligusticum tenuifolium Wats.		Fp		Fr					
Lomatium cous (Wats.) Coult. & Rose						D			
Lomatium macrocarpum (Nutt.) Coult. & Rose	B						Cr		
Lomatium triternatum ssp. platycarpum (Torr.) Cronq.	B		F		S				
Perideridia gairdneri (H. & A.) Math.		Fp				D			

Valerianaceae									
Valeriana dioica L.		Fp							
Valeriana sitchensis Bong.				Fr					
Violaceae									
Viola adunca var. *adunca* Sm.	B	Fp	F	Fr	S	D			
Viola nuttallii var. *major* Hook.	B		F		S				
Viola palustris L.		Fp		Fr			Cr		

APPENDIX B

Permanent Plot Localities and Data

The location and position of the permanent plots used in this study are described below. To relocate these plots refer to the 1972 forest Service aerial photograph with its accompanying overlay (Plate 19). When using a compass to locate these plots, a declination of 19 degrees east is required.

Concerning the plots themselves, the lower right pipe is always the starting point. The first line connects the lower right and lower left pipe with all of the other lines numbered consecutively in a clockwise manner.

The word "Vegetation" found at the end of some of the lists of species in the half-meter-squares refers to vascular plants which could not be identified due to a lack of reproductive structures.

Plot 1

From a large multiple-topped Pseudotsuga menziesii (Douglas fir) proceed 16 m at 280 degrees to the lower right corner of the plot, marked 1/LR. From this point the upper left pipe is a distance of 5 m at 218 degrees and the lower left pipe is a distance of 14.1 m at 128 degrees.

Five-Meter and Variable Plots

Species Name	D.B.H.	Age	Comments
Pinus contorta	7.3	92	Damaged top
Pinus contorta	8.8	86	
Pinus contorta	2.5	40	
Pseudotsuga menziesii	0.1	24	
Pinus contorta	9.6	87	
Pseudotsuga menziesii	0.1	23	
Pinus contorta	9.5	81	
Pseudotsuga menziesii	2.0	34	
Pinus contorta	1.5	28	
Pinus contorta	3.9	64	Dead top

Half-Meter-Square Plots

These plots were placed at 4.0 - 4.5, 8.0 - 8.5, and 12.0 - 12.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	4	8	12	1	3	4	8	12	1	3
Arnica cordifolia	20	15	3	25	40	7	1	40		
Anaphalis margaritacea				5						
Antennaria microphylla			1	2						
Berberis repens				4	3		10	3		
Carex concinnoides									7	
Carex geyeri									3	
Calamagrostis rubescens	80	70	90	90	90	70	40	80	80	40
Epilobium angustifolium									3	
Hieracium cynoglossoides			2							
Lupinus argenteus					3	4				
Pseudotsuga menziesii		2	1							
Solidago missouriensis			4			3				
Viola adunca	2	2	3	4	2	10			4	
Litter	10	15	5			5	50	5	10	70

Plot 2

From an old well in the ravine bottom proceed 81 m at 162 degrees. From a Pinus contorta (lodge pole pine) which stands alone in the ravine bottom and is surrounded by Salix spp. and Ribes spp. proceed 37.2 m at 254 degrees to the upper right corner pipe marked 2/UR. From here proceed 5 m at 162 degrees to the lower right pipe which is marked 2/LR. From this point proceed 5.9 m at 72 degrees to the lower left pipe.

Five-Meter and Variable Plots

Species Name	D.B.H.	Age	Comments
Pinus contorta	6.3	114	Dead top
Pinus contorta	2.3	36	
Pinus contorta	6.7	56	
Pinus albicaulis	0.2	31	
Pinus contorta	1.7	37	
Pinus contorta	2.1	35	
Pinus contorta	4.8	34	
Pinus contorta	2.2	38	
Pinus contorta	0.1	27	Badly chewed
Pinus contorta	1.2	27	

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Arnica cordifolia		2	2				4	2	1	3
Carex concinnoides							5			
Calamagrostis rubescens	20	50	40	50	30	5	30	20	20	30
Lupinus argenteus	4	5	2	10		2		10	5	2
Pyrola secunda										2
Spiraea betulifolia	3				3		5	4		
Vaccinium scoparium	80	20	60	50	70	2	20	60	70	60
Viola adunca				1						
Litter		40		10	5	95	50	10	5	10

Plot 3

From a Pseudotsuga menziesii (Douglas fir) with a small Douglas fir to the north, proceed 20.2 m at 293 degrees to the lower right pipe which is marked 3/LR. From here proceed 5 m at 293 degrees to the upper right pipe and 5 m at 203 degrees to the lower left pipe.

Five-Meter-SSquare Plot

The Artemisia tridentata community contained 26 individuals possessing an average crown area of 13.19 square dm. with a standard deviation of 17.36. The total area covered by this species was 342.9 square dm. or 13.7 percent of the five meter square.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium	5		7	7	3	3	5			
Agropyron spicatum	4	10	4	10	3	10	2	15	7	5
Amelanchier alnifolia						5				
Antennaria microphylla	4	2		5	1		7		3	7
Arenaria congesta	5	7	3	10	5	3	3	3	3	5
Artemisia tridentata		3	30		2		7		7	
Aster foliaceus						4		2		
Aster stenomeres		2				3	7	10		5
Balsamorhiza sagittata	10	20	2	10		15		30	10	10
Castilleja cusickii			3		3				3	
Carex geyeri										10
Calochortus nuttallii	5	5		2			1	2	3	2
Carex rossii	3		4	3	3				10	4
Crepis acuminata	2	2	12	3	3	2		3		2
Eriogonum umbellatum		1	3							
Festuca idahoensis	15	15	20	25	10	20	40	20	7	7
Frasera albicaulis		3	2	3	2		4	2	2	2
Gilia aggregata	4	3	2	2	2	3		2	1	2
Hieracium cynoglossoides	3	7	5	7	20	15		2		
Koeleria cristata	3	3	2		3	7		10	3	3
Lithospermum ruderale		2	3	7				4		3
Lomatium triternatum	2								2	
Lupinus wyethii	4			4	5		2	4		
Orthocarpus tenuifolius	3	3		1	1			1	2	
Pedicularis contorta		15								
Phlox longifolia			4						1	
Senecio integerrimus	2			2	3	3	1	2	1	
Solidago canadensis	7		7		5				2	
Zigadenus venenosus	3	2	3	2			5	3	2	2
Bare ground	15	20	15	5	40	7	7		15	10
Lichen	3				5				10	10
Litter		4		10		10	20	5		

Plot 4

On the lower portion of the steppe from a Pinus contorta (lodge pole pine) that is below the trail proceed 10 m at 133 degrees to the lower right pipe marked 4/LR. From here proceed 5 m at 290 degrees to the upper right pipe and 5 m at 200 degrees to the lower left pipe.

Five-Meter-Square Plot

The Artemisia tridentata (sagebrush) community contained 40 individuals possess an average crown area of 30.3 square dm. with a standard deviation of 38.34. The total area covered by this species was 1210.9 square dm. or 48.4 percent of the Five-Meter-Square Plot.

The Amelanchier alnifolia (serviceberry) community contained five plants 0.5 m or taller possessing an average crown area of 13.37 square dm. with a standard deviation of 6.5. The total area covered by this species was 66.8 dm. or 2.7 percent of the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at .5 - 1, 2.5 - 3, and 4 - 4.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium			7						4	
Agropyron spicatum	10	30	20	5	10		2	30	3	
Amelanchier alnifolia				7	50		2			
Antennaria microphylla										5
Arenaria congesta	15	4			1	3	4	7	7	5
Artemisia tridentata	20	5	30	60	10	60	70	20	90	50
Aster stenomeres		2				3		3	4	7
Castilleja cusickii	5	2			5	2	5	3		
Calochortus nuttallii		3		4						
Carex filifolia	20			40			5	4		
Carex petasata										2
Crepis acuminata							5	2		
Erigeron speciosus						5				
Eriogonum umbellatum	15	15	20	2	1	7			3	
Festuca idahoensis	10	10	10			25	30	5	10	20
Frasera albicaulis	5	4	15			10	5	5	10	3
Hieracium cynoglossides			5						5	
Koeleria cristata	5	15				5	3	2		5
Lithospermum ruderale		4					20	10	5	5
Lupinus wyethii	4	1	30				5		3	
Orthocarpus tenuifolius			2				1			1
Senecio integerrimus	3	1	3		2		2	3		3
Taraxacum laevigatum						2				
Viola adunca			1							
Bare ground	15	5								5
Litter	5	10	5	10	30					4

Plot 5

From two Salix spp. (willows) by the Indian village on the floodplain proceed 14 m at 137 degrees and 12 m at 317 degrees to the lower right pipe marked 5/LR. From here proceed 5 m at 317 degrees to the upper right pipe and 5 m at 227 degrees to the lower left pipe.

Five-Meter-Square Plot

There were no woody species in the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m. along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Allium geyeri							2			
Arnica chamissonis	3						3	5		
Aster chilensis	3	2	4		5	3	3	5	10	10
Carex douglasii		3	2		3		2	2		
Carex nebraskensis	2		10						15	
Deschampsia caespitosa			4							
Juncus balticus	80	50	50	80	70	80	70	50	80	60
Montia linearis					1					
Phleum pratense									3	
Polygonum bistortoides		1								
Poa palustris	7	15	20	10	5	20	10	15	25	10
Poa pratensis	5	20	15	20	30	20	20	20	5	20
Stellaria longipes	3									
Taraxacum laevigatum	15	25	10	10	15	7		7	4	7
Trifolium longipes	2									
Trifolium repens					5		2			
Moss								5		

Plot 6

On the floodplain by the parking lot from the point of a line of Salix spp. (willows) proceed 21 m at 273 degrees and from the north willow of a three willow triangle proceed 15.2 m at 112 degrees. This is the lower right pipe marked 6/LR. From here proceed 5 m at 340 degrees to the upper right pipe and 5 m at 250 degrees to the lower left pipe.

Five-Meter-Square Plot

There were no woody plants above 0.5 m in height in the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium	10	10	10	15	20	7	15	10	30	15
Agoseris glauca	7	10	3	5	3	30	20	3	3	2
Antennaria microphylla		2	1						2	
Camassia quamash	4	5	2	2			1	5	3	5
Carex douglasii		15	2	1	3	2	7		3	15
Cerastium arvense					1	5				3
Danthonia intermedia	4	2		2	2					2
Equisetum arvense									2	
Fragaria virginiana							3	15		
Gentiana affinis	4				2	3	3			
Juncus balticus	5				1				20	1
Perideridia gairdneri			7							
Penstemon procerus	1	5	7					2		7
Phleum pratense	10	20	20		50	7	20	7	7	5
Polygonum bistortoides	2	2	3		7	2		3	3	2
Potentilla diversifolia	10	7			10	5	4	5	15	10
Potentilla fruticosa			15		10	20	5	20		50
Poa pratensis	50	30	40	40		30	15	20	15	20
Solidago canadensis								15		
Stellaria longipes								1		
Taraxacum laevigatum	2			3		3	7		2	7
Trifolium longipes								1		
Trifolium repens	2	20								
Viola adunca	3				3				2	

Plot 7

On the bench near the "T" at the end of the sewer drain field proceed 25.4 m at 340 degrees to the lower right pipe marked 7/LR. From here preceed 5 m at 130 degrees to the upper right pipe and 5 m at 40 degrees to the lower left pipe.

Five-Meter-Square Plot

The Artemisia tridentata (sagebrush) community contained 39 individuals possessing an average crown area of 22.14 square dm. with a standard deviation of 54.15. The total are covered by this species was 863.6 square m or 34.5 percent of the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium	15	7	5	10	5			7	5	
Agropyron spicatum		3		10					20	5
Antennaria microphylla		3	7	5	2	3	7	10		2
Arenaria congesta	15	15		7	7	40	10	20	15	20
Arnica fulgens		10	2	4		5			15	10
Arabis nuttallii	3								3	
Artemisia tridentata	7		1			20	4	80	1	60
Aster stenomeres					1		1			
Castilleja cusickii						5	4			4
Carex filifolia						5			2	10
Carex petasata	7	7	3			15		3		3
Crepis acuminata							1			
Eriogonum umbellatum	7	5	6	4		4	5	3	4	
Festuca idahoensis	7	30	50	60	80		20	2		7
Geum trifolium				2	40	30				
Haplopappus lanuginosus	5	5					3			
Koeleria cristata	3	3	3	7	3	3		2		
Lomatium triternatum			2			2		2		
Lupinus wyethii	2	5				3			7	7
Mertensia viridis		1	3	1	1			3	2	
Microseris nigrescens		3					7			
Orthocarpus tenuifolius	10	15		2	2				5	
Pedicularis contorta	1				7	3		5		
Phlox longifolia			4	2						
Sedum lanceolatum	1	2	2	3	5	3	1			
Stipa occidentalis	1				3		3	1	2	
Viola adunca	1								1	1
Zigadenus venenosus	10	5	4	5	3	15	3		2	3
Bare ground						2				7
Lichen	5	3	3	2		2	10	5		
Litter		3	2	2	1			10	3	5
Moss	3	1	4	1			3	30		

Plot 8

Plot eight is located on the bench near the sewage plant and the gulch. There was no permanent object from which to measure, but this plot can easily be found. From the lower right pipe go 5 m at 330 degrees to the upper right pipe and 5 m at 240 degrees to the lower left pipe.

Five-Meter-Square Plot

There were no woody plants in the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m. along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m. on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium	10	15	15	10	7	3		5	1	1
Agropyron spicatum				5		5		5	15	7
Antennaria microphylla	30	20	20		20	20	20	15	20	20
Arenaria congesta	10	15	10	15		15	10	10	15	10
Arnica fulgens	2	5	7	10	7	10	3			5
Aster stenomeres								1		
Castilleja cusickii		4	3		3		3			3
Carex rossii					5	1				2
Crepis acuminata	6	5	10	10	10		2	2	5	2
Dodecatheon conjugens	5					1		1		2
Erigeron corymbosus							5	5	7	3
Eriogonum umbellatum		3	7	5	5		10	5	4	7
Festuca idahoensis	20	20	15	50	20	10	30	30	20	30
Frasera albicaulis	3	1	10			7		10		
Geum triflorum	18				10	1	20	15		15
Koeleria cristata	5	1	3		4	1		1	2	
Lomatium triternatum		1			1	3	3			
Lupinus wyethii				15	3					
Mertensia viridis	2	3	2	5						
Microseris nigrescens	2								5	5
Orthocarpus tenuifolius						1				
Phlox longifolia	1		2		3		1			3
Sedum lanceolatum	2	3	3	2	1	1	7	1	7	2
Senecio integerrimus		1			2					
Stipa occidentalis	1					5				
Zigadenus venenosus	4	2	3	5	3	4				
Bare ground							4			
Lichen	7	5	5	3	1	5	2		4	
Moss	7	1	5	3	5	5	4		15	

Plot 9

Plot nine is on the floodplain on the south side of the parking lot near a tight group of living Pinus contorta (lodge pole pine). From a dead P. contorta that is the most north-westerly of the group proceed 6 m at 170 degrees. From a P. contorta that is the most north-easterly of the group proceed 4.3 m at 120 degrees to the lower right pipe to marked 9/LR. From here proceed 5 m at 300 degrees to the upper right pipe and proceed 11 m at 30 degrees to the lower left pipe.

Five-Meter and Variable Plots

Species Name	Cover in square meters
Salix geyeriana	10.5
Salix geyeriana	5.0
Salix geyeriana	3.7
Salix geyeriana	2.0
Salix drummondiana	2.1
Salix geyeriana	6.0
Salix geyeriana	4.0
Salix geyeriana	17.5
Salix drummondiana	6.7
Salix geyeriana	1.2

The total area covered by the willows is 77.7 square meters or 141 percent of the five-meter and varialbe plots. The reason that this is over 100 percent is due to overlapping canopies.

Half-Meter-Square Plots

These plots were placed at 3 - 3.5, 6 - 6.5, and 9 - 9.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	3	6	9	1	3	3	6	9	1	3
Carex nebraskensis		5				20				80
Carex petasata				3						
Epilobium watsonii						1		5		
Equisetum arvense		1		3		1		7		
Galium bifolium				3	4	2	2		3	1
Ligusticum tenuifolium	20	20	15	5				3		
Poa palustris	60	40	70	80	80	10	5	15	80	15
Smilacina stellata			1	5				4		
Stellaria longipes					2			4		
Viola palustris		3			1				1	
Litter	40	50	30	10		80	95	70	20	20
Moss		10			20	10		15		
Vegetation	5	2	3	4						

Plot 10

Plot ten is located on the floodplain on the north side of the parking lot. From a *Salix* sp. proceed 3.1 m at 176 degrees and from another *Salix* sp. proceed 9 m at 40 degrees. This is the lower right pipe which is marked 10/LR. From here proceed 5 m at 142 degrees to the upper right pipe and 5 m at 52 degrees to the lower left pipe.

Five-Meter-Square Plot

No woody plants were found in the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m on the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Alopecurus alpinus						30	20			15
Arnica chamissonis			7	7		3		5		5
Carex nebraskensis	20	20	20	10				10	5	
Carex rostrata	80	80	80	40	90	80	80	90	90	85
Galium bifolium	2					3			40	7
Mentha arvensis			5	5						
Litter				40	10					

Plot 11

Plot eleven can be found near the Indian village on the floodplain. From a stake driven on July 6 1981 that located a sharpshooters shell proceed 2.08 m at 305 degrees to the lower right pipe marked 11/LR. From here proceed 5 m at 274 degrees to the upper right pipe and 5 m at 184 degrees to the lower left pipe.

Five-Meter-Square Plot

No woody plants were found in the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m along the sides (right to left pipes) amd 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium	30	15	10	15	20	15	20		7	10
Agropyron caninum					5	7	3	4	5	3
Antennaria microphylla	15	70	15	15	10	30	60	10	30	5
Camassia quamash		2	4	5	2	3	4	3	3	3
Carex aurea	2									
Carex microptera	3			3		4				
Carex praticola	3	5	10	10	3	10	10	4	15	7
Crepis runcinata		3	3							
Danthonia intermedia	10	4		10	5	10	25	15	30	5
Deschampsia caespitosa	10	10	10	10	15	10	7	5	5	10
Fragaria virginiana		3	15	1		10				5
Galium boreale	7	5	7	7			5	3	10	3
Hieracium cynoglossoides					4		4			
Juncus balticus	5		7		5	3			4	
Koeleria cristata	3	2								4
Luzula campestris			2							
Microseris nigrescens	7		7	3		25	15	7	7	20
Penstemon procerus						3	7			3
Polygonum bistortoides		10		4	7	7	4	5		2
Potentilla diversifolia						15	10	7	20	10
Potentilla gracilis	10	10	10		15	5		7	5	5
Poa pratensis		10	5	7	30	30	10	50	20	20
Rumex paucifolius							3	3	4	
Senecio integerrimus	3	10	15	15						
Stellaria longipes	3	3	10	5	7	5	4		5	7
Stipa occidentalis		3		4			5			
Taraxacum laevigatum	15	20	5	10	7	10	10	7	7	10
Trifolium longipes	20		3	4	30	20	15	10	20	30
Trifolium repens								2		
Trisetum wolfii	5	5	3	7	10					

Plot 12

Plot thirteen is located on the floodplain by the trail to the Indian village. No permanent object was available. To the west of the path proceed 15 m and from a small bog in the middle of a field proceed east 30 m From the lower right pipe the Populus tremuloides (quaking aspen) patch on the southern portion of the steppe is 292 degrees, the twin fir trees are 350 degrees, and the visitor center is 174 degrees. From the lower right pipe proceed 5 m at 284 degrees to the upper right pipe and 5 m at 194 degrees to the lower right pipe.

Five-Meter-Square Plot

No woody plants were found in the five-meter-square plot.

Half-Meter-Square PloTs

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m along the sides (right to left pipes) and at 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pipes).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium	5	15	3	4	7	5	10	15		4
Antennaria microphylla			4	1			1			
Arnica fulgens	4	3	4	7	5	7	7	7	7	7
Camassia quamash	5	3		3	3	3			3	3
Calochortus nuttallii			2		3	1		3	3	2
Carex petasata						2		5		
Cerastium arvense	7									
Danthonia californica	5									
Danthonia intermedia	5	4	5	25	7	3	30	3	5	3
Erigeron corymbosus	15									
Festuca idahoensis	60	70	70	50	50	70	60	60	60	70
Hieracium cynoglossoides		10	3	3		4	2		5	2
Juncus balticus		2			5		5	2	7	
Juncus longistylis									3	
Koeleria cristata		3					3	4	3	4
Microseris nigrescens	3	3	4	5	20		2	5		
Pedicularis parryi							1			
Polygonum bistortoides	3	3	4	3	3	3	2	2	3	3
Potentilla diversifolia	2	4	10	2	5		3	2	2	3
Potentilla gracilis		4	1	2	5	5		7	3	4
Spiranthes romanzoffiana			1							
Taraxacum laevigatum						2				
Trifolium longipes	2			5		2	2		3	1
Litter									5	5
Moss						7		5		

Plot 13

Plot fourteen is located on floodplain on an island in a conspicuous community of *Artemisia tridentata* (sagebrush) along an old fence line. No plastic pipe was used here but the iron pins were driven into the ground. Wood fence rails were laid close to the east, south, and west lines. The northeast pin is the lower right plot marker. From here proceed 5 m at 252 degrees to the upper right pin and 5 m at 126 degrees to the lower left pin.

Five-Meter-Square Plot

The sagebrush community contained 30 individuals possessing an average crown area of 14.9 square dm. with a standard deviation of 30.0. The total area covered by the species was 447.3 square dm. or 18 percent of the five-meter-square plot.

Half-Meter-Square Plots

These plots were placed at 0.5 - 1.0, 2.5 - 3.0, and 4.0 - 4.5 m along the sides (right to left pins) and 1.0 - 1.5 and 3.0 - 3.5 m on the ends of the plot (lower to upper pins).

Species Name	Percent Cover									
	Line 1			Line 2		Line 3			Line 4	
	.5	2.5	4	1	3	.5	2.5	4	1	3
Achillea millefolium				5			2			4
Agropyron spicatum	20	5			3				10	10
Antennaria microphylla	10				2	3			40	
Arenaria congesta	3	10	20	20	10		5			
Arnica fulgens	3	4	3			7			2	
Artemisia tridentata		1	7	20		1			1	5
Calochortus nuttallii							2			
Carex filifolia				25	7	3	30		5	15
Carex petasata				20						
Carex rossii	5	4	5		10				30	7
Danthonia intermedia	5		5		7		10			
Erigeron corymbosus							4			3
Eriogonum umbellatum	15	20	30	40	10	7	20		1	50
Festuca idahoensis	30	20	15	5	30	20	10		7	15
Geum triflorum				5		10			3	
Koeleria cristata	3	4	7		5	5	5		2	2
Orthocarpus tenuifolius		2	5		3	1	3		10	
Penstemon procerus		2								
Penstemon diversifolia		7								
Potentilla gracilis	7	3	15		2		10			15
Stipa occidentalis				7						
Viola adunca		1	3	3	4		4			
Bare ground		15				20				
Litter	5		4		10		10		5	5
Moss	7		7			10	2			

APPENDIX C

Summation of Permanent Plot Data

The following summation of cover data for each species was derived from each plot in Appendix B. A cluster analysis was then obtained from this information.

No effort was made to separate species of mosses. However, two were observed, one group preferred aquatic habitats while the other preferred open, sunny, xeric habitats.

Species Name	Plot Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Berberidaceae													
Berberis repens	2.0												
Boraginaceae													
Lithospermum ruderale			1.9	4.8									
Mertensia viridis							1.1	1.2					
Caryophyllaceae													
Arenaria congesta			7.7	4.6			14.9	11.0					7.6
Cerastium arvense									0.9			0.7	
Stellaria longipes					0.3	0.1			0.2		4.9		
Compositae													
Achillea millefolium			3.0	1.1		14.2	5.4	6.7			14.2	6.8	1.3
Agoseris glauca						8.6							
Anaphalis margaritacea	0.5												
Antennaria microphylla	0.3		2.9	0.5		0.5	3.9	18.5			26.0	0.6	6.1
Arnica chamissonis					1.1					2.7			
Arnica cordifolia	15.1	1.4											
Arnica fulgens							4.6	4.9				5.8	2.1
Artemisia tridentata			4.9	41.5			17.3						3.9
Aster chilensis					4.5								
Aster foliaceus			0.6										
Aster stenomers			2.7	1.9			0.2	0.1					
Balsamorhiza sagittata			10.7										
Crepis acuminata			2.9	0.7			0.1	5.2					
Crepis runcinata												0.6	
Erigeron corymbosus								2.0				1.5	0.8
Erigeron speciosus				0.5									
Haplopappus lanuginosus							1.3						
Hieracium cynoglossoides	0.2		6.4	1.0							0.8	2.9	
Microseris nigrescens							1.0	1.2			9.1	4.2	2.9
Senecio intergerrimus			1.4	1.9				0.3			4.3		
Solidago canadensis			2.1			1.5							
Solidago missourensis	0.7												
Taraxacum laevigatum				0.2	10.0	2.4					10.1	0.2	

Species Name	Plot Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Crassulaceae													
Sedum lanceolatum							1.7	2.9					
Cruciferae													
Arabis nuttallii							0.6						
Cyperaceae													
Carex aurea												0.2	
Carex concinnoides	0.7	0.5											
Carex douglasii					1.2	4.8							
Carex filifolia				6.9			1.7						9.4
Carex geveri	0.3		0.1										
Carex microperta											1.0		
Carex nebraskensis					2.7				10.5	8.5			
Carex petasata				0.2			3.8		0.3			0.7	2.2
Carex praticola											7.7		
Carex rossii			2.7					0.8					6.8
Carex rostrata										79.5			
Ericaceae													
Pyrola secunda		0.2											
Vaccinium scoparium		49.2											
Equisetaceae													
Equisetum arvense						0.2			1.2				
Gentianaceae													
Frasera albicaulis			2.6	5.7				3.1					
Gentiana affinis						1.2							
Gramineae													
Agropyron caninum											2.7		
Agropyron spicatum			7.0	11.0			3.8	3.7					5.6
Alopecurus alpinus										1.5			
Calamagrostis rubescens	75.0	29.2											
Danthonia californica												0.5	
Danthonia intermedia						1.2					11.4	9.0	3.0
Deschampsia caespitosa					0.4						9.5		

Species Name	Plot Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Festuca idahoensis			17.9	12.0			25.6	24.5				62.0	16.9
Koeleria cristata			4.0	3.5			2.5	1.7			0.9	1.7	3.7
Phleum pratense					0.3	14.6							
Poa palustris					13.7				45.5				
Poa pratensis					17.5	2.6					17.8		
Stipa occidentalis							1.0	0.6			1.2		0.8
Trisetum wolfii											3.0		
Juncaceae													
Juncus balticus					67.0	2.7					2.4	2.1	
Juncus longistylis												0.3	
Luzula campestris											0.2		
Labiatae													
Mentha arvensis										1.0			
Leguminosae													
Lupinus argenteus	0.7	4.0											
Lupinus wyethii			1.9	4.3			2.4	1.8					
Trifolium longipes					0.2	6.2					15.2	1.5	
Trifolium repens					0.5	2.2					0.2		
Liliaceae													
Allium geyeri					0.2								
Calochortus nuttallii			2.0	0.7								1.4	0.2
Camassia quamash						2.7					2.9	2.9	
Smilacina stellata									1.0				
Zigadenus venenosus			2.9				5.0	2.1					
Onagraceae													
Epilobium angustifolium	0.3												
Epilobium watsonii									0.6				
Orchidaceae													
Spiranthes romanzoffiana												0.1	
Pinaceae													
Pseudotsuga menziesii	0.3												

Species Name	Plot Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Polemoniaceae													
Gilia aggregata			2.1										
Phlox longifolia			0.5				0.6	1.0					
Polygonaceae													
Eriogonum umbellatum			0.4	6.3			3.8	4.6					21.4
Polygonum bistortoides					0.1	2.9					3.7	3.5	
Rumex paucifolius											1.0		
Portulacaceae													
Montia linearis					0.1								
Primulaceae													
Dodecatheon conjugens								0.9					
Rosaceae													
Amelanchier alnifolia			0.5	5.7									
Fragaria virginiana						1.8					3.4		
Geum triflorum							7.2	7.9					2.0
Potentilla diversifolia						6.6					6.2	3.9	0.8
Potentilla fruticosa						12.7							
Potentilla gracilis											7.1	3.1	5.8
Spiraea betulifolia		1.5											
Rubiaceae													
Galium bifolium									1.5	5.2			
Galium boreale											4.7		
Scrophulariaceae													
Castilleja cusickii			0.9	2.2			1.3	1.6					
Orthocarpus tenuifolius			1.1	0.4			3.4	0.1					2.7
Pedicularis contorta			1.5				1.6						
Pedicularis parryi												0.1	
Penstemon procerus						2.2					1.3		0.2
Umbelliferae													
Ligusticum tenuifolium									6.3				
Lomatium triternatum			0.4				0.6	0.8					
Perideridia gairdneri						0.7							

Species Name	Plot Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Violaceae													
Viola adunca	2.7	0.1		0.1		0.8	0.3						1.7
Viola palustris									0.5				
Litter	17.0	22.5	4.9	6.4			2.6		41.5			1.0	4.3
Bare ground			13.2	2.5			0.9	0.4					3.9
Lichen		2.8					3.0	3.2					
Moss, wet					0.5				6.5				
Moss, dry							4.2	4.5				1.2	
Vegetation								0.2	1.4				

APPENDIX D

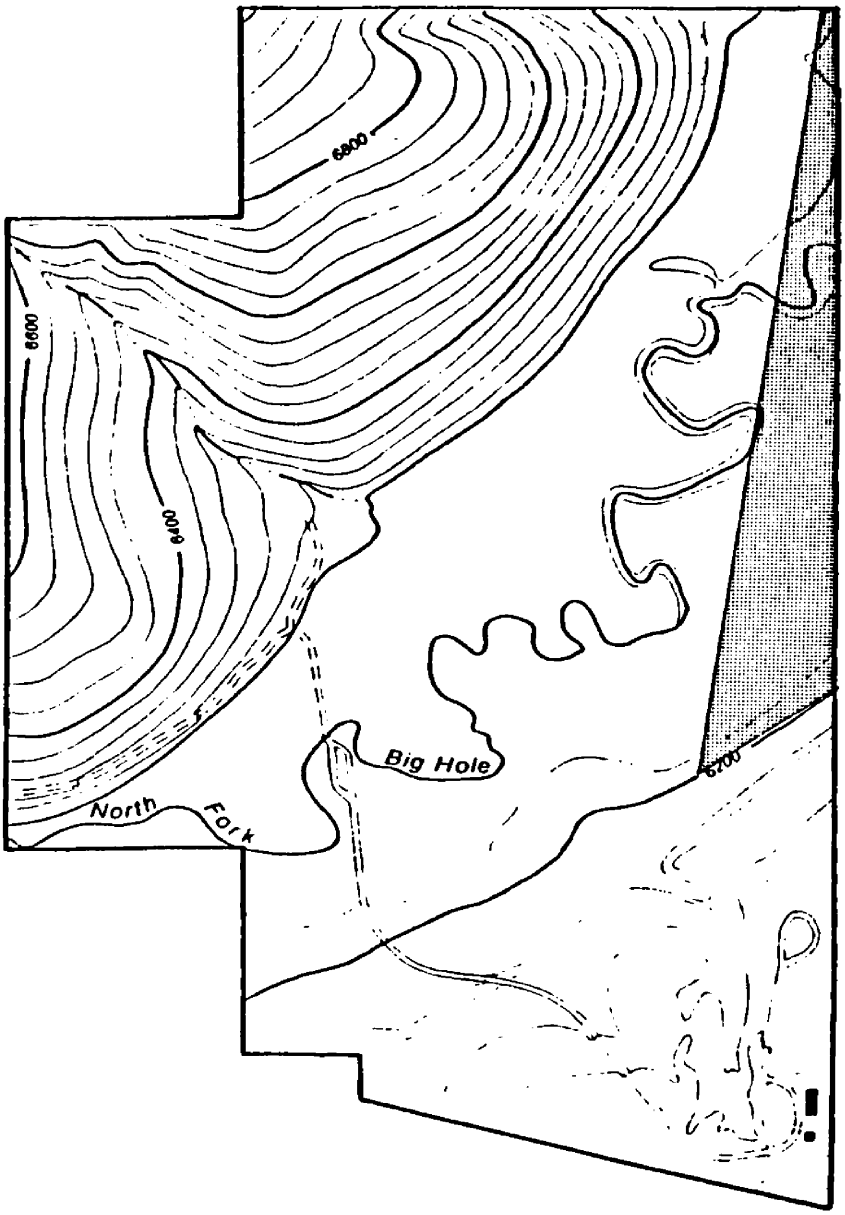
There are 15 archival photographs and one drawing in this appendix. The archival illustration is always at the top of the plate. Associated with each plate on the facing page is a map which shows the area seen in the lower photograph. This area is delineated by dark shading.

PLATE 1

View of the northern portion of the bench and floodpain looking northeast.

A. Archival photograph of the area in 1925. (Washington State University Library Archives, U.S.F.S. # 203599, taken by K. Swan).

B. Same area in 1981. (Photographed by J. Pierce).



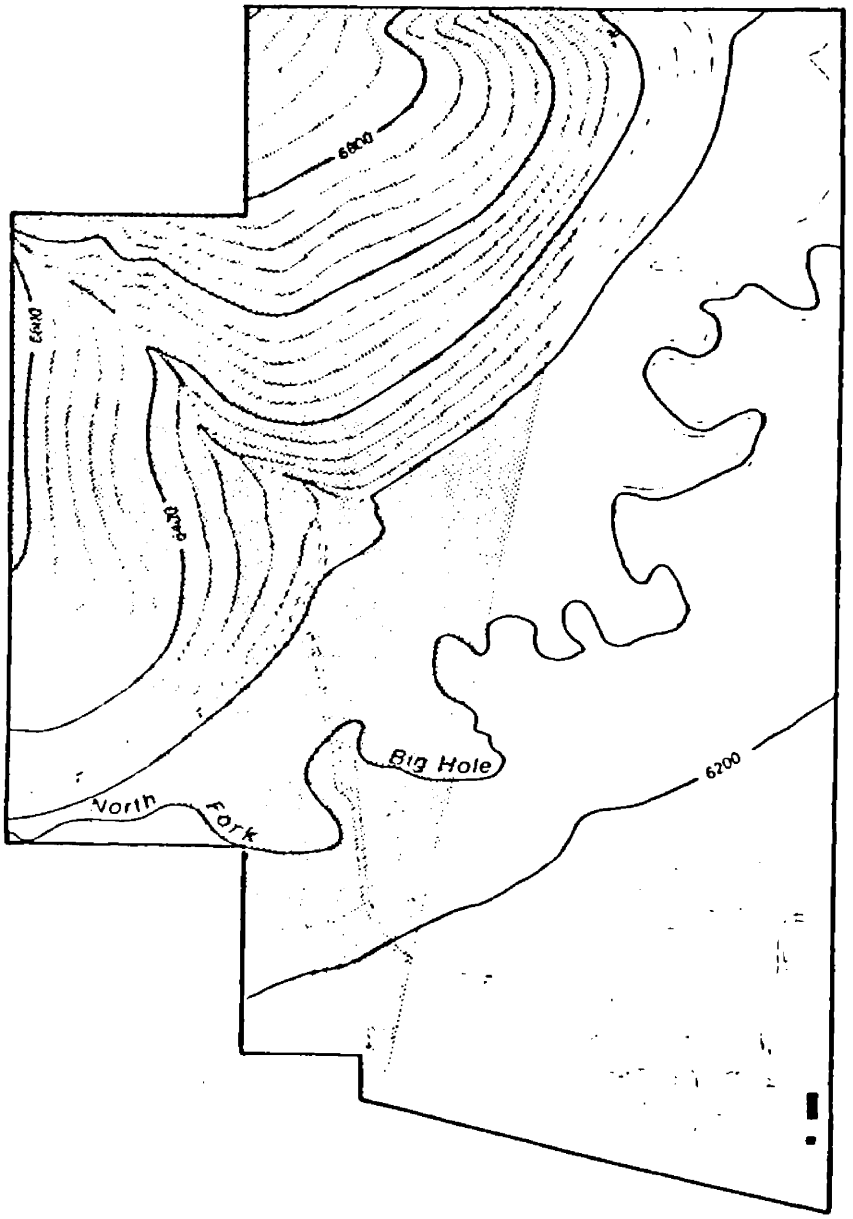

203599

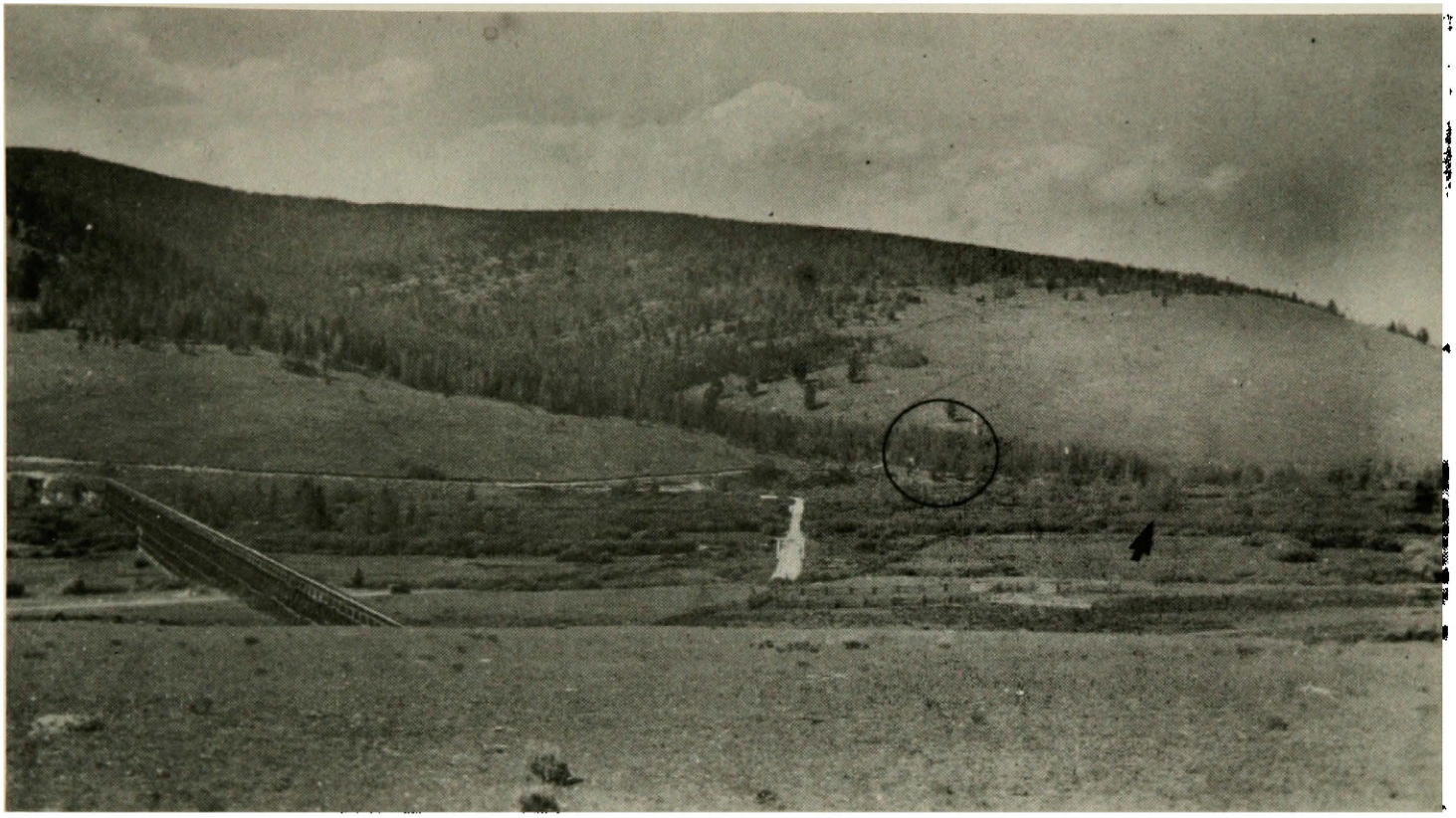
PLATE 2

View of the southern portion of the floodplain and mountain slope looking north.

A. Archival photograph of the area in ca. 1935. (Big Hole National Battlefield, photographer unknown).

B. Same area in 1980. (Photographed by J. Pierce).





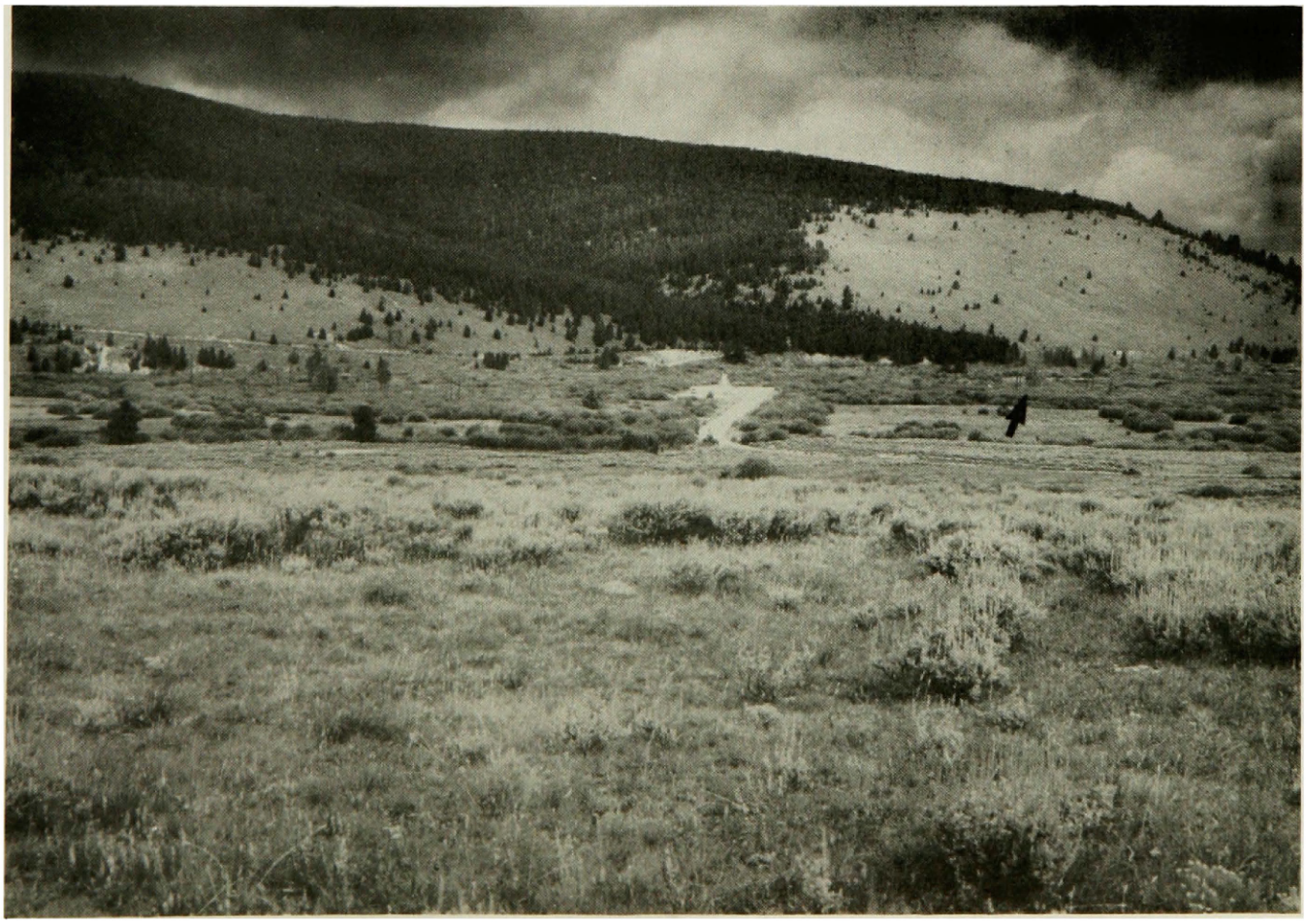
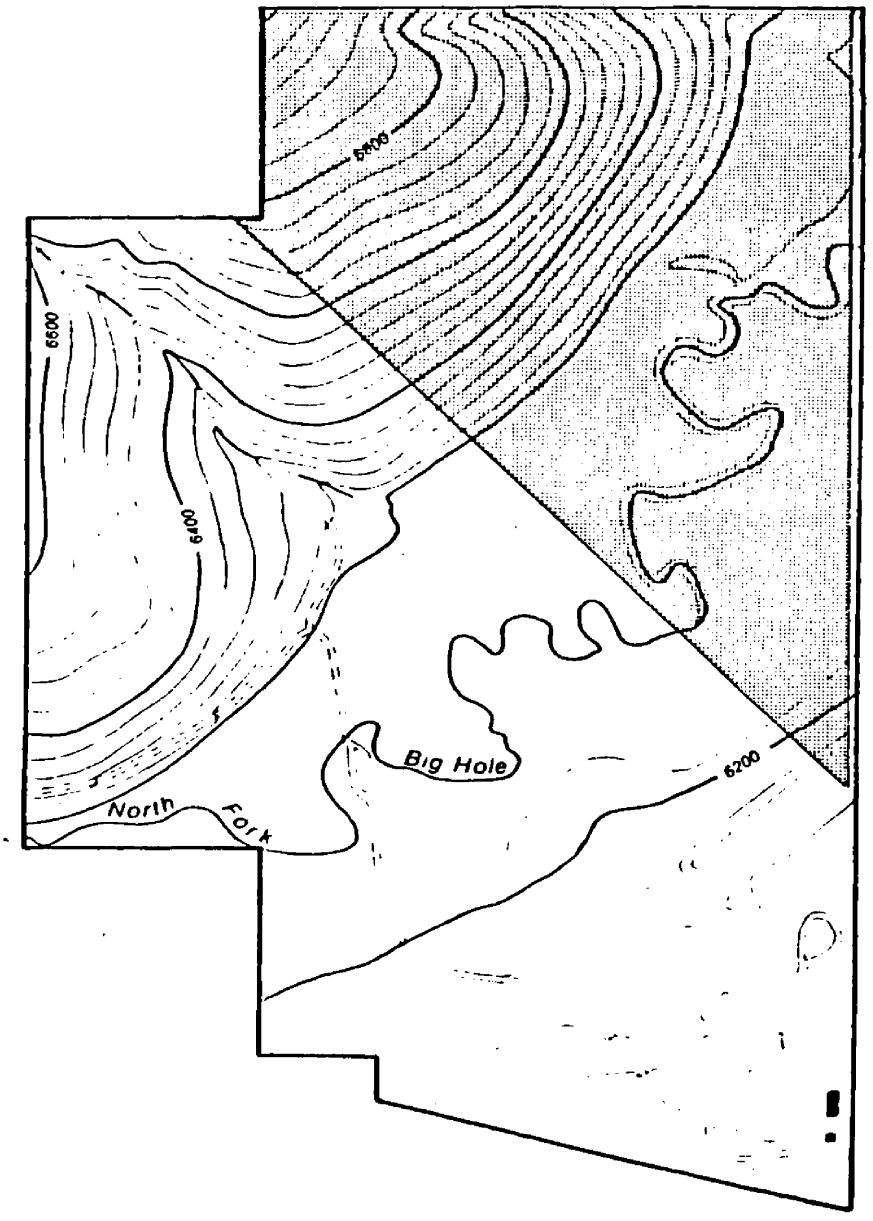


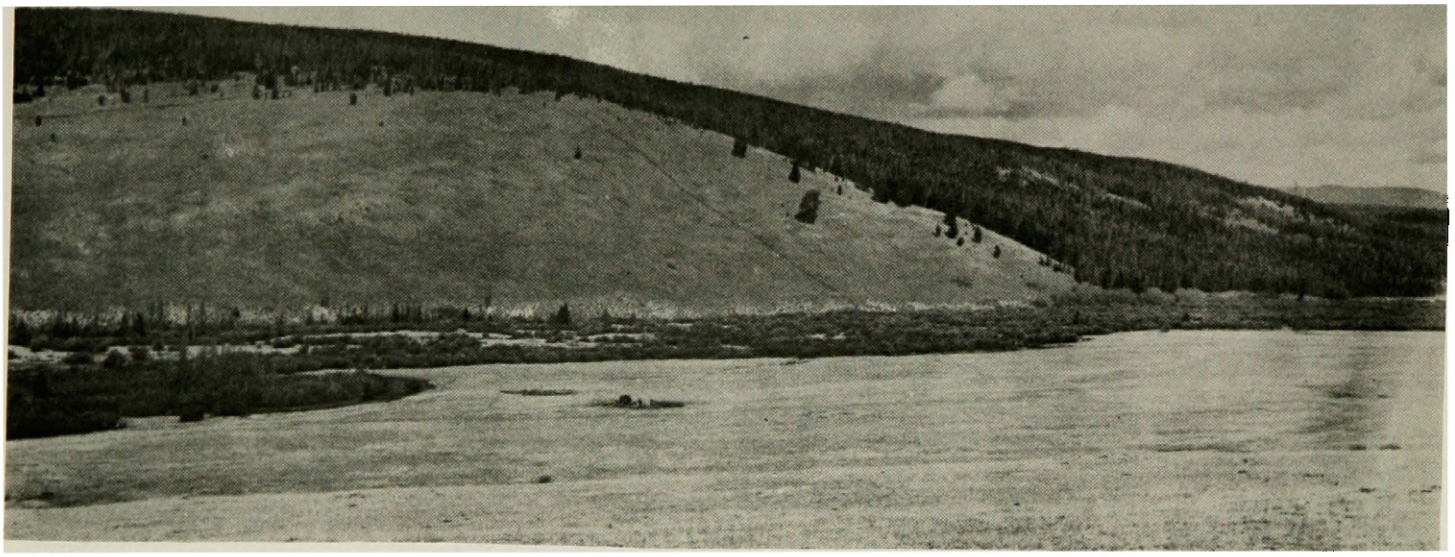
PLATE 3

View of the northern portion of the bench, floodplain, and mountain slope looking northwest.

A. Archival photograph of the area in 1951. (Big Hole National Battlefield, photographer unknown).

B. Same area in 1980. (Photographed by J. Pierce).





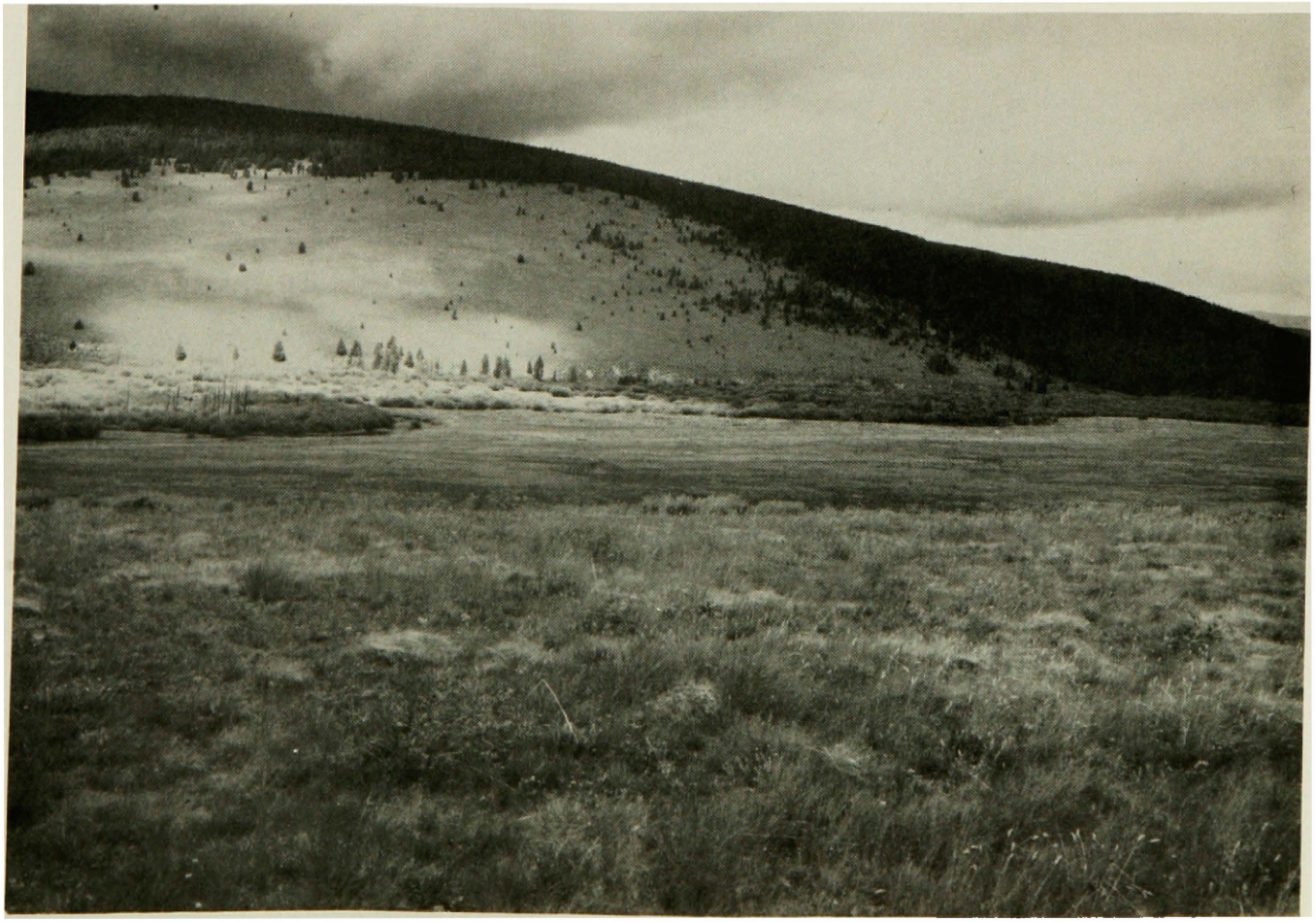


PLATE 4

View of the floodplain and the northern portion of the mountain slope looking north.

A. Archival photograph of the area in ca. 1916. (University of Montana Library Archives, photographer unknown).

B. Same area in 1981. (photograph by J. Pierce).

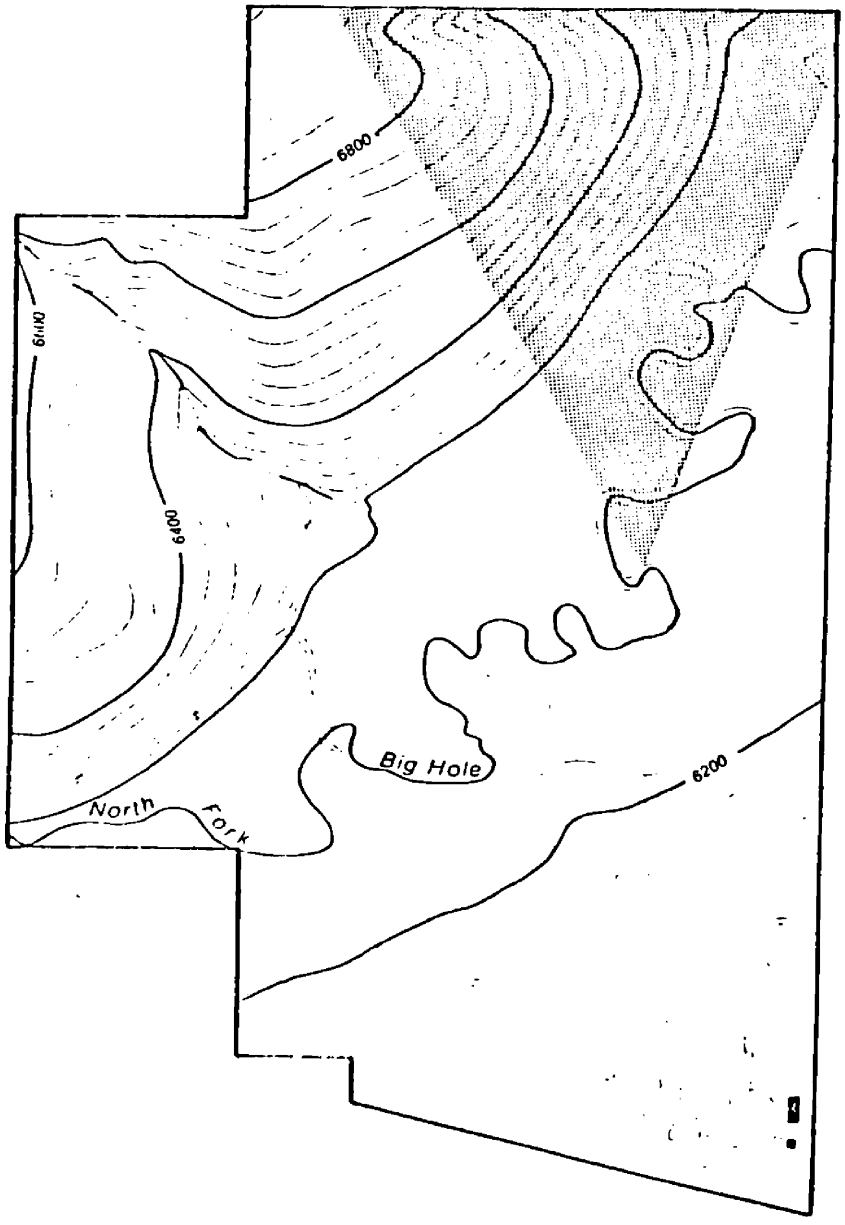


PLATE 5

View of the northern portion of the floodplain and mountain slope looking north.

A. Archival photograph of the area in ca. 1916. (University of Montana Library Archives, photographer unknown).

B. Same area in 1981. (Photographed by J. Pierce).

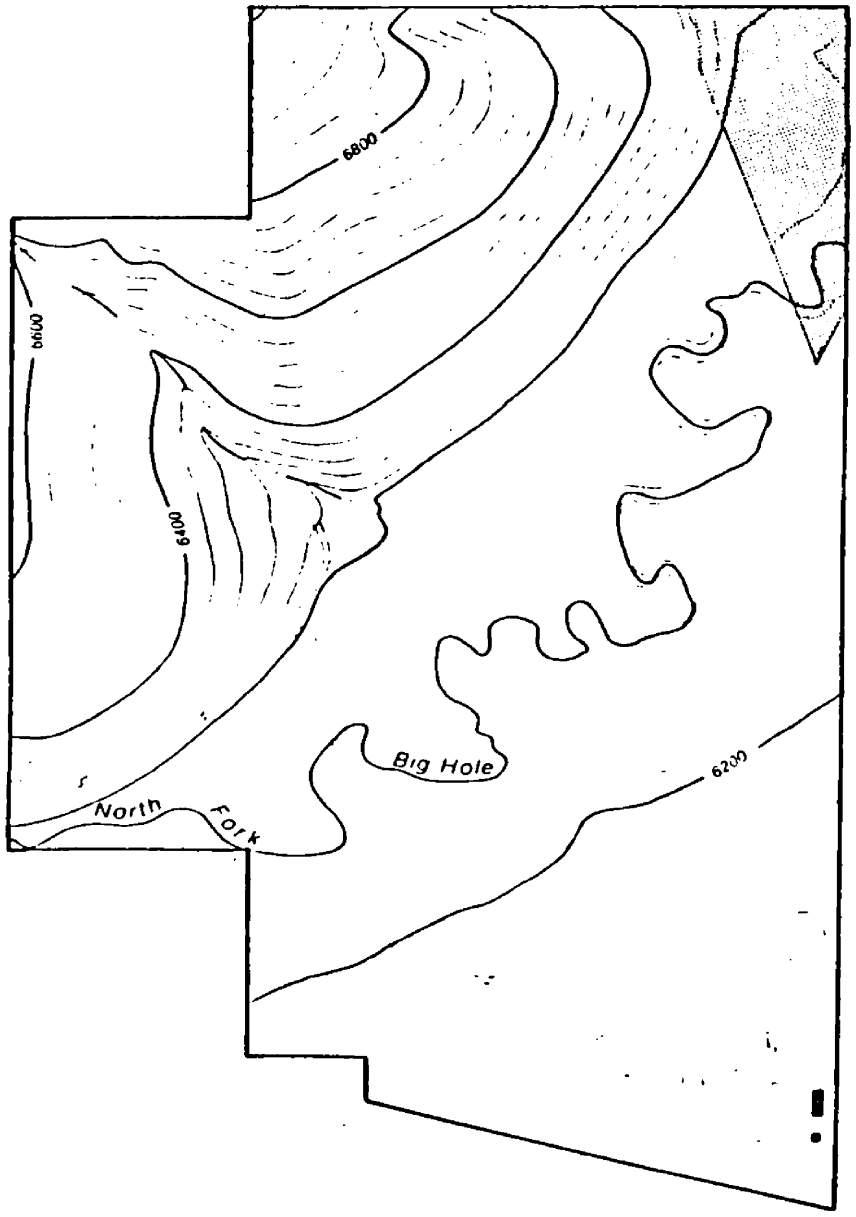
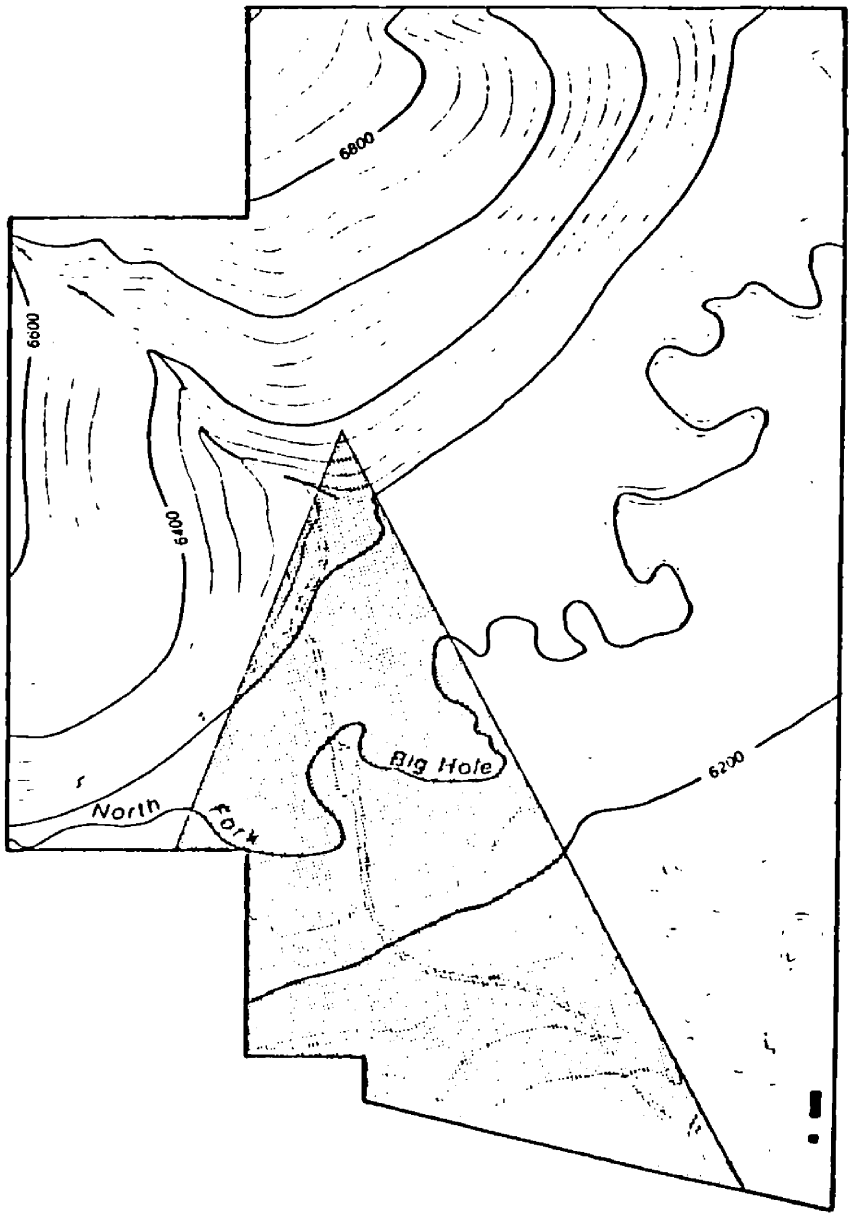


PLATE 6

View of the mountain slope and southern portion of the floodplain and bench looking south.

A. Archival photogarph of the area in ca. 1910. (Big Hole National Battlefield, taken by Wood).

B. Same area in 1981. (Photographed by J. Pierce).



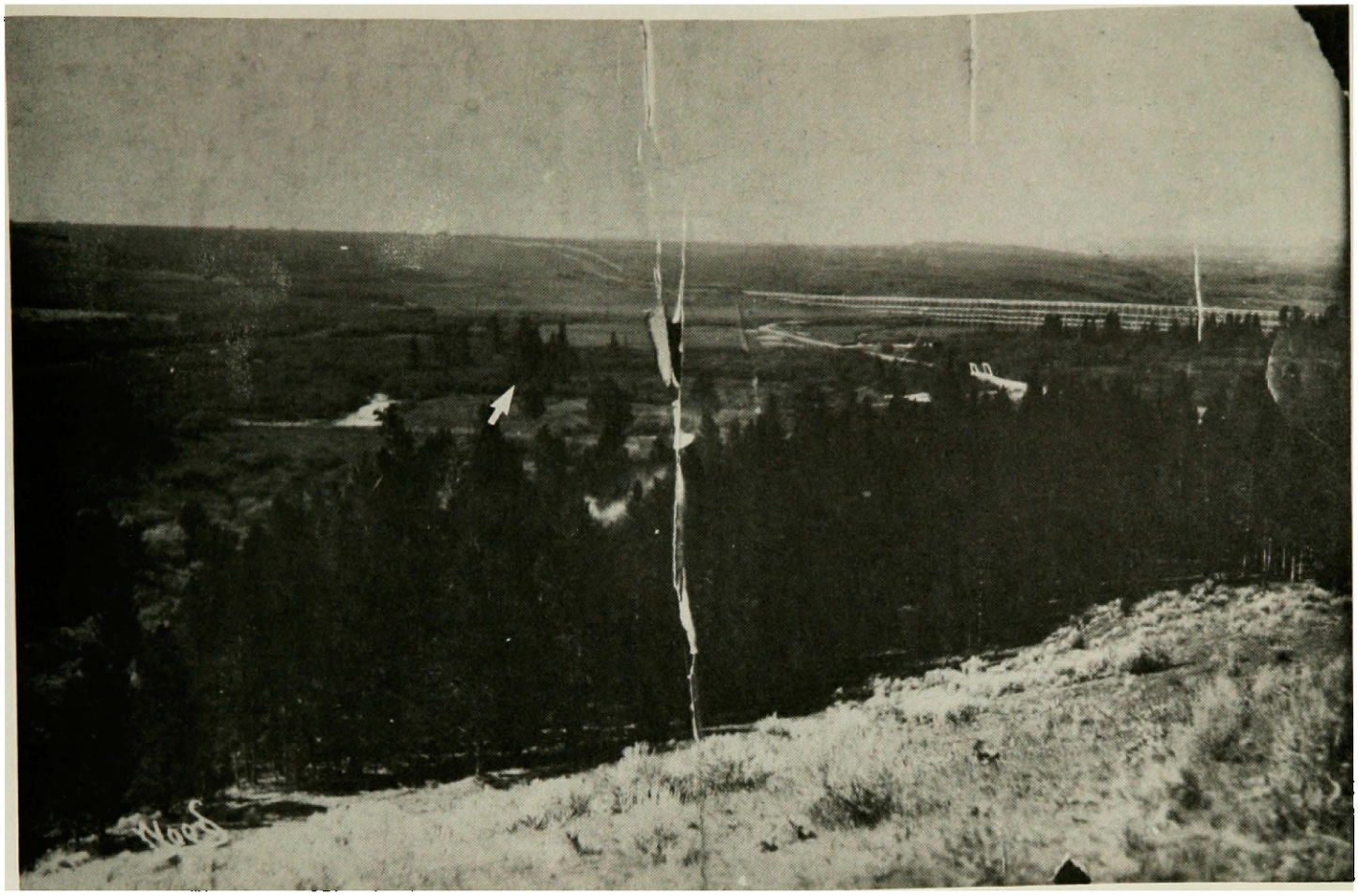
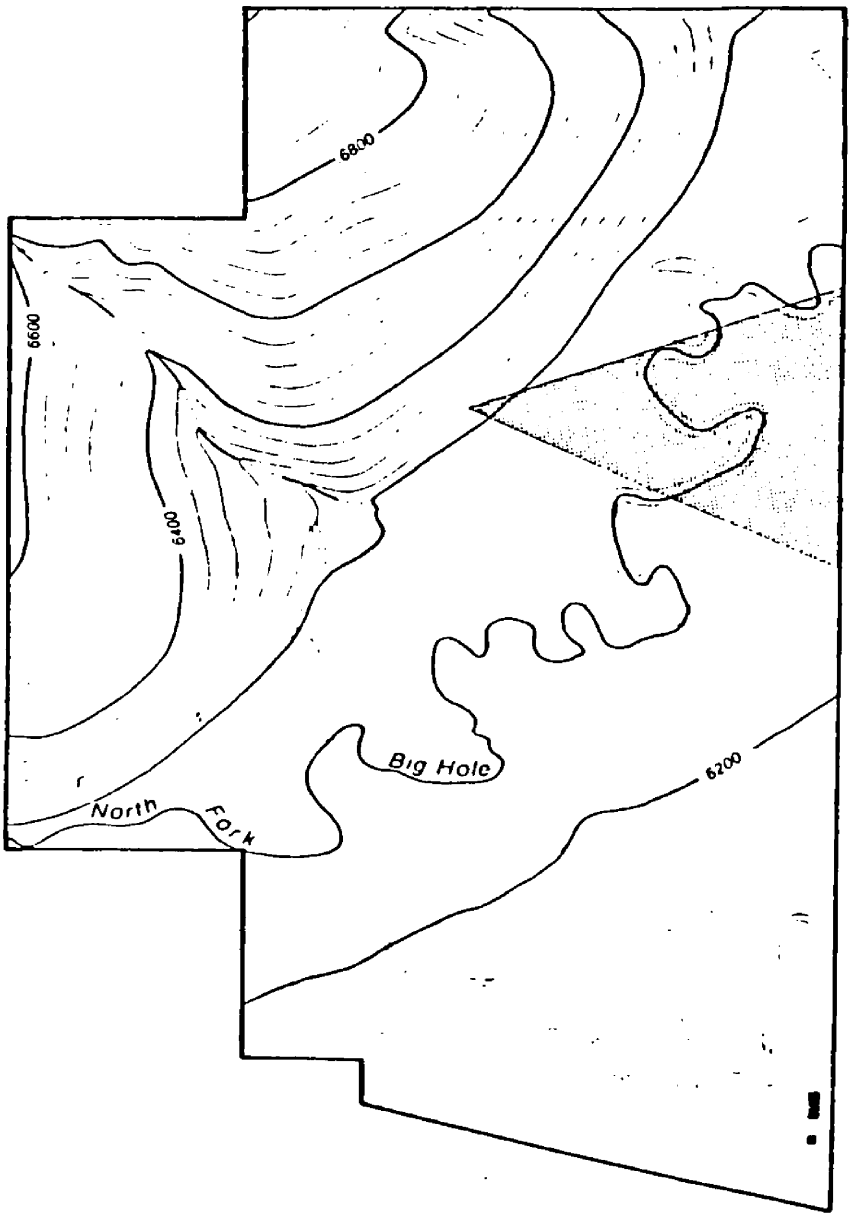


PLATE 7

View of the mountain slope and floodplain looking east.

A. Archival photograph of the area in ca. 1910. (Big Hole National Battlefield, taken by Wood).

B. Same area in 1980. (Photographed by J. Pierce).



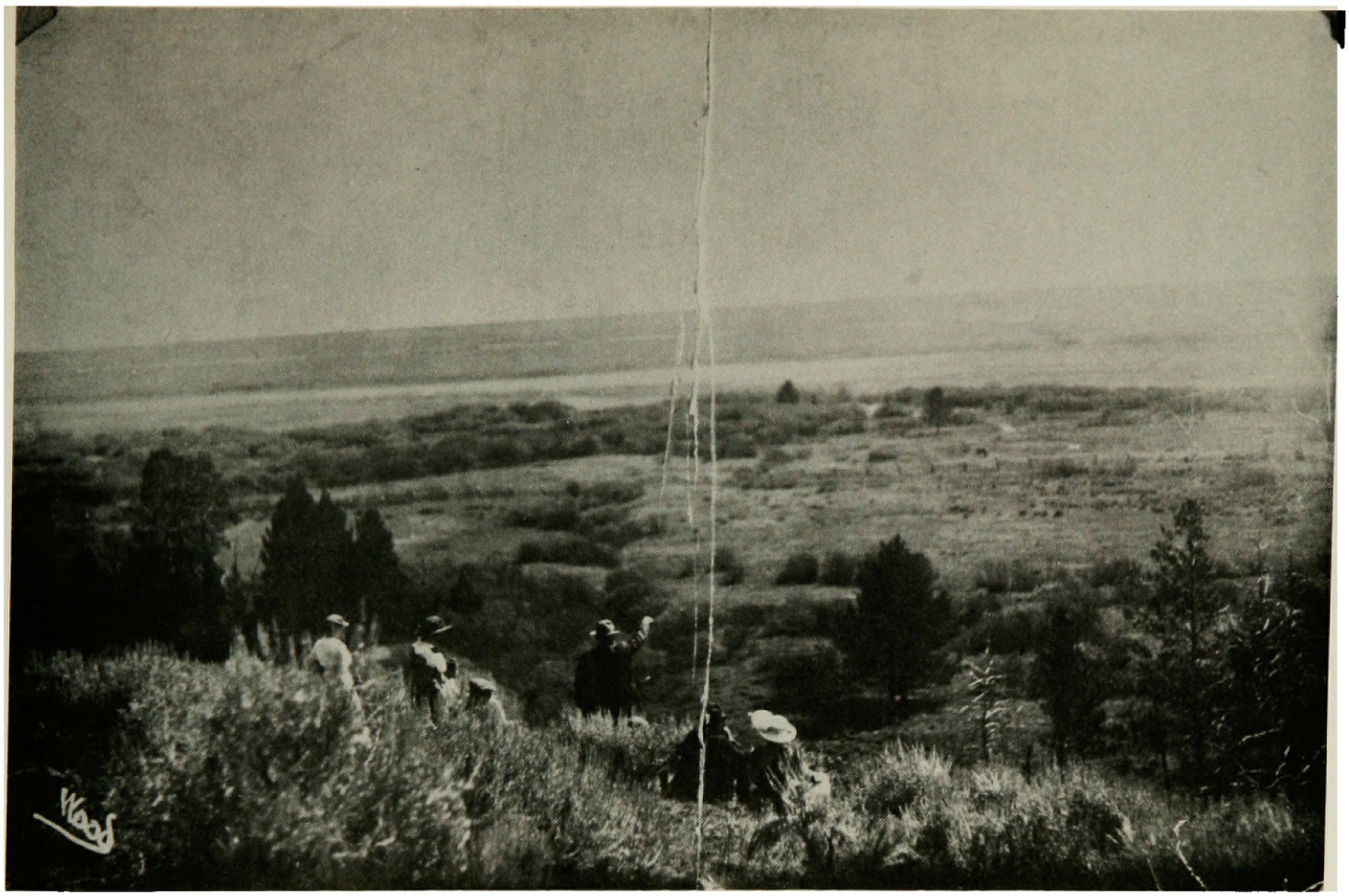
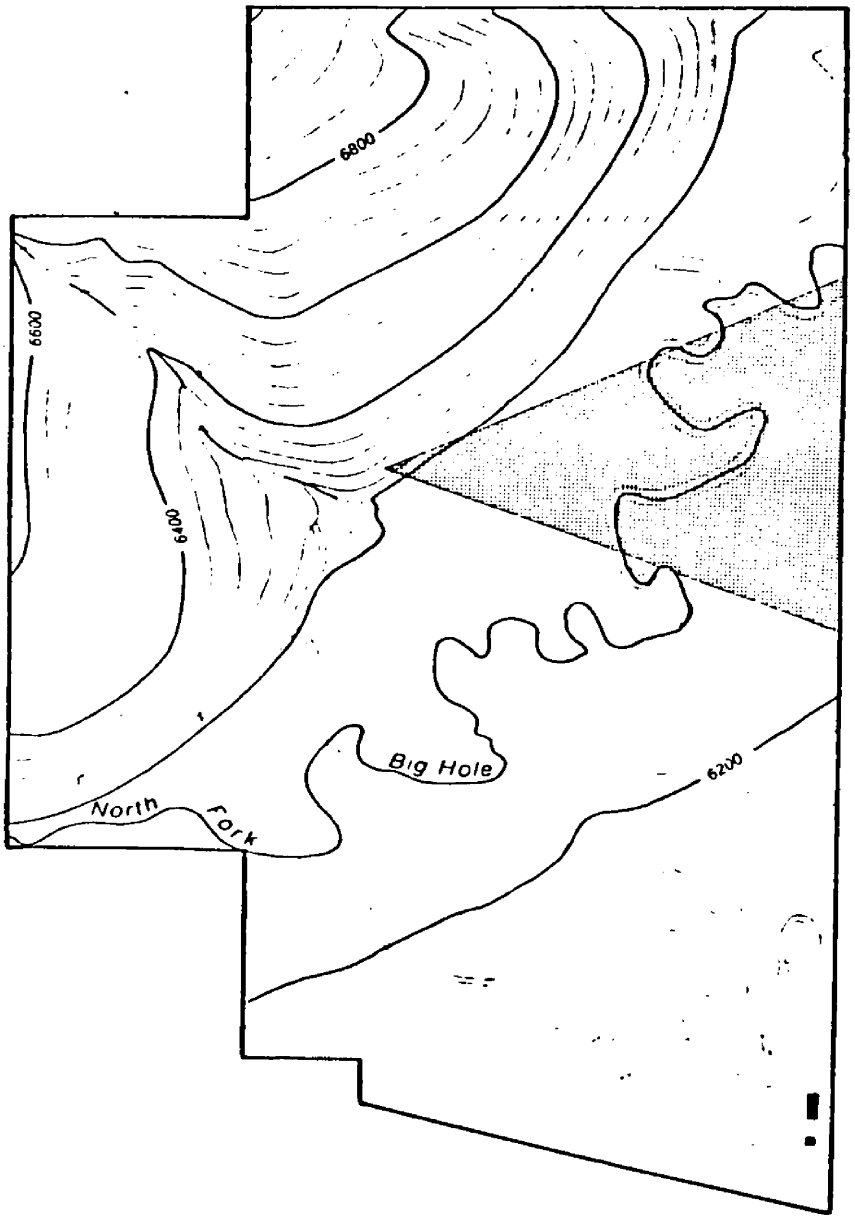

Wood

PLATE 8

View of the mountain slope and floodplain looking east.

A. Archival photograph of the area in ca. 1916. (University of Montana Library Archives, photographer unknown).

B. Same area in 1980. (Photographed by J. Pierce).



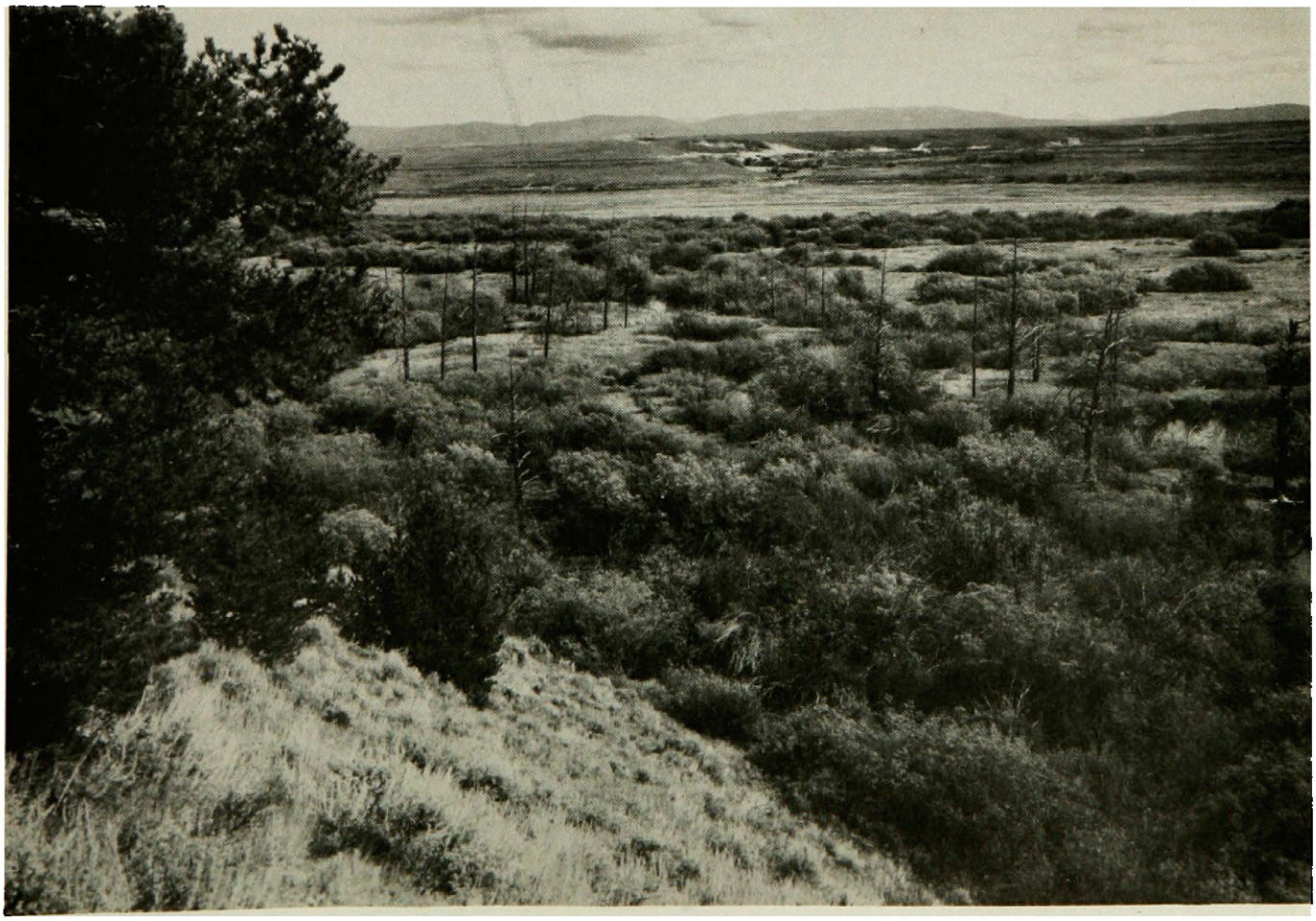


PLATE 9

View of the mountain slope, floodplain, and northern portion of the bench looking southeast.

A. Archival photograph of the area in 1937. (Washington State University Library Archives, taken by L. McWhorter).

B. Same are in 1981. (Photographed by J. Pierce).

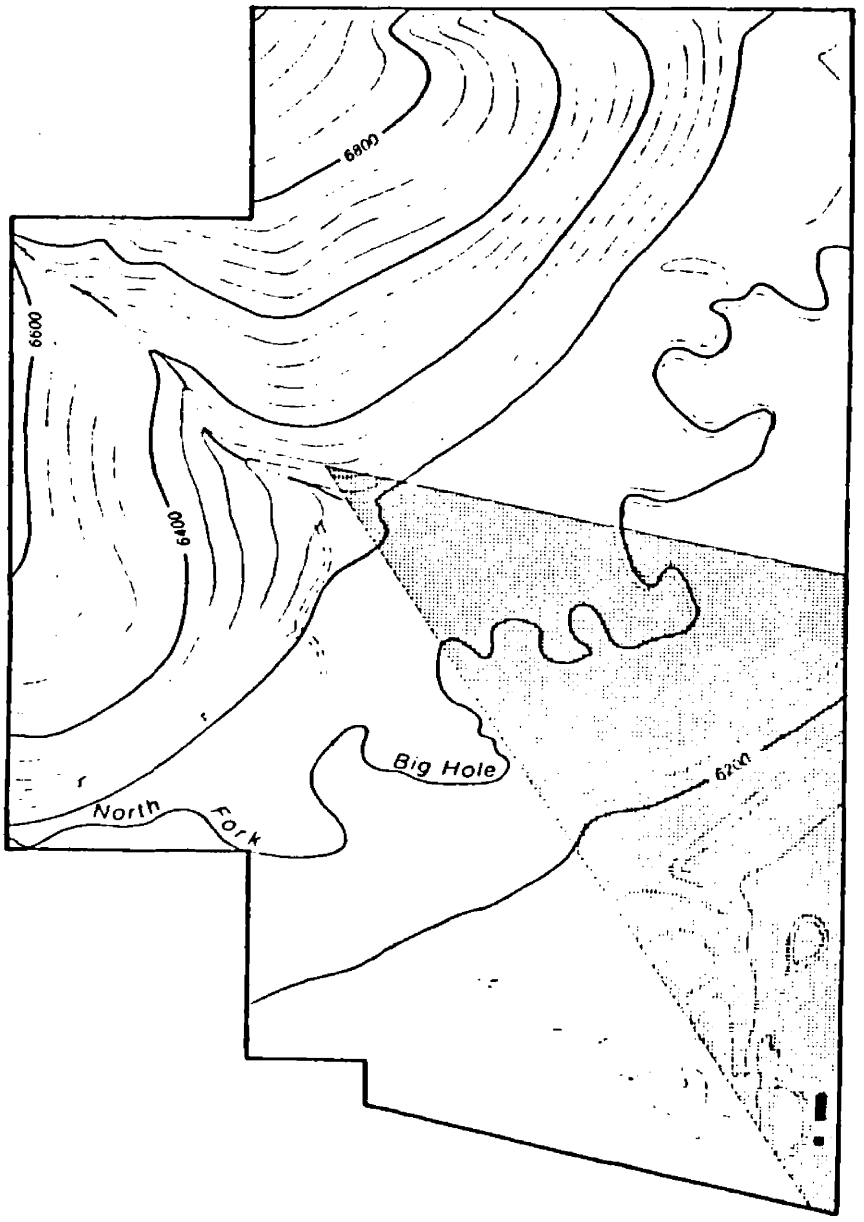
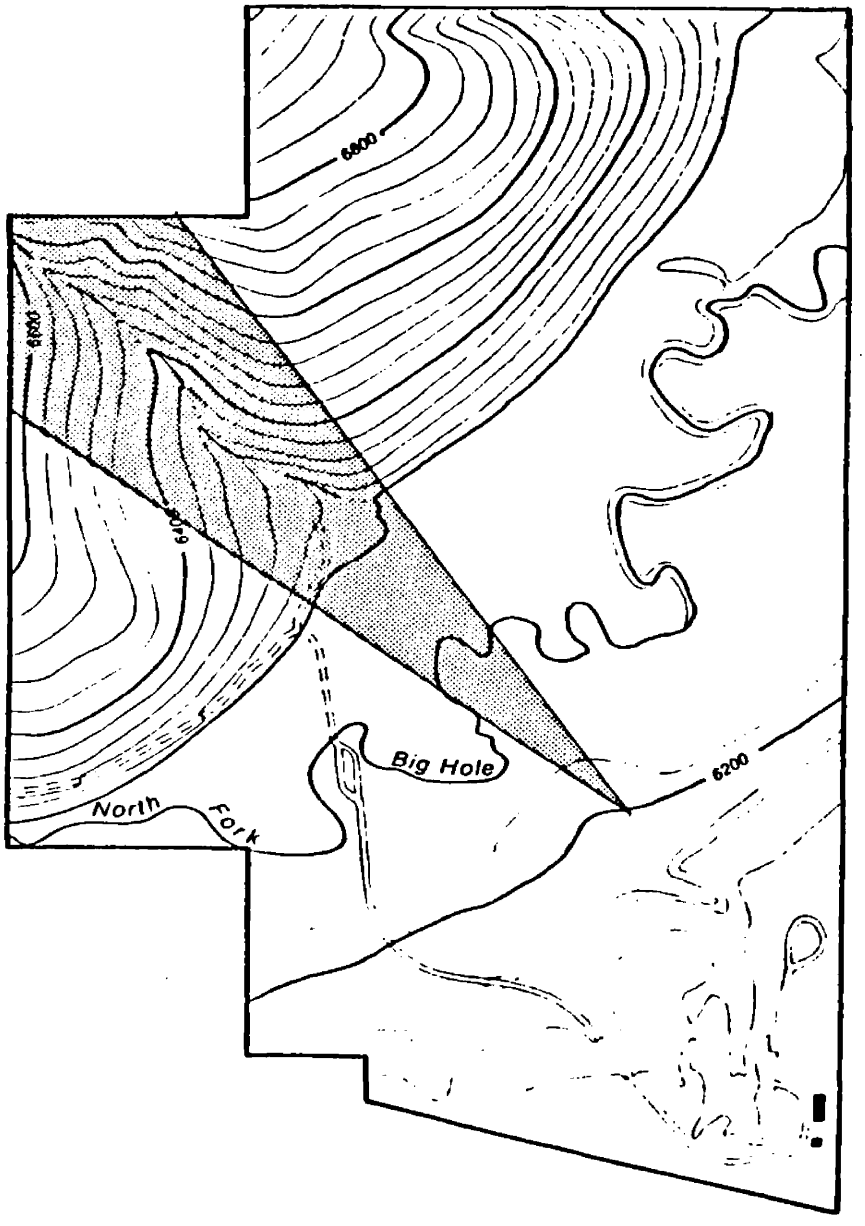


PLATE 10

View of the floodplain and mountain slope looking northwest.

A. Archival photograph of the area in 1925. (United States Archives, U.S.F.S. # 203600, taken by K. Swan).

B. Same area in 1981. (Photographed by J. Pierce).



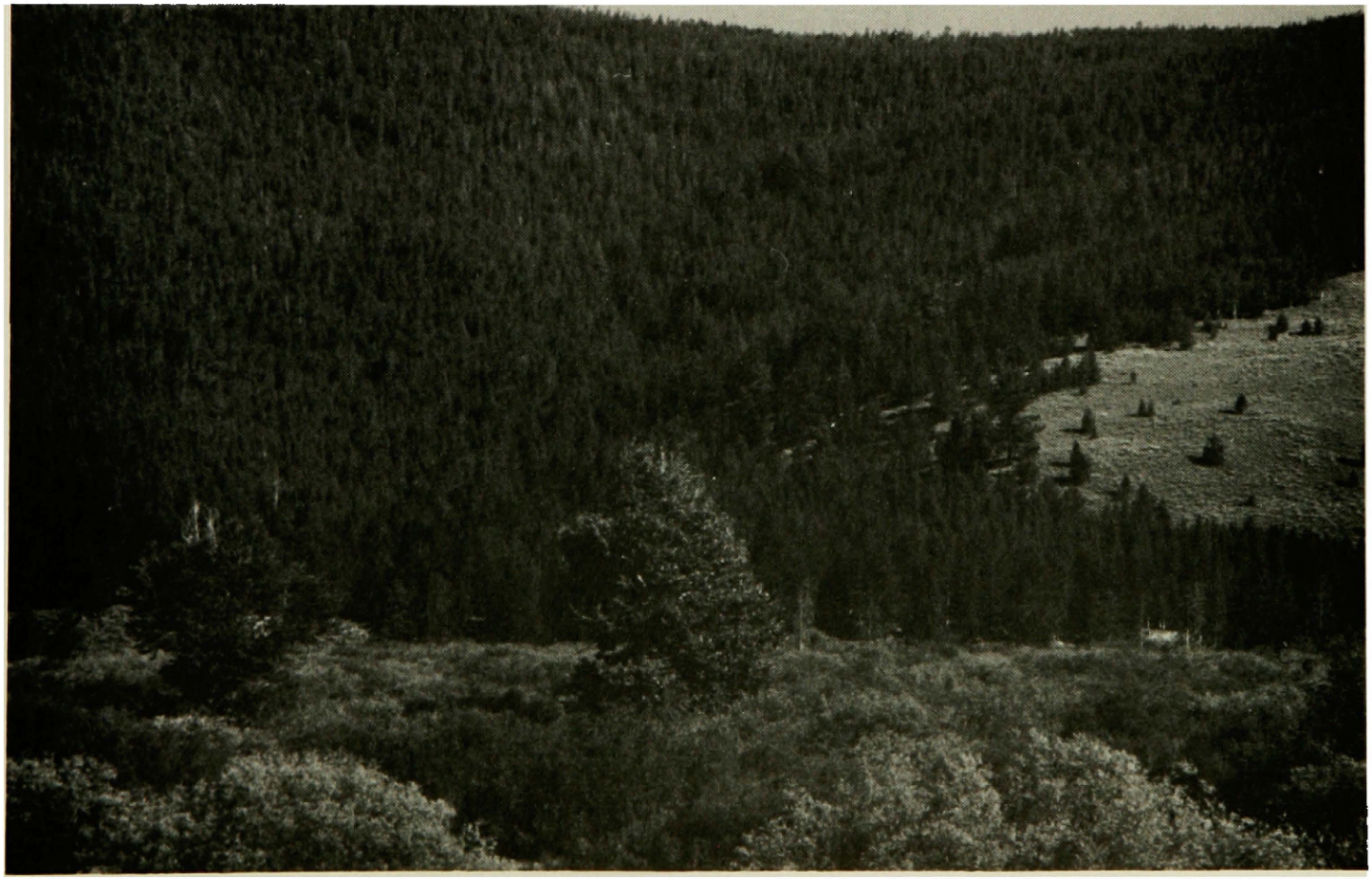


PLATE 11

View of the floodplain looking east.

A. Archival photograph of the area in 1916. (University of Montana Library Archives, photographer unknown).

B. Same area in 1980. (Photographed by J. Pierce).

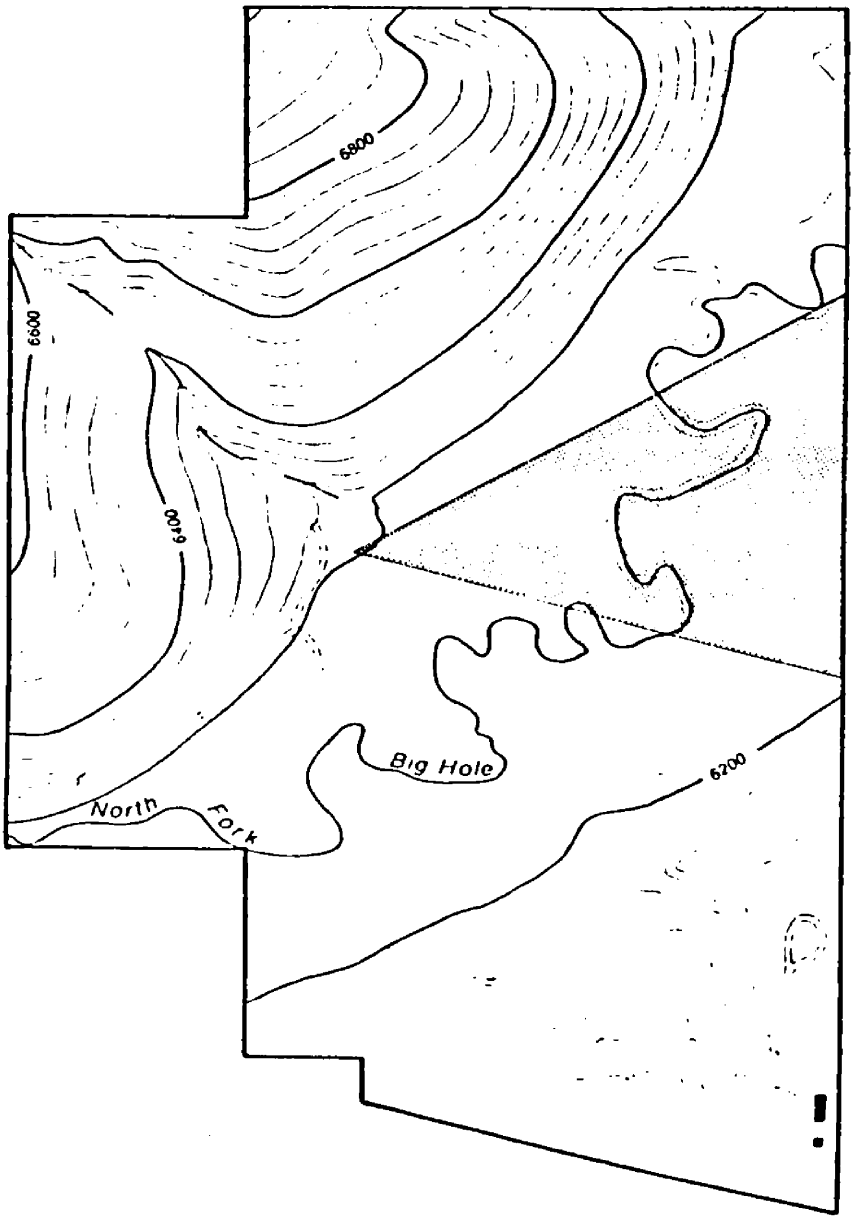


PLATE 12

View of the siega area on the mountain slope looking southwest.

A. Archival photograph of the area in 1925. (Washington State University Library Archives, U.S.F.S. # 203596, taken by K. Swan).

B. Same area in 1981. (Photographed by J. Pierce).

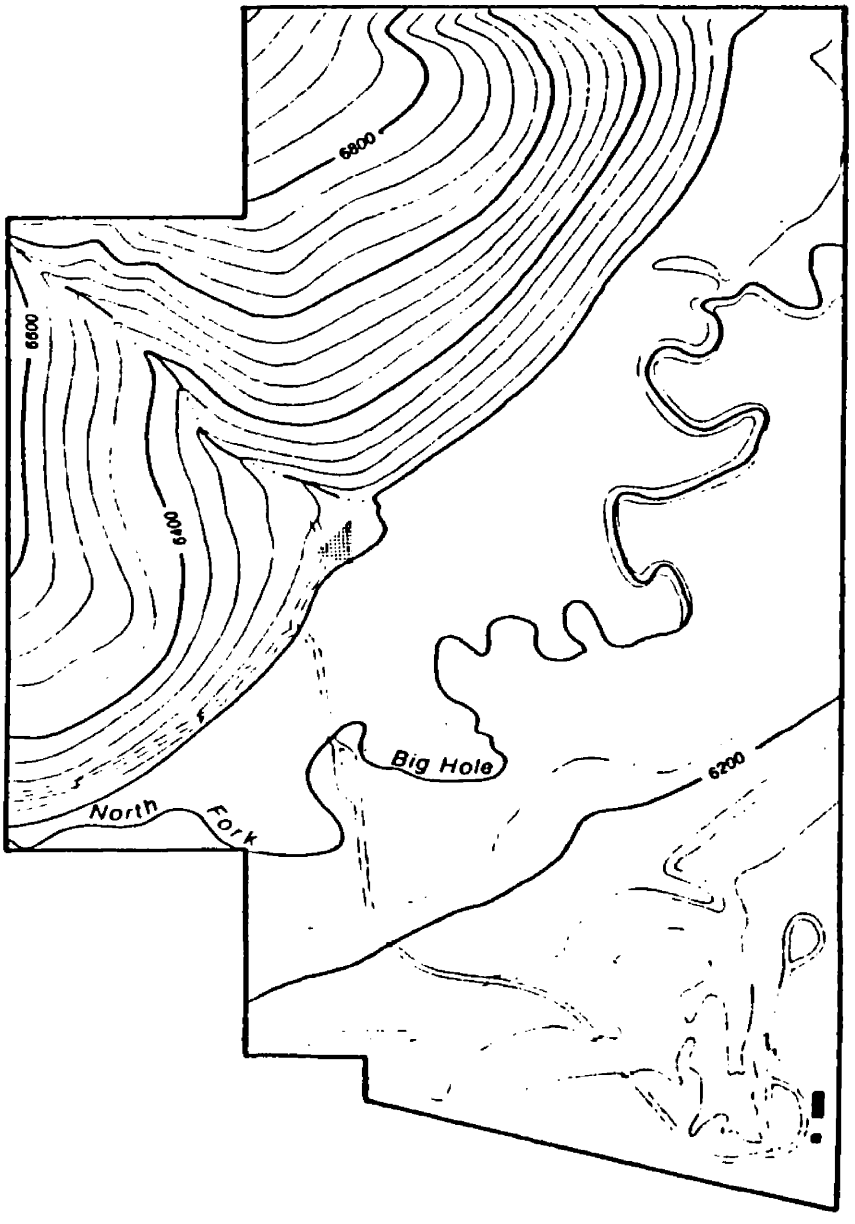


PLATE 13

View of the mountain slope and floodplain looking east.

A. Archival photograph of the area in 1937. (Washington State University Archives, taken by L. McWhorter).

B. Same area in 1981. (Photographed by J. Pierce).

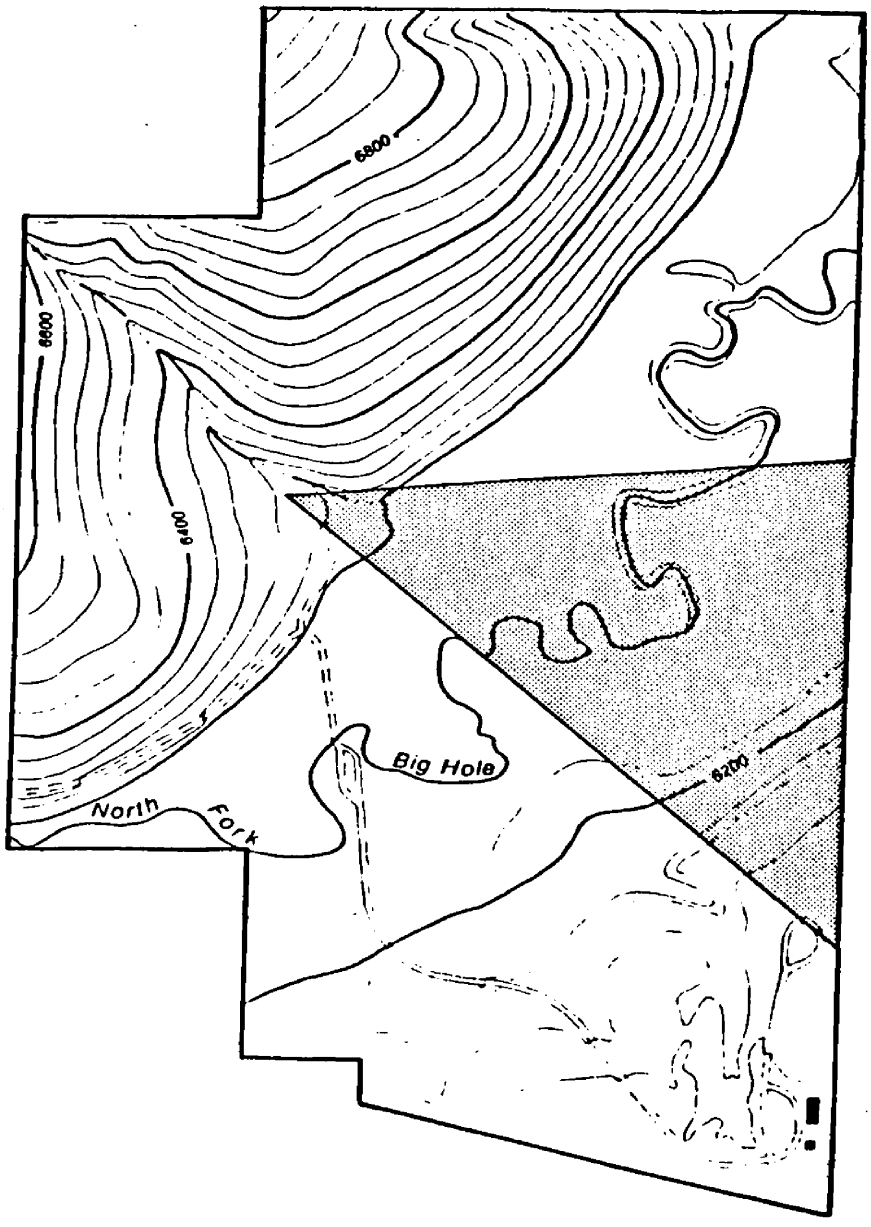
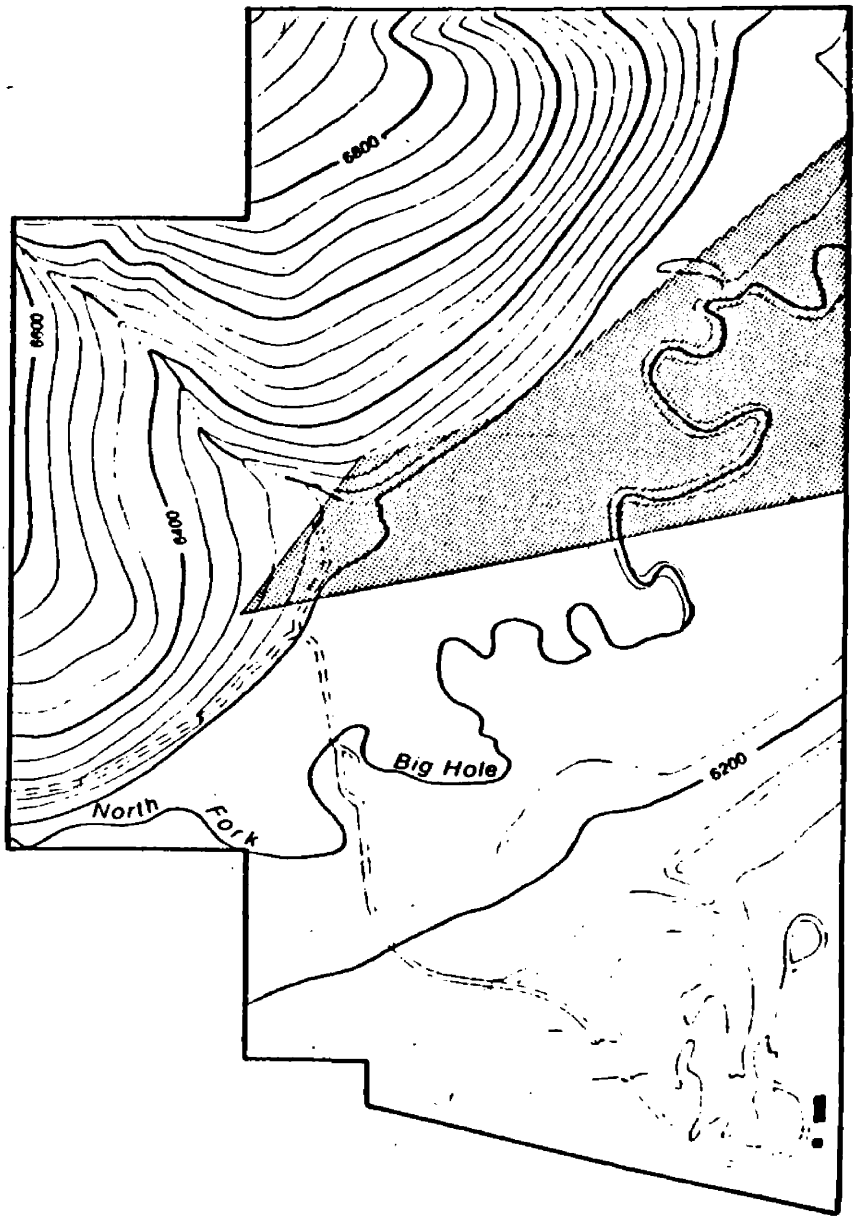


PLATE 14

View of the mountain slope and floodplain looking northeast.

A. Archival photograph of the area in ca. 1916. (University of Montana Library Archives, photographer unknown).

B. Same area in 1981. (Photographed by J. Pierce).



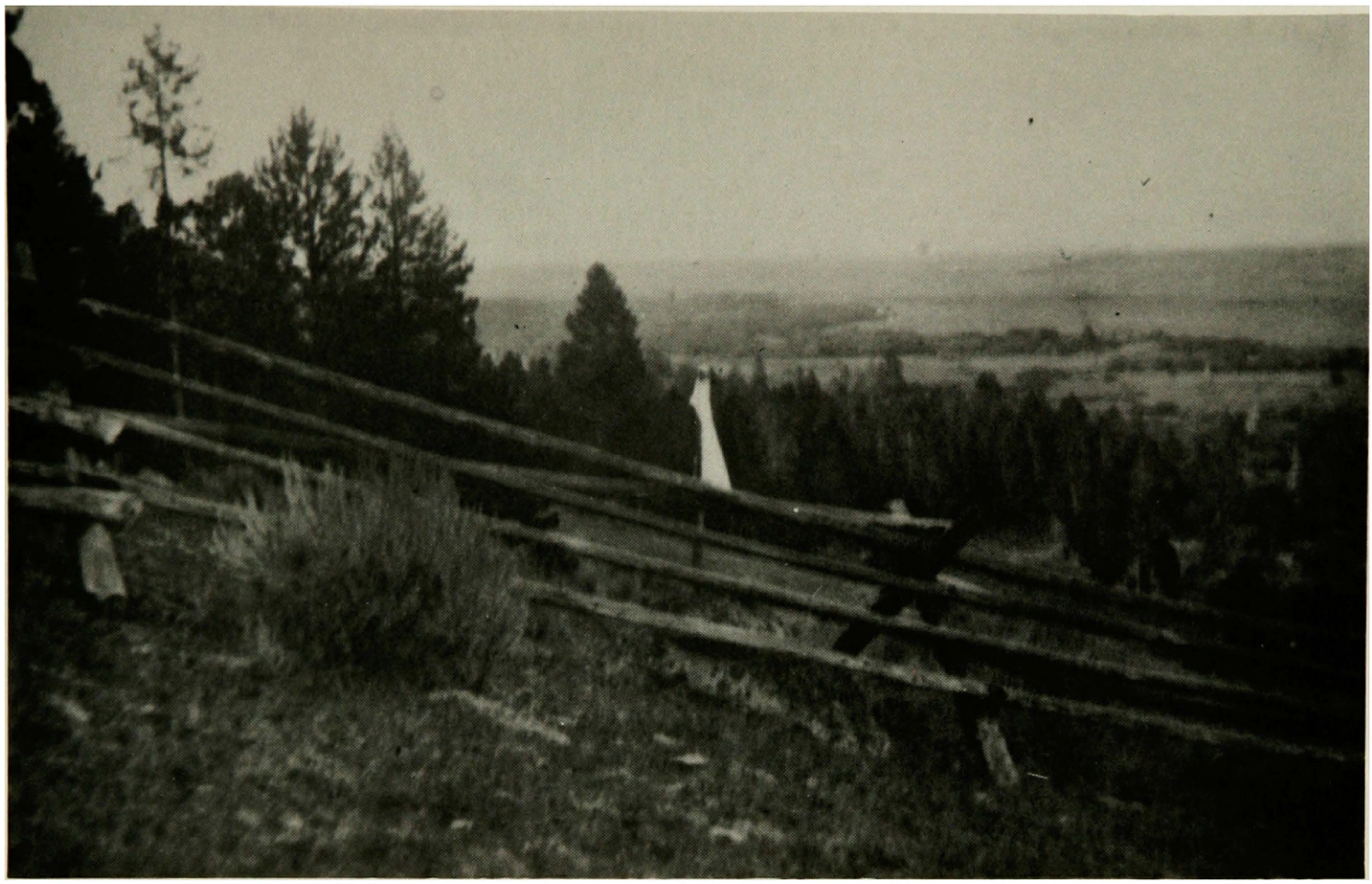
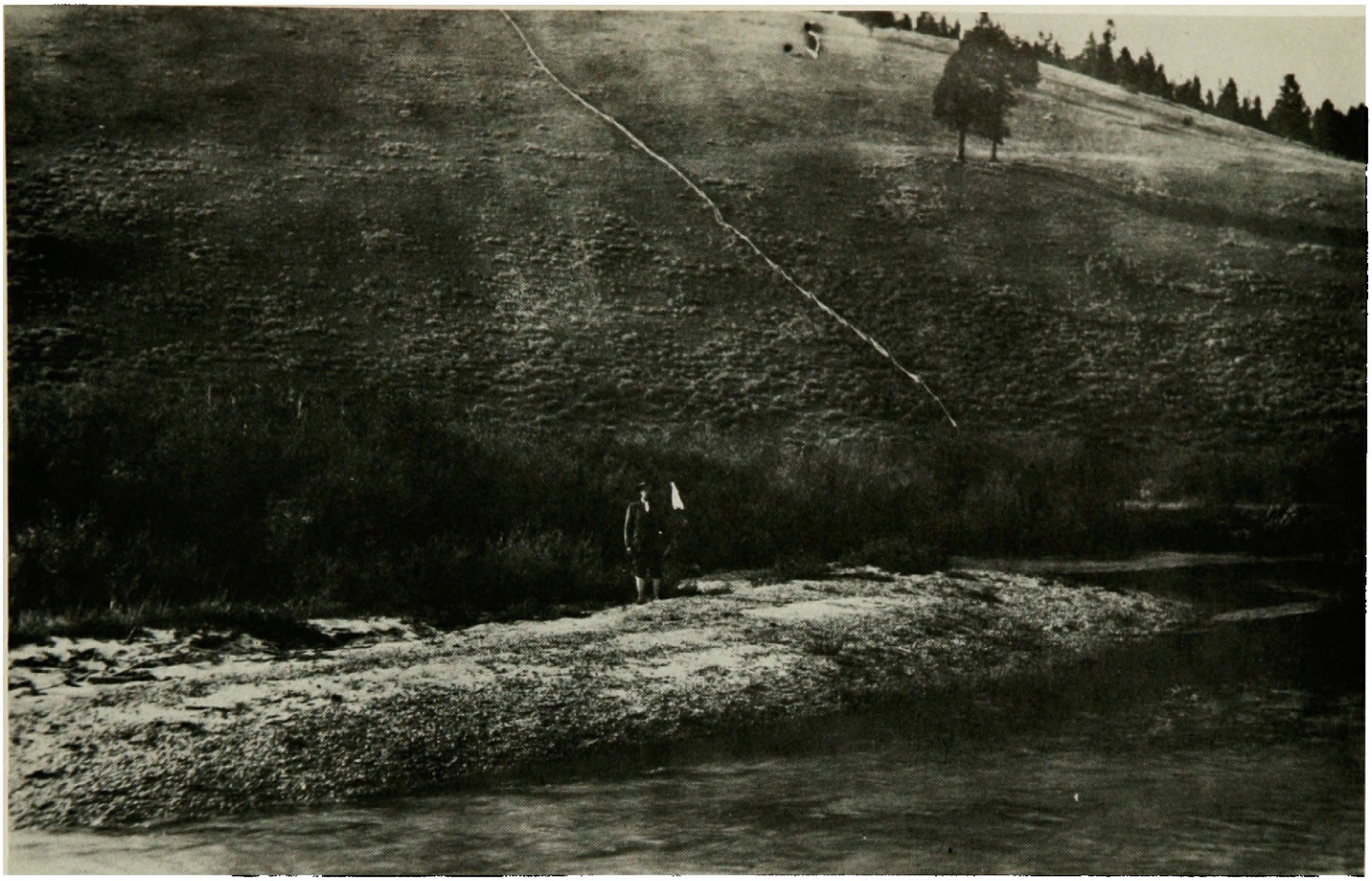


PLATE 15

View of the floodplain and northern portion of the mountain slope looking northwest.

A. Archival photograph of the area in ca. 1916. (University of Montana Library Archives, photographer unknown).

B. Same area in 1980. (Photographed by J. Pierce).



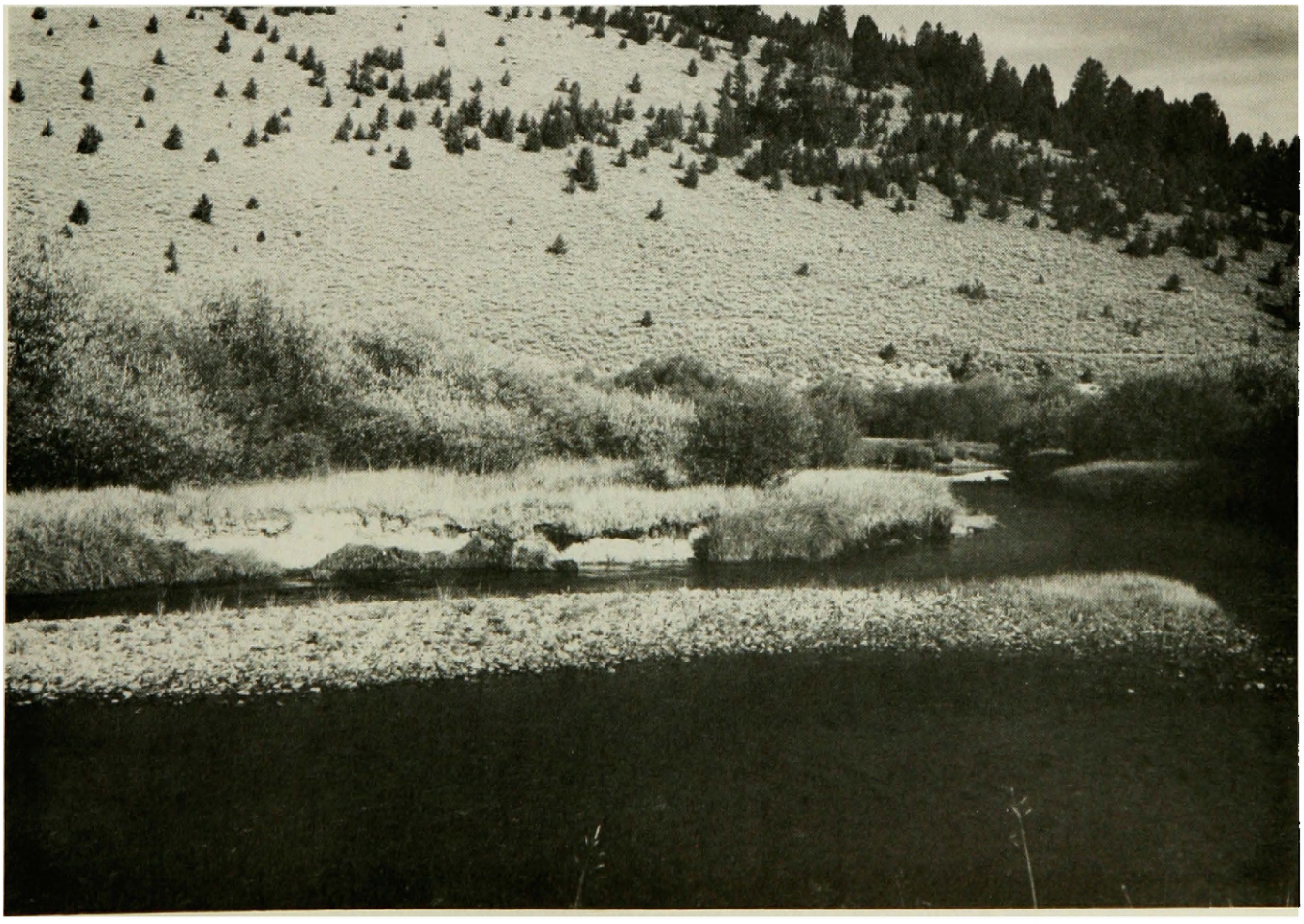
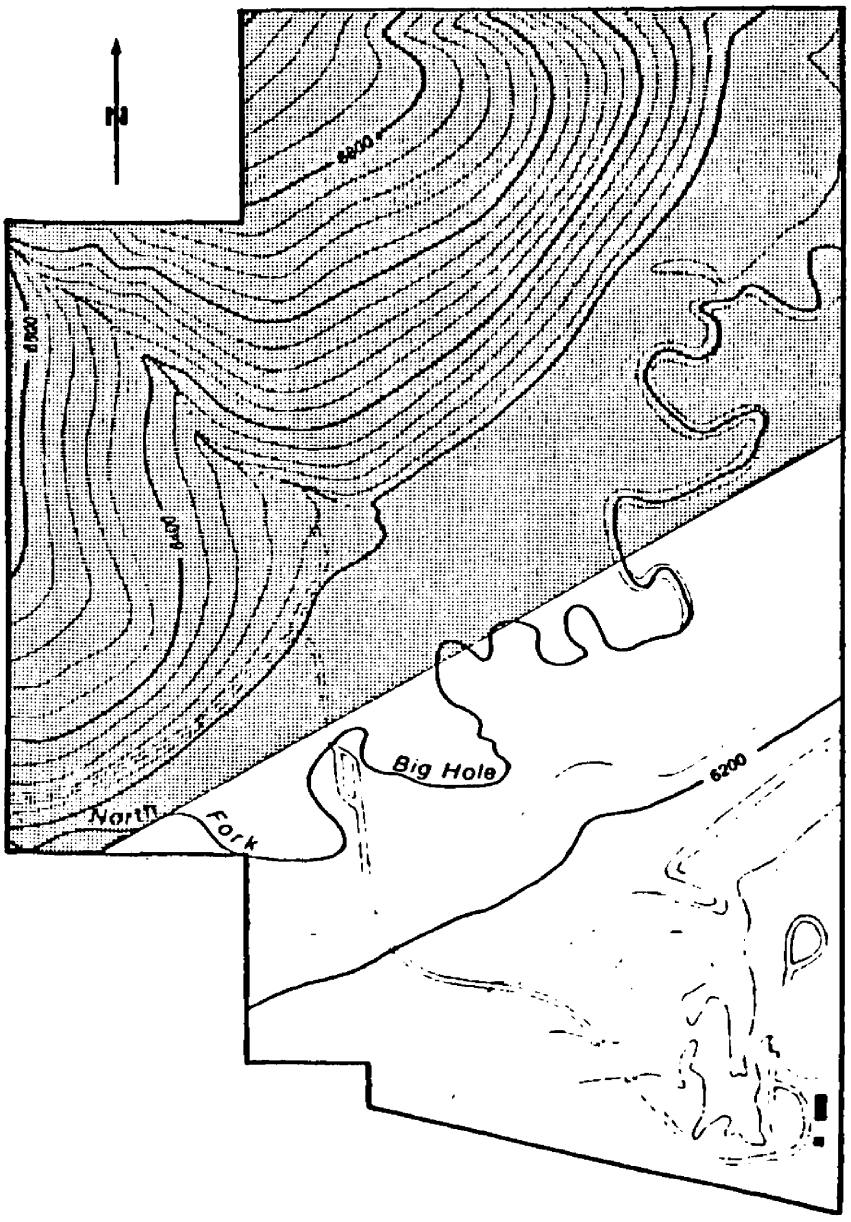


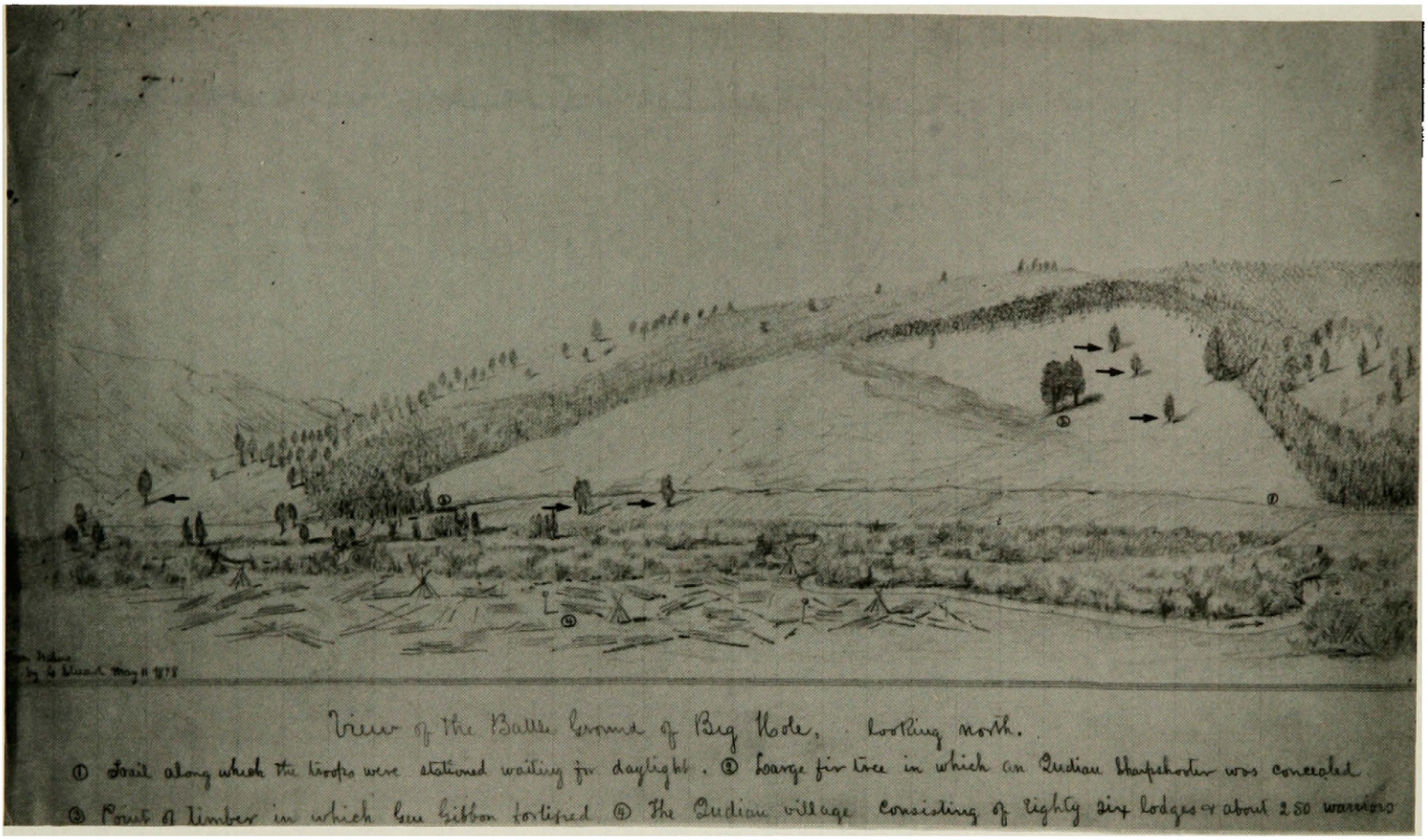
PLATE 16

View of the floodplain and mountain slope looking southwest.

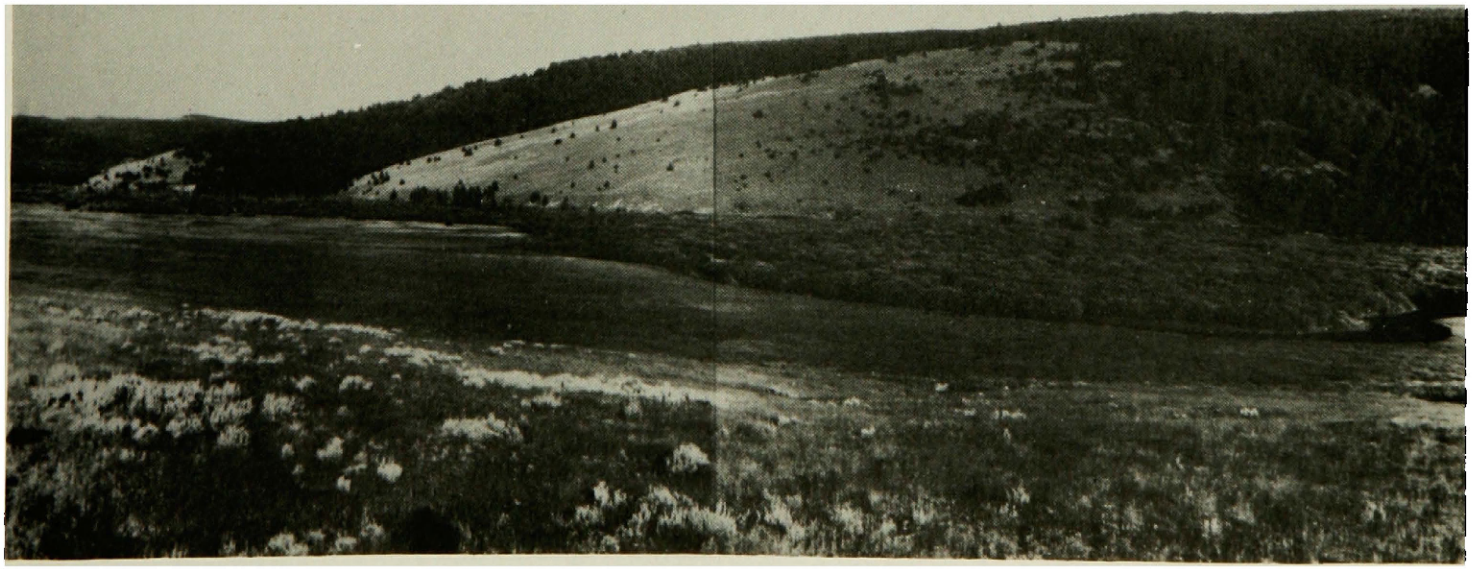
A. Drawing of the area in 1878. (Montana State Historical Society, drawn by G. Stewart).

B. Same area in 1981. (Photographed by J. Pierce).





View of the Battle Ground of Big Hole. Looking north.
① Trail along which the troops were stationed waiting for daylight. ② Large fir tree in which an Indian Sharpshooter was concealed
③ Point of timber in which Gen Gibbon fortified ④ The Indian village consisting of Eighty Six lodges or about 250 warriors



APPENDIX E

Aerial photographs of the Big Hole National Battlefield from 1936 to 1981.

PLATE 17

Aerial photograph of Big Hole Battlefield area, taken on 10 September 1936.

(From U.S.D.A., U.S.F.S., # EY-22-3).

PLATE 18

Aerial photograph of Big Hole Battlefield area, taken on 13 August 1960.

(From U.S.D.A., U.S.F.S., # EIN-4-39).


8-13-60

PLATE 19

Aerial photograph of Big Hole Battlefield area, taken on 27 August 1972.

(From U.S.D.A., U.S.F.S., # 3001 1273 36).


3
4
5
11
10
13
12
6
8
7

PLATE 20

Aerial photograph of Big Hole Battlefield area, taken on 25 June 1981. (From U.S.D.A., A.S.C.S., # 24 611020 280-125).

APPENDIX F

Surveys conducted for
the Battlefield

PLATE 21

1909 survey conducted by the U.S.F.S.

(Beaverhead National Forest, Big Hole Ranger Station Archives).

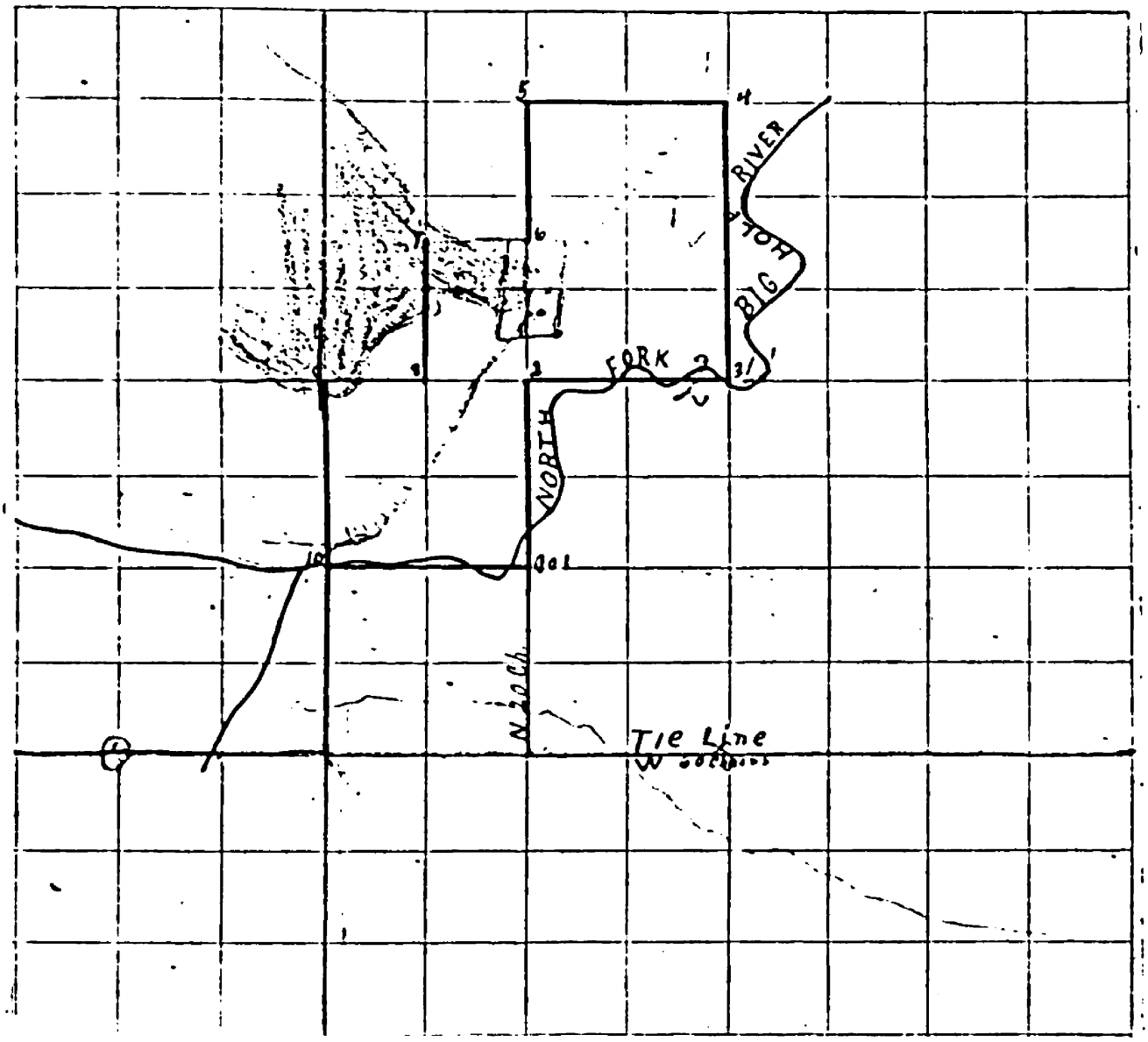
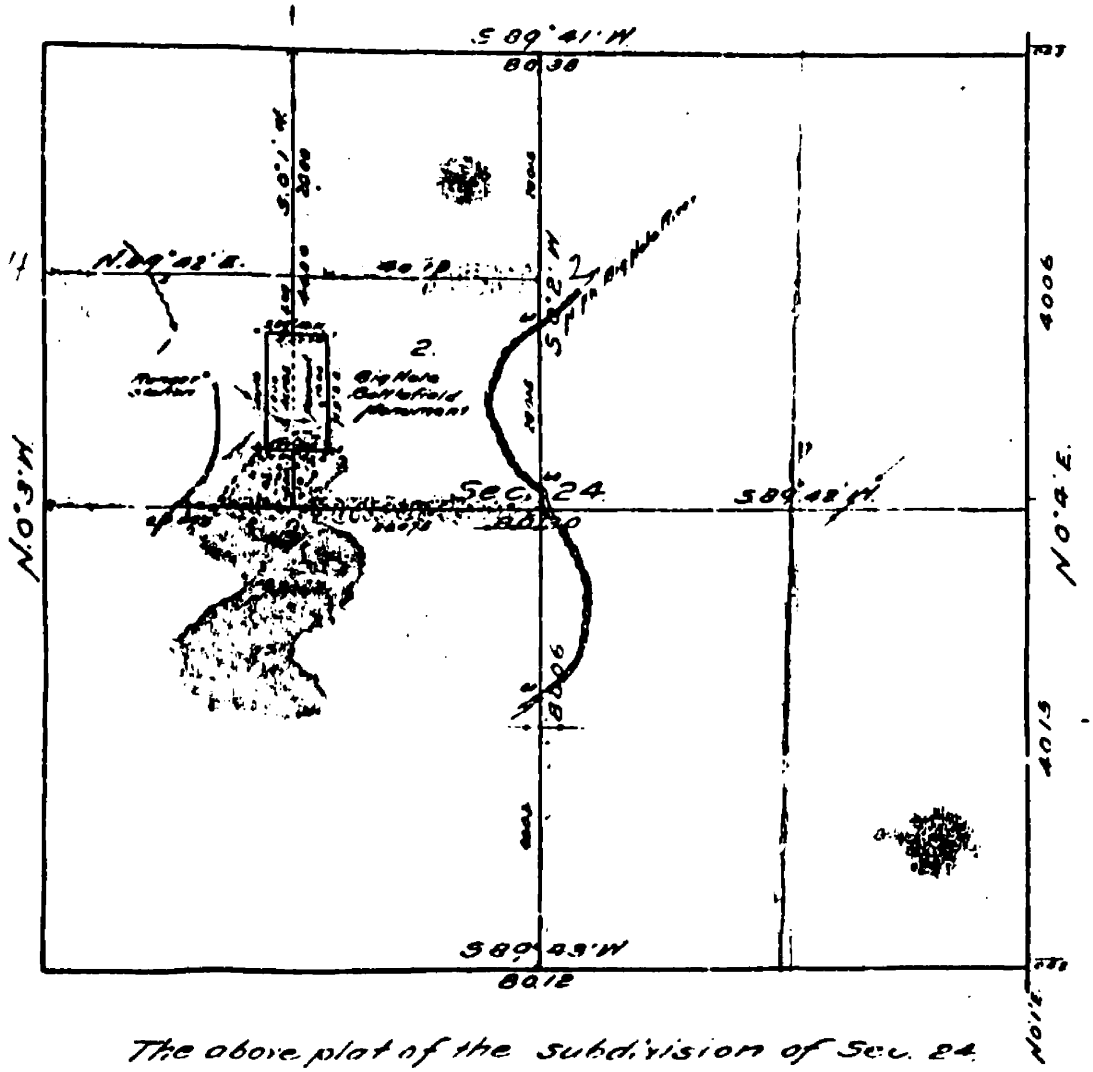

5
4
RIVER
BIG
FORK
3
2
NORTH
Tie Line

PLATE 22

Survey conducted in 1915 by the U.S. Surveyer General's Office. (Bureau of Land Management, Billings, Montana).



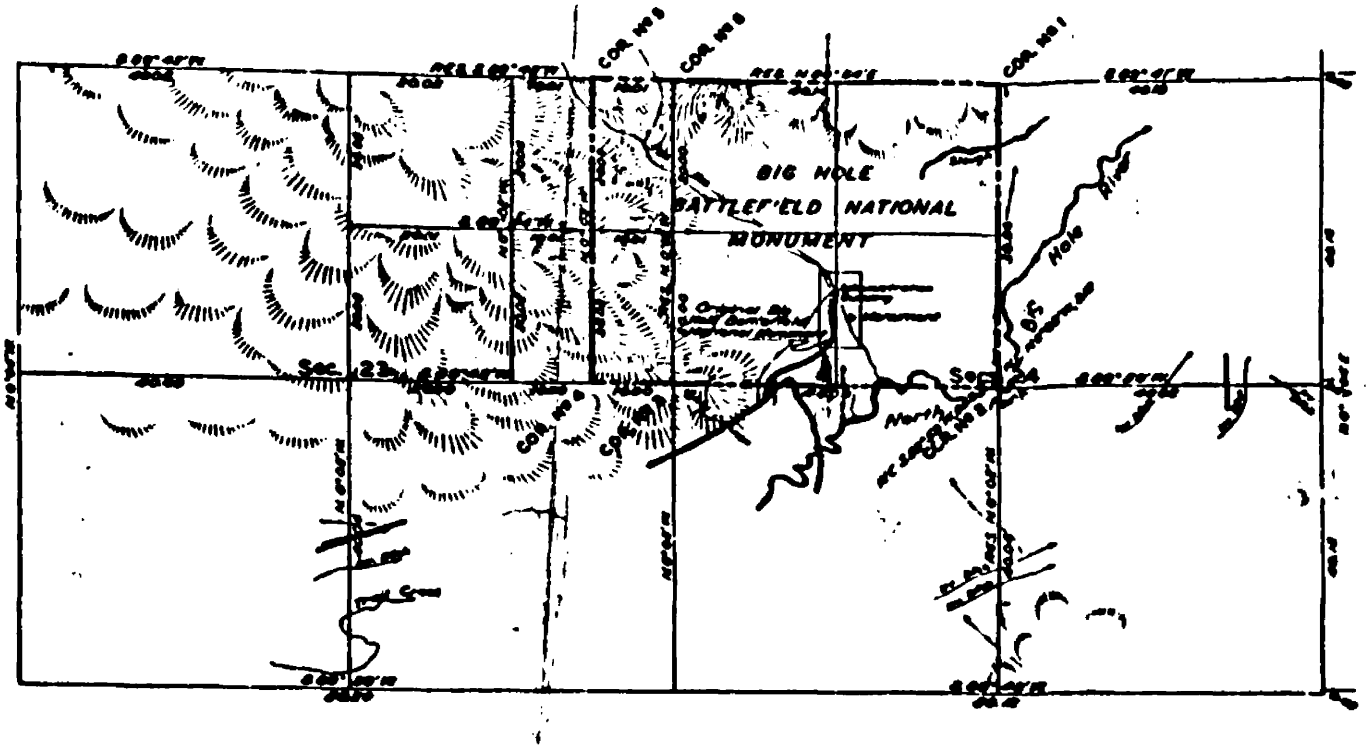
The above plat of the subdivision of Sec. 24 Tp. 2 S. Rg. 17 W. P.M. Montana and the survey of the boundries of the Big Hole Battlefield Monument therein, is strictly conformable to the field notes of the survey thereof on file in this office, which have been examined and approved

U.S. Surveyor Generals Office.
Helena, Mont. July 19, 1917.

U.S. Surveyor General

PLATE 23

Survey conducted in 1939 by the U.S. Department of the Interior General Land Office. (Bureau of Land Management, Billings, Montana).



Survey of additions to the Big Hole Battlefield National Monument in accordance with the provisions of Executive Order No. 2339, dated June 23, 1939 with necessary resurveys and subdivisions of Sections 23 and 24 incident thereto, executed by Ernest Parker, surveyor, October 20 to 25, 1939, under special instructions dated Oct. 18, 1939, for Group No. 385, authorized by the Commissioner Oct. 16, 1939.

Sections 23 and 24 were originally surveyed by A.P. Horner and Donald Mix Roe, transitmen, as shown on the plat approved July 19, 1917; and the survey of the original monument was executed by A.P. Horner, transitman, Sept. 17, 1915, as shown on the plat approved July 19, 1917.

OFFICE OF THE SUPERVISOR OF SURVEYS

Denver, Colorado, Feb. 1, 1940

The above supplemental plat of Sections 23 and 24, Township No. 2 South, Range No. 17 West of the Principal Meridian, Montana, is strictly conformable to the field notes of the survey thereof which have been examined and approved.

SUPERVISOR OF SURVEYS

APPENDIX G

Forest Plot Data

The following codes were used in tabulating the forest plot data from the mountain slope. Codes used are: DBH, diameter at breast height in inches; Age, age of the tree; Growth, d.b.h. devided by age; Agsp, *Agropyron spicatum*; Artr, *Artemisia tridentata*; dArtr, dead *Artemisia tridentata*; Caru, *Calamagrostis rubescens*; Vasc, *Vaccinium scaparium*; dotr, down trees; rotr, rotten trees (can be kicked apart); Fire Scars, maximum number of fire scars on trees in or near the plot; and Stumps, presence of stumps resulting from past logging. Trees which do not have a growth rate had their d.b.h. measured at three dm from the ground since they were too small to be measured at breast height.

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 1											
Pinus contorta	5.1	20	.255								
Pinus contorta	1.5	12	.125	Agsp	Artr						
Plot 2											
Pinus contorta	13.2	83	.159								
Pinus contorta	5.9	32	.184								
Pinus contorta	1.5	18	.083	Agsp	Artr						
Plot 3											
Pseudotsuga menziesii	5.4	23	.234								
Pinus contorta	5.5	24	.229	Agsp	Artr		Caru				
Plot 4											
Pinus contorta	6.7	25	.269								
Pinus ponderosa	3.8	25	.152								
Pinus contorta	0.6			Agsp	Artr	dArtr	Caru				
Plot 5											
Pinus contorta	10.6	49	.216								
Pseudotsuga menziesii	0.9	26	.035								
Pinus contorta	0.4			Agsp	Artr	dArtr	Caru				
Plot 6											
Pinus contorta	13.7	93	.147								
Pinus contorta	2.0	30	.067								
Pinus contorta	6.3	37	.170			dArtr	Caru		dotr		
Plot 7											
Pinus contorta	1.8	36	.050								
Pinus contorta	8.1	67	.121				Caru		dotr		
Plot 8											
Pinus contorta	6.8	55	.124								
Pinus contorta	1.5	44	.034				Caru	Vasc	dotr	2	p
Plot 9											
Pinus contorta	5.2	59	.088								
Pinus contorta	2.2	42	.062								
Pseudotsuga menziesii	0.2	24					Caru	Vasc	dotr	2	p
Plot 10											
Pinus contorta	8.2	142	.058								
Pinus contorta	1.7	36	.047				Caru	Vasc	dotr	2	p
Plot 11											
Pinus contorta	7.7	95	.081								
Pinus contorta	3.0	87	.034				Caru	Vasc	dotr	1	p
Plot 12											
Pinus contorta	5.8	40	.145								
Pinus contorta	0.8	29	.027								
Pinus contorta	14.7	93	.158				Caru		dotr	rotr	p
Plot 13											
Pinus contorta	5.3	23	.230								
Pseudotsuga menziesii	6.4	29	.221								
Pinus contorta	3.7	23	.160	Agsp	Artr						
Plot 14											
Pinus contorta											
Pseudotsuga menziesii	1.1	28	.039								
Pseudotsuga menziesii	5.2	29	.179								
Pinus contorta	2.3	23	.100	Agsp	Artr						
Plot 15											
Pinus contorta	10.4	45	.231								
Pseudotsuga menziesii	1.6	20	.080								
Pinus contorta	2.1	24	.088								
Pinus contorta	12.1	45	.267	Agsp	Artr						
Plot 16											
Pinus ponderosa	29.0	189	.153								
Pinus contorta	5.5	37	.149								
Pinus contorta	2.1	37	.054	Agsp	Artr						
Plot 17											
Pinus contorta	2.6	14	.186								
Pinus contorta	5.3	22	.241	Agsp	Artr						
Plot 18											
Pinus contorta	2.9	20	.186								
Pseudotsuga menziesii	7.4	32	.231								
Pseudotsuga menziesii	2.6	21	.124								
Pinus contorta	14.8	61	.243								
Pinus ponderosa	4.9	30	.163								
Pinus ponderosa	0.9	22	.041	Agsp	Artr				rotr		

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 19											
Pseudotsuga menziesii	2.8	43	.065								
Pseudotsuga menziesii	34.9	140	.249								
Pinus contorta	4.3	79	.054								
Pinus contorta	3.8	55	.069								
Pinus ponderosa	4.0	48	.083								
Pinis ponderosa	1.6	44	.036	Agsp	Artr				dotr		
Plot 20											
Pinus contorta	3.4	34	.100								
Pinus contorta	9.9	43	.230								
Pinus contorta	12.1	68	.178	Agsp	Artr	dArtr	Caru		dotr		
Plot 21											
Pinus contorta	7.0	94	.074								
Pinus contorta	0.8	36			Artr	dArtr	Caru		dotr		
Plot 22											
Pinus contorta	1.6	42	.038								
Pseudotsuga menziesii	2.1	38	.055								
Pinus contorta	10.8	86	.126				Caru		dotr	rotr	
Plot 23											
Pinus contorta	3.9	41	.095								
Pinus contorta	8.5	43	.198				Caru	Vasc	dotr	rotr	1
Plot 24											
Pinus contorta	2.7	38	.071								
Pinus contorta	7.8	52	.150				Caru		dotr		p
Plot 25											
Pinus contorta	10.3	169	.061								
Pinus contorta	0.3	39	.008								
Pseudotsuga menziesii	1.0	35					Caru		dotr	rotr	2
Plot 26											
Pinus contorta	7.3	93	.078								
Pinus contorta	2.5	42	.059				Caru	Vasc	dotr	rotr	1 p
Plot 27											
Pinus contorta	10.1	172	.059								
Pinus contorta	1.3	47	.028				Caru	Vasc	dotr	rotr	3
Plot 28											
Pinus contorta	2.7	43	.063								
Pinus contorta	12.2	149	.082								
Pinus contorta	5.9	47	.126								
Pseudotsuga menziesii	0.8	20					Caru	Vasc	dotr	rotr	2 p
Plot 29											
Pinus contorta	0.2	19									
Pinus contorta	9.8	163	.060								
Pinus contorta	12.6	146	.086				Caru	Vasc	dotr	rotr	3 p
Plot 30											
Pinus contorta	1.2	34	.035								
Pinus contorta	9.8	162	.060								
Pinus contorta	12.0	169	.071				Caru	Vasc	dotr	rotr	2 p
Plot 31											
Pinus contorta	1.5	37	.013								
Pinus contorta	9.3	150	.062								
Pinus albicaulis	0.6	38					Caru	Vasc	dotr	rotr	1 p
Plot 32											
Pinus contorta	2.1	51	.041								
Pinus contorta	5.6	51	.109								
Pseudotsuga menziesii	13.5	101	.134								
Pseudotsuga menziesii	1.7	57	.030								
Pseudotsuga menziesii	4.2	59	.071								
Pinus contorta	14.0	205	.068				Caru	Vasc	dotr		2 p
Plot 33											
Pinus contorta	5.1	81	.063								
Pinus contorta	1.0	73	.014								
Pseudotsuga menziesii	9.5	89	.107								
Pseudotsuga menziesii	15.4	112	.137								
Pseudotsuga menziesii	2.4	68	.035				Caru		dotr	rotr	2 p
Plot 34											
Pinus contorta	2.5	39	.064								
Pinus contorta	5.4	37	.146								
Pseudotsuga menziesii	2.6	34	.076								
Pseudotsuga menziesii	6.0	34	.176								
Pinus contorta	12.3	87	.141				Caru		dotr		p
Plot 35											
Pinus contorta	5.5	42	.131								
Pinus contorta	0.9	32	.028								
Pseudotsuga menziesii	2.1	38	.050		Artr	dArtr	Caru		dotr		2 p

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 36											
Pinus contorta	10.2	59	.173								
Pinus contorta	3.5	57	.061								
Pinus ponderosa	27.2	115	.236	Agsp	Artr			dotr			
Plot 37											
Pinus contorta	1.7	20	.085								
Pinus contorta	5.0	29	.172								
Pseudotsuga menziesii	7.1	38	.187								
Pseudotsuga menziesii	0.3	13	.023								
Pseudotsuga menziesii	14.9	96	.155								
Pinus contorta	13.9	74	.188	Agsp	Artr			dotr			
Plot 38											
Pinus contorta	3.7	18	.205								
Pinus contorta	8.9	37	.240	Agsp	Artr						
Plot 39											
Pinus contorta	6.8	23	.296								
Pinus contorta	1.0	19	.053								
Pseudotsuga menziesii	2.6	14	.186								
Populus tremuloides	0.8	15	.053	Agsp	Artr						
Plot 40											
Pinus contorta	0.8	10									
Pinus contorta	4.5	29	.155								
Pseudotsuga menziesii	0.6	19	.032								
Pseudotsuga menziesii	6.1	24	.254								
Populus tremuloides	4.8	47	.102	Agsp	Artr						
Plot 41											
Pinus contorta	4.1	23	.178								
Pinus contorta	0.3	14	.075								
Pseudotsuga menziesii	3.0	17	.176	Agsp	Artr						
Plot 42											
Pinus contorta	6.1	34	.179								
Pinus contorta	2.3	21	.109								
Pinus contorta	12.6	53	.238								
Pseudotsuga menziesii	0.6	15									
Pseudotsuga menziesii	4.9	39	.126		Artr	dArtr	Caru		dotr		
Plot 43											
Pinus contorta	10.0	103	.097								
Pinus contorta	2.9	31	.094								
Pseudotsuga menziesii	6.2	42	.148								
Pseudotsuga menziesii	0.8	32	.025			dArtr	Caru		dotr		
Plot 44											
Pinus contorta	6.7	46	.146								
Pinus contorta	2.2	34	.065								
Pseudotsuga menziesii	2.7	45	.060								
Pseudotsuga menziesii	5.5	47	.117			dArtr	Caru		dotr	rotr	
Plot 45											
Pinus contorta	1.3	39	.033								
Pinus contorta	10.6	86	.123								
Pseudotsuga menziesii	9.7	79	.123								
Pseudotsuga menziesii	2.2	53	.042				Caru		dotr	rotr	1 p
Plot 46											
Pinus contorta	2.7	42	.064								
Pinus contorta	8.3	86	.096								
Pseudotsuga menziesii	0.9	50									
Pseudotsuga menziesii	20.7	157	.132								
Pseudotsuga menziesii	11.0	134	.082				Caru	Vasc	dotr	rotr	3 p
Plot 47											
Pinus contorta	5.7	46	.124								
Pinus contorta	3.5	51	.069								
Pseudotsuga menziesii	3.0	53	.057								
Pseudotsuga menziesii	4.2	58	.072				Caru	Vasc	dotr	rotr	2 p
Plot 48											
Pinus contorta	8.3	169	.049								
Pinus contorta	2.4	40	.060								
Pseudotsuga menziesii	0.5	83	.015								
Pseudotsuga menziesii	24.4	178	.137								
Pseudotsuga menziesii	10.3	110	.094				Caru	Vasc	dotr	rotr	3
Plot 49											
Pinus contorta	2.8	46	.061								
Pinus contorta	11.1	173	.064								
Pseudotsuga menziesii	3.0	44	.068								
Pseudotsuga menziesii	6.2	40	.155								
Pinus albicaulis	0.2	26					Caru	Vasc	dotr	rotr	3

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 50											
Pinus contorta	7.8	58	.134								
Pinus contorta	1.8	50	.036								
Pseudotsuga menziesii	5.9	54	.109								
Pseudotsuga menziesii	0.6	42	.014								
Pinus albicaulis	0.2	35					Caru		dotr	rotr	3	p
Plot 51											
Pinus contorta	3.0	47	.064								
Pinus contorta	9.7	98	.099								
Pseudotsuga menziesii	1.2	37	.032				Caru	Vasc	dotr	rotr	1	p
Plot 52											
Pinus contorta	5.2	42	.124								
Pinus contorta	0.8	37	.022								
Pseudotsuga menziesii	2.5	34	.074								
Pinus albicaulis	1.5	35	.014				Caru	Vasc	dotr	rotr	?	
Plot 53											
Pinus contorta	8.7	165	.053								
Pinus contorta	2.6	31	.084								
Pseudotsuga menziesii	4.3	36	.119								
Pseudotsuga menziesii	2.7	43	.063				Caru	Vasc	dotr	rotr	4	
Plot 54											
Pinus contorta	9.8	123	.080								
Pinus contorta	2.1	26	.081								
Pseudotsuga menziesii	8.2	88	.093								
Pseudotsuga menziesii	1.7	44	.039								
Pinus albicaulis	0.2	23					Caru	Vasc	dotr	rotr	2	p
Plot 55											
Pinus contorta	3.4	46	.074								
Pinus contorta	10.9	86	.127								
Pseudotsuga menziesii	2.6	45	.058				Caru		dotr	rotr	3	
Plot 56											
Pinus contorta	10.7	131	.082								
Pseudotsuga menziesii	2.7	54	.050								
Pseudotsuga menziesii	8.6	54	.159								
Pseudotsuga menziesii	14.7	76	.193				Caru	Vasc	dotr	rotr	1	p
Plot 57											
Pinus contorta	3.7	33	.112								
Pinus contorta	9.4	46	.204								
Pseudotsuga menziesii	6.1	35	.174								
Pseudotsuga menziesii	15.5	48	.323								
Pinus albicaulis	2.2	34	.065				Caru		dotr	rotr		p
Plot 58											
Pinus contorta	2.1	47	.045								
Pinus contorta	9.2	78	.118				Caru		dotr	rotr		p
Plot 59											
Pinus contorta	0.5	34	.015								
Pinus contorta	8.2	47	.174				Caru		dotr	rotr	1	p
Plot 60											
Pinus contorta	4.7	67	.070								
Pinus contorta	2.0	53	.038				Caru		dotr	rotr	2	p
Plot 61											
Pinus contorta	9.5	88	.108								
Pinus contorta	3.3	54	.061								
Pseudotsuga menziesii	3.3	27	.122	Agsp	Artr				dotr		1	
Plot 62											
Pinus contorta	1.9	23	.083								
Pinus contorta	6.7	38	.176								
Pseudotsuga menziesii	4.2	35	.120								
Pseudotsuga menziesii	1.1	18		Agsp	Artr				dotr		1	
Plot 70											
Pinus contorta	2.1	22	.095								
Pinus contorta	7.0	42	.167								
Pseudotsuga menziesii	1.7	25	.068								
Pseudotsuga menziesii	5.4	37	.150								
Pseudotsuga menziesii	19.3	106	.182								
Pinus ponderosa	4.3	26	.165								
Pinus ponderosa	2.5	24	.104	Agsp	Artr		Caru		dotr	rotr	2	
Plot 71											
Pinus contorta	8.6	162	.053								
Pinus contorta	3.6	40	.090				Caru		dotr		2	
Plot 72											
Pinus contorta	8.0	49	.163								
Pinus contorta	2.1	44	.048								
Pinus contorta	13.1	104	.126								
Pinus ponderosa	10.9	60	.182								
Pinus ponderosa	2.6	53	.049								
Pinus ponderosa	15.8	68	.232	Agsp			Caru		dotr	rotr	1	

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 73											
Pinus contorta	13.4	62	.216								
Pinus contorta	0.4	24									
Pinus contorta	7.1	59	.120								
Pseudotsuga menziesii	2.9	24	.121	Agsp			Caru		dotr	1	
Plot 74											
Pinus contorta	1.0	26	.038								
Pinus contorta	6.7	74	.090								
Pseudotsuga menziesii	0.9	28	.032								
Pseudotsuga menziesii	14.2	93	.153								
Pseudotsuga menziesii	10.3	63	.163	Agsp	Artr				dotr	1	
Plot 63											
Pinus contorta	8.0	41	.195								
Pinus contorta	2.1	39	.054								
Pinus contorta	14.4	44	.327	Agsp	Artr	dArtr	Caru		dotr	1	
Plot 64											
Pinus contorta	0.8	24									
Pinus contorta	4.9	45	.109								
Pseudotsuga menziesii	0.3	23	.013		Artr	dArtr	Caru		dotr	1	p
Plot 65											
Pinus contorta	15.3	65	.235								
Pinus contorta	2.6	24	.108								
Pinus contorta	8.7	23	.264	Agsp	Artr	dArtr	Caru		dotr	1	
Plot 66											
Pinus contorta	5.8	38	.153								
Pinus contorta	0.8	8		Agsp	Artr				dotr		
Plot 67											
Pinus contorta	1.6	16	.100								
Pinus contorta	10.4	47	.221								
Pinus ponderosa	13.5	58	.233	Agsp	Artr				dotr		
Plot 68											
Pinus contorta	1.8	49	.037								
Pinus contorta	5.0	54	.092								
Pinus contorta	14.2	63	.225	Agsp	Artr				dotr		
Plot 69											
Pinus contorta	10.2	66	.154								
Pinus contorta	2.7	45	.060			dArtr	Caru		dotr	2	
Plot 75											
Pinus contorta	1.7	43	.040								
Pinus contorta	9.6	86	.112								
Pseudotsuga menziesii	2.0	44	.045								
Pseudotsuga menziesii	13.8	110	.125				Caru		dotr rotr	1	
Plot 76											
Pinus contorta	10.8	88	.123								
Pinus contorta	3.8	84	.045				Caru		dotr rotr	1	
Plot 77											
Pinus contorta	6.8	46	.148								
Pinus contorta	0.3	25	.012	Agsp	Artr		Caru		dotr rotr	1	
Plot 78											
Pinus contorta	6.3	21	.300								
Pinus contorta	3.8	21	.181								
Pseudotsuga menziesii	0.8	18									
Populus tremuloides	5.9	58	.102								
Populus tremuloides	2.0	53	.038	Agsp	Artr		Caru		dotr		
Plot 79											
Pinus contorta	10.5	38	.276								
Pseudotsuga menziesii	2.8	17	.165	Agsp	Artr						
Plot 80											
Pinus contorta	7.4	53	.140								
Pinus contorta	0.3	15									
Pseudotsuga menziesii	1.0	24	.042								
Pseudotsuga menziesii	11.4	63	.181	Agsp	Artr	dArtr	Caru		dotr	3	
Plot 81											
Pinus contorta	9.3	100	.093								
Pinus contorta	1.2	60	.020								
Pseudotsuga menziesii	2.0	43	.046				Caru		dotr rotr	3	
Plot 82											
Pinus contorta	3.0	48	.063								
Pinus contorta	6.1	53	.115								
Pseudotsuga menziesii	10.8	54	.200								
Pseudotsuga menziesii	0.9	26	.035				Caru	lasc	dotr rotr	2	p
Plot 83											
Pinus contorta	9.1	71	.128								
Pinus contorta	3.9	45	.087				Caru		dotr rotr	1	p

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 84											
Pseudotsuga menziesii	2.8	15	.187	Agsp	Artr						
Plot 85											
Pseudotsuga menziesii	8.0	31	.258								
Pseudotsuga menziesii	2.0	19	.105	Agsp	Artr						
Plot 86											
Pseudotsuga menziesii	3.5	24	.146								
Pseudotsuga menziesii	10.7	45	.238	Agsp	Artr						
Plot 87											
Pseudotsuga menziesii	1.5	14	.107								
Pseudotsuga menziesii	4.0	18	.222	Agsp	Artr						
Plot 88											
Pinus contorta	5.2	17	.306								
Pinus contorta	1.0	15	.067								
Pseudotsuga menziesii	1.7	18	.094								
Pseudotsuga menziesii	5.2	28	.186								
Pinus ponderosa	0.7	8	.087								
Pinus ponderosa	15.4	104	.148	Agsp	Artr						
Plot 89											
Pinus contorta	6.1	53	.115								
Pseudotsuga menziesii	20.6	130	.158								
Pseudotsuga menziesii	1.8	24	.075								
Pseudotsuga menziesii	4.8	35	.135		Artr	dArtr	Caru		dotr	rotr	2	
Plot 90											
Pinus contorta	6.3	37	.170								
Pinus contorta	2.0	34	.059								
Pseudotsuga menziesii	0.4	18	.022								
Pseudotsuga menziesii	4.3	33	.130								
Pseudotsuga menziesii	18.1	115	.157	Agsp			Caru		dotr	rotr		
Plot 91											
Pinus contorta	2.4	36	.067								
Pinus contorta	7.0	45	.155								
Pseudotsuga menziesii	0.8	22	.036								
Pseudotsuga menziesii	6.3	42	.150				Caru		dotr	rotr	2	p
Plot 92											
Pseudotsuga menziesii	4.1	21	.195								
Pseudotsuga menziesii	0.4	13	.031	Agsp	Artr						
Plot 93											
Pseudotsuga menziesii	49.5	420	.118								
Pseudotsuga menziesii	5.8	34	.170								
Pseudotsuga menziesii	2.7	37	.073	Agsp	Artr		Caru				1	
Plot 94											
Pseudotsuga menziesii	1.6	19	.084								
Pseudotsuga menziesii	6.5	28	.232	Agsp	Artr							
Plot 95											
Pseudotsuga menziesii	2.5	17	.147	Agsp	Artr							
Plot 96											
Pseudotsuga menziesii	5.5	23	.239								
Pseudotsuga menziesii	0.5	14	.036	Agsp	Artr							
Plot 97											
Pseudotsuga menziesii	1.7	18	.094								
Pseudotsuga menziesii	16.5	57	.289								
Pseudotsuga menziesii	8.5	38	.224	Agsp	Artr	dArtr						
Plot 98											
Pseudotsuga menziesii	19.5	116	.168								
Pseudotsuga menziesii	4.5	40	.113								
Pseudotsuga menziesii	0.2	14	.014	Agsp	Artr		Caru				2	
Plot 99											
Pinus contorta	9.1	97	.094								
Pinus contorta	2.9	42	.069								
Pseudotsuga menziesii	7.8	59	.132								
Pseudotsuga menziesii	3.0	42	.071				Caru		dotr	rotr	2	
Plot 100											
Pinus contorta	2.9	38	.076								
Pinus contorta	7.5	50	.150								
Pseudotsuga menziesii	11.4	54	.211								
Pseudotsuga menziesii	3.1	45	.069				Caru		dotr	rotr	3	
Plot 101											
Pseudotsuga menziesii	2.0	19	.105								
Pseudotsuga menziesii	7.0	27	.259	Agsp	Artr							

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 102											
Pseudotsuga menziesii	0.9	12									
Pseudotsuga menziesii	5.7	22	.259	Agsp	Artr						
PLot 103											
Pinus contorta	3.9	21	.186								
Pseudotsuga menziesii	4.9	22	.223								
Pseudotsuga menziesii	2.8	24	.177	Agsp	Artr						
Plot 104											
Pseudotsuga menziesii	22.4	119	.188								
Pseudotsuga menziesii	1.1	18	.009	Agsp	Artr	Caru					
Plot 105											
Pinus contorta	7.3	117	.062								
Pseudotsuga menziesii	1.0	26	.038								
Pseudotsuga menziesii	15.9	119	.134								
Pseudotsuga menziesii	7.3	68	.107			Caru		dotr		2	p
Plot 106											
Pinus contorta	7.2	177	.041								
Pinus contorta	2.8	134	.021								
Pseudotsuga menziesii	0.3	22									
Pinus albicaulis	0.2	26				Caru	Vasc	dotr		2	
Plot 107											
Pinus contorta	7.0	168	.061								
Pinus contorta	1.9	114	.017			Caru	Vasc	dotr	rotr	1	
Plot 108											
Pinus contorta	12.1	52	.233								
Pinus contorta	0.4	12	.033								
Pseudotsuga menziesii	0.4	9									
Pseudotsuga menziesii	15.2	40	.380	Agsp	Artr						
Plot 109											
Pinus contorta	11.8	54	.233								
Pinus contorta	3.7	23	.161								
Pseudotsuga menziesii	0.2	16	.012	Agsp	Artr	Caru		dotr	rotr		
Plot 110											
Pinus contorta	9.3	43	.216								
Pinus contorta	0.8	22	.036								
Pseudotsuga menziesii	7.9	33	.239								
Pseudotsuga menziesii	2.3	27	.085	Agsp	Artr	Caru					
Plot 111											
Pinus contorta	14.4	92	.156								
Pinus contorta	6.2	59	.105								
Pinus contorta	2.4	55	.044								
Pseudotsuga menziesii	0.7	26	.027			Caru		dotr	rotr	3	
Plot 112											
Pinus contorta	7.4	145	.051								
Pinus contorta	1.6	79	.020								
Pseudotsuga menziesii	0.2	28									
Pinus albicaulis	0.2	25				Caru	Vasc	dotr	rotr	1	p
Plot 113											
Pinus contorta	8.9	151	.051								
Pinus contorta	2.1	40	.053								
Pseudotsuga menziesii	2.9	32	.091								
Pseudotsuga menziesii	4.5	46	.099			Caru	Vasc	dotr	rotr	1	
Plot 114											
Pinus contorta	7.1	153	.046								
Pinus contorta	0.6	35				Caru	Vasc	dotr	rotr	1	
Plot 115											
Pinus contorta	8.4	159	.053								
Pinus contorta	2.8	44	.064			Caru	Vasc	dotr	rotr		
Plot 116											
Pinus contorta	6.2	64	.131								
Pinus contorta	2.3	38	.060			Caru	Vasc	dotr	rotr	3	p
Plot 117											
Pinus contorta	10.0	162	.062								
Pinus contorta	3.9	41	.095			Caru		dotr	rotr	2	
Plot 118											
Pinus contorta	15.3										
Pinus contorta	9.6	148	.065								
Pinus contorta	0.2	22	.009			Caru		dotr	rotr		

	DBH	AGE	GROWTH								FIRE SCARS	STUMPS
Plot 119												
Pinus contorta	8.9	147	.060				Caru		dotr	rotr	3	
Pinus contorta	2.0	36	.055									
Plot 120												
Pinus contorta	5.2	51	.102				Caru		dotr	rotr	2	
Pinus contorta	0.5	29										
Plot 121												
Pinus contorta	8.4	161	.052									
Pinus contorta	3.7	39	.095	Agsp	Artr		Caru		dotr	rotr	1	
Plot 122												
Pinus contorta	7.9	43	.184									
Pinus contorta	1.5	33	.045									
Pinus ponderosa	23.6	130	.182	Agsp	Artr		Caru		dotr	rotr	2	
Plot 123												
Pinus contorta	8.5	39	.218									
Pinus contorta	2.1	16	.131									
Pinus ponderosa	4.7	26	.181									
Pinus ponderosa	2.5	21	.119									
Pinus ponderosa	19.0	113	.168	Agsp	Artr					rotr	2	
Plot 124												
Pinus contorta	16.9	115	.147									
Pinus contorta	5.9	38	.155									
Pinus contorta	0.3	9										
Pinus ponderosa	7.5	30	.250	Agsp	Artr					rotr		
Plot 125												
Pinus contorta	8.9	31	.287									
Pinus contorta	3.9	18	.217	Agsp	Artr							
Plot 126												
Pinus contorta	6.0	22	.273									
Pinus contorta	0.8	10										
Pseudotsuga menziesii	2.0	18	.111	Agsp	Artr							
Plot 127												
Pinus contorta	15.2	57	.267									
Pinus contorta	4.4	21	.209									
Pinus contorta	0.4	14	.028									
Pseudotsuga menziesii	1.0	24		Agsp	Artr							
Plot 128												
Pinus contorta	2.6	20	.130									
Pinus contorta	10.2	51	.200	Agsp	Artr					rotr		
Plot 129												
Pinus contorta	2.2	21	.105	Agsp	Agsp							
Plot 130												
Pinus contorta	6.9	28	.246									
Pinus contorta	3.1	19	.163	Agsp	Artr							
Plot 131												
				Agsp	Artr							
Plot 132												
Pinus contorta	14.1	82	.172									
Pinus contorta	1.4	26	.054									
Pseudotsuga menziesii	0.2	24	.008	Agsp	Artr		Caru		dotr	rotr		
Plot 133												
Pinus contorta	13.7	65	.211									
Pinus contorta	0.2	17	.016									
Pinus contorta	4.5	24	.187									
Pseudotsuga menziesii	0.7	15	.047	Agsp	Artr	dArtr	Caru		dotr	rotr	2	
Plto 134												
Pinus contorta	4.3	41	.105									
Pinus contorta	12.8	102	.125									
Pinus contorta	0.3	16										
Pseudotsuga menziesii	16.8	103	.163									
Pseudotsuga menziesii	1.8	21	.086				Caru		dotr	rotr	2	
Pseudotsuga menziesii	5.1	36	.142									
Plot 135												
Pinus contorta	6.0	154	.039									
Pinus contorta	2.7	65	.041									
Pseudotsuga menziesii	0.5	27										
Pinus albicaulis	0.2	23					Caru		dotr	rotr	2	
Plot 136												
Pinus contorta	6.4	143	.045									
Pinus contorta	3.1	124	.025									
Pseudotsuga menziesii	0.1	21										
Pinus albicaulis	0.3	22					Caru	Vasc	dotr	rotr	2	

	DBH	AGE	GROWTH							FIRE SCARS	STUMPS
Plot 137											
Pinus contorta	10.9	155	.070								
Pinus contorta	1.4	33	.042			Caru	Vasc	dotr	rotr	1	
Plot 138											
Pinus contorta	7.0	148	.047								
Pinus contorta	2.6	42	.062								
Pinus albicaulis	0.3	27				Caru	Vasc	dotr	rotr	2	
Plot 139											
Pinus contorta	7.0	139	.050								
Pinus contorta	0.3	10				Caru	Vasc	dotr	rotr	1	
Plot 140											
Pinus contorta	5.5	49	.112								
Pinus contorta	2.0	44	.045			Caru	Vasc	dotr	rotr	2	
Plot 141											
Pinus contorta	6.9	86	.080								
Pinus contorta	3.2	54	.059			Caru		dotr	rotr	2	
Plot 142											
Pinus contorta	9.1	79	.115								
Pinus contorta	3.4	79	.043			Caru		dotr	rotr	2	
Plot 143											
Pinus contorta	4.8	33	.145								
Pinus contorta	2.5	19	.131	Agsp	Artr			dotr	rotr	1	
Plot 144											
Pinus contorta	11.3	96	.118								
Pinus contorta	0.5	23	.022	Agsp	Artr	Caru		dotr	rotr	1	
Plot 145											
Pinus contorta	7.3	78	.094								
Pinus contorta	1.2	36	.033	Agsp	Artr	Caru		dotr	rotr	1	

APPENDIX H

Occurrence of fires at the Battlefield
during the period 1662-1932.

	Forest Plot Number									Floodplain	Steppe	Arno and Gruell (unpub.)
	10	27	48	53	64	69	81	113	116			
1932				X		X						
1904							X					
1902	X	X	X	X	X			X	X			X
1871		X	X	X					X			
1861	X					X	X			X		
1858										X		
1841		X	X	X			X					X
1801									X			
1791												X
1761									X			X
1756												X
1754											X	
1738									X		X	
1734											X	
1733											X	
1726											X	
1716											X	X
1695												X
1662												X

APPENDIX I

Key to the Vascular Plants on the Battlefield

Following is a key for the vascular plants found on the Big Hole National Battlefield. This key is designed for those who have not had a course in plant identification.

The key is dichotomous in construction, i.e., there are always two opposing descriptive phrases designated by the same number which is followed by an "a" or "b". One of these phrases should fir the description of the plant in question while the other will not. Ignore all of the subordinate phrases under the phrase that does not fit and read the next set of phrases under the one that does. Eventually the name for the plant in question will be encountered. Figure 19 indicates the terminology applyed to the basic flower parts and inflorescence types used in the key.

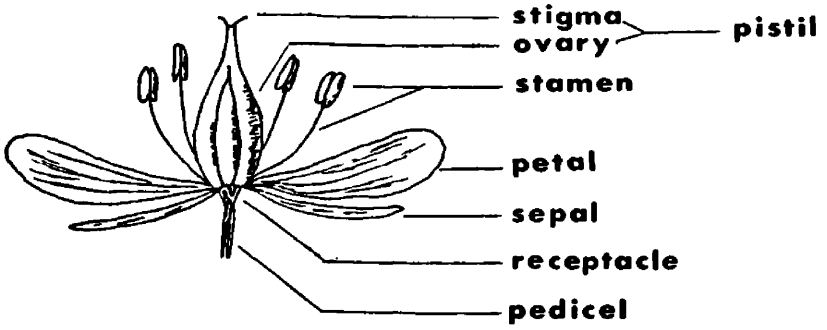
Figure 19

Basic flower parts and inflorescence types.

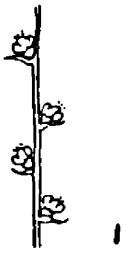
A. Basic flower parts.

B. Basic inflorescence types.

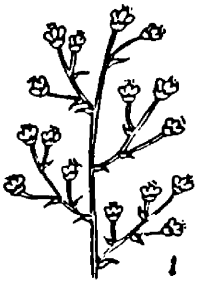
A. FLOWER PARTS



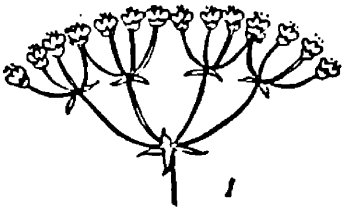
B. INFLORESCENCE TYPES



spike



panicle



compound umbel

[1] Anonymous 1971

Figure 19

Key to Major Groups

1a. Plants woody; leaves needle shaped (linear), or scale-like; fruit a cone or berry. Examples are pine, fir, and juniper.
Group I, Page

1b. Plants not as above.

2a. Plants flowering as indicated by flower buds, flowers, or fruits.

3a. Plants grass-like or rush-like; flowers not showy.
Group II, Page

3b. Plants not grass-like or rush-like; flowers may be showy.

4a. Flowers many on a common receptacle and appearing as 1 flower; when dissected the individual flowers can be seen. Examples are dandelions, daisies, thistles, and sagebrush.
Group III, Page

4b. Flowers 1 per receptacle.

5a. Petals lacking; flowers not showy. Group IV, Page

5b. Petals present, though sometimes very small.

6a. Flowers having petals that are all alike and have equal spacing. Group V

6b. Flowers having petals that are not all alike, or the spacing between the petals is unwqual. Group VI, Page

2b. Plants never flowering. Examples are ferns and club mosses.
Group VII, Page

Key to Group I Species

1a. Shrubs; leaves needle-like or scale-like; fruit whitish blue and berry-like. Common Juniper. *Juniperous communis*.

1b. Trees; leaves needle-like.

2a. Leaves 2 to 5 and clustered.

3a. Leaves 2 per cluster. Lodgepole Pine. *Pinus contorta*.

3b. Leaves more than 2 per cluster.

4a. Leaves 3 per cluster. Ponderosa Pine. *Pinus ponderosa*.

4b. Leaves 5 per cluster. Whitebark Pine. *Pinus albicaulis*.

2b. Leaves borne singly.

5a. Leaves soft with a blunt tip.

6a. Leaves attached to all sides of the branch; bark thick on older trees; cones hanging on lower branches and falling in 1 piece. Douglas Fir. *Pseudotsuga menziesii*.

6b. Leaves attached only to 2 sides of the branch; bark thin; cones upright on the upper branches and falling in numerous pieces. Grand Fir. Abies grandis.

5b. Leaves hard with a sharp tip. Engelmann Spruce. Picea engelmanni.

Key to Group II Sections
Grasses, Sedges, and Rushes

Illustrations for this section are in Figure 20 on page

1a. Glumes present. Grass Family. (Gramineae) Section 1, Page

1b. Glumes absent.

2a. Perigynia and scale present; stem triangular; tepals absent. Sedge Family. (Cyperaceae) Section 2, Page

2b. Perigynia and scale absent; stem round; tepals present. Rush Family. (Juncaceae) Section 3, Page

Key to Section 1 Species
Grass Family (Gramineae)

1a. Inflorescence a spike; florets more than 1 per spikelet.

2a. Spikelets 1 per node (a node is the point where a spikelet or leaf is attached to the stem).

3a. Inflorescence appearing to be flattened and congested; plants forming a bunch. Crested Wheatgrass. Agropyron cristatum.

3b. Inflorescence not flattened.

4a. Awn more than 10 mm long; plant forming a bunch. Bluebunch Wheatgrass. Agropyron spicatum.

4b. Awn less than 5 mm long.

5a. Spikelets 13 mm or longer; stem with a powdery waxy covering. Tall Wheatgrass. Agropyron elongatum.

5b. Spikelets 12 mm or shorter; stem without a powdery waxy covering. Slender Wheatgrass. Agropyron caninum.

2b. Spikelets more than 1 per node.

6a. Awn 30 mm or longer.

7a. Spikelets 2 per node. Squirreltail. Sitanion hystrix.

7b. Spikelets 3 per node, the 2 lateral spikelets raised on a stalk and sterile. Foxtail Barley. Hordeum jubatum.

Figure 20

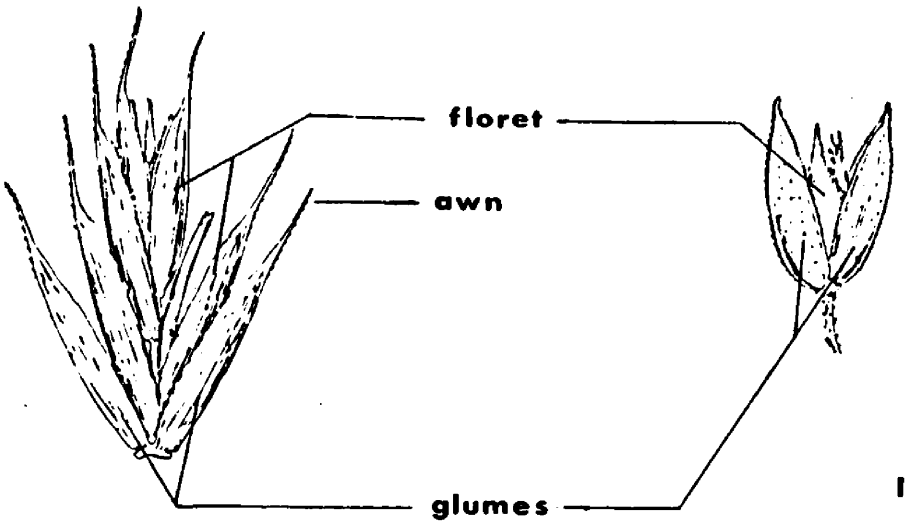
Illustrations of a typical grass flower and leaf, sedge fruit, and rush flower.

A. Typical grass flower or spikelet.

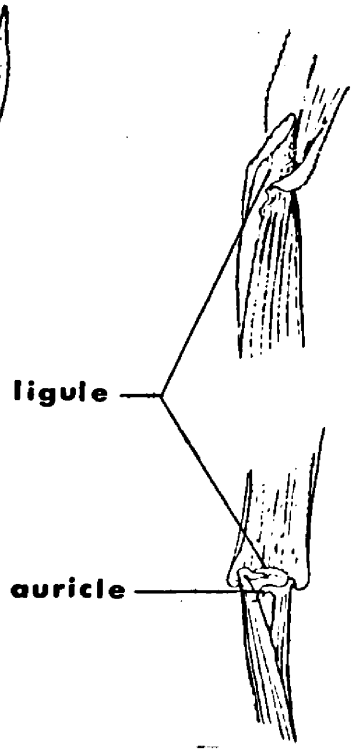
B. Diagnostic parts of a typical grass leaf.

C. Typical sedge fruit.

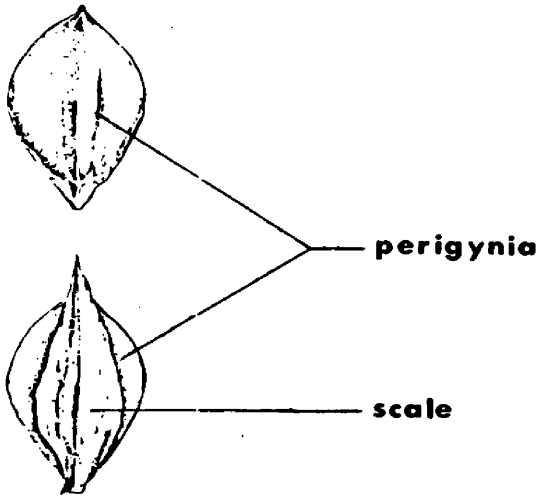
D. Typical rush flower.



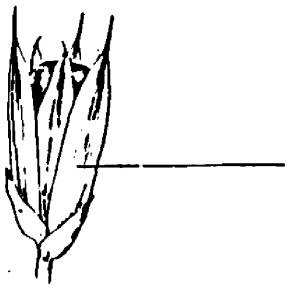
A. Typical Grass Spikelets [1]



B. Leaf Characteristics of Grasses (Gramineae) [1]



C. Fruit of Sedges (Carex) [2]



D. Flower of Rushes (Juncaceae) [3]

[1] Anonymous 1971

[2] Hermann. 1970

[3] Hermann 1975

Figure 20

6b. Awn less than 10 mm long.

8a. Plants 1 m or more in height. Basin Wildrye. Elymus cinereus.

8b. Plants shorter.

9a. Inflorescence 80 mm or longer; awn less than 7 mm long. Blue Wildrye. Elymus glaucus.

9b. Inflorescence 60 mm or less and compact; awn 7 or more mm long. Meadow Barley. Hordeum branchyantherum.

1b. Inflorescence a panicle with 1 to many florets per spikelet or a dense spike-like panicle with 1 floret per spikelet.

10a. Spikelets with only 1 floret.

11a. Awn 2 mm or longer.

12a. Awn 2-4 mm long; inflorescence spike-like.

13a. Inflorescence 40 mm long or less. Alpine Foxtail. Alopecurus alpinus.

13b. Inflorescence 60 mm or longer. Meadow Foxtail. Alopecurus pratensis.

12b. Awn 10 mm or longer.

14a. Inflorescence open, greater than 10 cm wide. Richardson Needlegrass. Stipa richardsonii.

14b. Inflorescence congested, less than 3 cm wide. Western Needlegrass. Stipa occidentalis.

11b. Awn less than 2 mm long or absent.

15a. Glumes about as long as broad and flattened. American Sloughgrass. Bechmannia syzigachne.

15b. Glumes longer than broad and folded along the midvein.

16a. Spikelets 4 mm or longer. Pine Reedgrass. Calamagrostis rubescence.

16b. Spikelets less than 3.5 mm long.

17a. Inflorescence spike-like and less than 1 mm wide; rachis (stem to which the spikelets are attached) not apparent.

18a. Spikelets with fine appressed hairs; florets short awned. Stream Foxtail. Alopecurus aequalis.

18b. Spikelets with coarse spreading hairs; florets awnless. Timothy. Phleum pratense.

17b. Inflorescence more than 1 cm wide; rachis visible.

19a. Plants 5 dm or taller.

20a. Leaves mostly 7 mm or wider when mature. Bluejoint Reedgrass. *Calamagrostis canadensis*.

20b. Leaves mostly less than 7 mm wide when mature. Northern Reedgrass. *Calamagrostis inexpansa*.

19b. Plants less than 5 dm tall.

21a. Inflorescence less than 1.5 cm wide when mature. Thin Bentgrass. *Agrostis diegoensis*.

21b. Inflorescence 1.5 cm wide or wider when mature.

22a. Branches of the inflorescence more than 4 cm long.

23a. Branches tending to be upright; inflorescence less than 4 cm wide. Idaho Bentgrass. *Agrostis idahoensis*.

23b. Branches spreading and delicate; inflorescence more than 4 cm wide when mature. Rough Bentgrass. *Agrostis scabra*.

22b. Branches of the inflorescence less than 4 cm long. Redtop. *Agrostis alba*.

10b. Spikelets having more than 1 floret.

24a. Glumes longer than or equal to the florets; if florets awned, then awned from the back.

25a. Inflorescence less than 2.5 cm wide.

26a. Florets 2 per spikelet. Wolf's Trisetum. *Trisetum wolfii*.

26b. Florets more than 2 per spikelet. Junegrass. *Koeleria cristata*.

25b. Inflorescence more than 2.5 cm wide.

27a. Spikelets less than 2 mm wide. Tufted Hairgrass. *Deschampsia caespitosa*.

27b. Spikelets more than 2 mm wide. Common Sweetgrass. *Hierochloe odorata*.

24b. Glumes shorter than the florets; if florets awned, then awned from the tip.

28a. Ligule consisting of hairs.

29a. Inflorescence usually consisting of 1 spikelet; leaves with long hairs. Onespike Oatgrass. Danthonia unispicata.

29b. Inflorescence having more than 1 spikelet.

30a. Inflorescence branches appressed. Timber Oatgrass. Danthonia intermedia.

30b. Inflorescence branches spreading. California Oatgrass. Danthonia californica.

28b. Ligule consisting of a membranous flap ot tissue.

31a. Spikelets more than 1 cm long; if florets awned, then the awn from a rounded tip or between two teeth.

32a. Awn more than 11 cm long. Cheatgrass. Bromus tectorum.

32b. Awn less than 11 cm long.

33a. Awn bent. Japanese Brome. Bromus japonicus.

33b. Awn straight.

34a. Spikelets 2 cm or longer.

35a. Florets 12 mm or longer; awn 2 mm or longer. Mountain Brome. Bromus carinatus.

35b. Florets less than 12 mm long; awn 2 mm long or absent. Smooth Brome. Bromus inermis.

34b. Spikelets less than 2 cm long.

36a. Spikelets less than 2 mm wide; plants of wet places. Northern Mannagrass. Glyceria borealis.

36b. Spikelets more than 2 mm wide; plants of dry places. Meadow Fescue. Festuca pratensis.

31b. Spikelets less than 1 cm long; if florets awned, then awned from a gradually tapered tip.

37a. Mature leaves 7 mm or wider. American Mannagrass. Glyceria grandis.

37b. Mature leaves less than 7 mm wide.

38a. Spikelets 2 mm long or less; stems tending to be prostrate. Mat Muhly. Muhlenbergia richardsonis.

38b. Spikelets more than 2 mm long; stems upright.

39a. Leaves with a prow-like tip and double midvein; awns lacking.

40a. Webbed hairs present at the base of the florets.

41a. Spikelets about 4 mm long. Kentucky Bluegrass. Poa pratensis.

41b. Spikelets about 3 mm long. Fowl Bluegrass. Poa palustris.

40b. Webbed hairs absent at the base of the florets.

42a. Florets over 4.5 mm long. Big Bluegrass. Poa juncifolia.

42b. Florets less than 4.5 mm long.

43a. Plants less than 4 dm tall. Sandberg Bluegrass. Poa sandbergii.

43b. Plants over 4 dm tall. Glaucous Bluegrass. Poa glaucifolia.

39b. Leaves without a prow-like tip and double mid vein; awns present or lacking.

44a. Awns lacking. King Spikefescue. Hesperochloa kingii.

44b. Awns present but less than 4 mm long.

45a. Florets over 7 mm long. Rough Fescue. Festuca scabrella.

45b. Florets less than 7 mm long.

46a. Florets 5-7 mm long. Idaho Fescue. Festuca Idahoensis.

46b. Florets 3-5 mm long. Sheep Fescue. Festuca ovina.

Key to Section 2 Species
Sedge Family (Cyperaceae)

1a. Leaves absent; inflorescence very compact and unbranched.

2a. Plants less than 10 cm tall. Needle Spike-sedge. Eleocharis acicularis.

2b. Plants more than 10 cm tall. Common Spike-rush. Eleocharis palustris.

1b. Leaves present; inflorescence various.

3a. Inflorescence unbranched; leaves wire-like. Threadleaf Sedge. Carex filifolia.

3b. Inflorescence branched; leaves various.

4a. Spikes appearing different, narrow staminate (pollen producing) spike or spikes above the wider pistillate (seed producing) spikes, or at times one staminate spike may be half staminate and half pistillate with the staminate above.

5a. Perigynia hairy.

6a. Plants of wet places. Wooly Sedge. Carex lanuginosa.

6b. Plants of the dry forest and grasslands.

7a. Leaf below the inflorescence longer than the inflorescence itself. Ross Sedge. Carex rossii.

7b. Leaf below the inflorescence shorter than the inflorescence itself. Northwest Sedge. Carex concinnoides.

5b. Perigynia not hairy.

8a. Pistillate spikes with 10 or less flowers each.

9a. Plants found on wet sites. Golden Sedge. Carex aurea.

9b. Plants of the dry forest or grassland. Elk Sedge. Carex geyeri.

8b. Pistillate spikes with more than 10 flowers each.

10a. Perigynia less than 3.5 mm long. Nebraska Sedge. Carex nebraskensis.

10b. Perigynia more than 3.5 mm long. Beaked Sedge. Carex rostrata.

4b. Spikes not appearing different.

11a. Plants either staminate or pistillate. Douglas Sedge. Carex douglasii.

11b. Plants having both staminate and pistillate flowers.

12a. Inflorescence almost as broad as high. Smallwing Sedge. Carex microperta.

12b. Inflorescence much taller than broad.

13a. Plants growing in clumps.

14a. Perigynia less than 6 mm long. Meadow Sedge. Carex praticola.

14b. Perigynia more than 6 mm long. Liddon's Sedge. Carex petasata.

13b. Plants not growing in clumps but widely spaced. Clustered Field Sedge. Carex pragracilis.

Key to Section 3 Species
Rush Family (Juncaceae)

1a. Bases of leaves hairy; seeds 3 per fruiting pistil. Field Woodrush. Luzula campestris.

1b. Base of leaves, if leaves are present, not hairy; seeds many per fruiting pistil.

2a. Leaves absent. Wire Rush. Juncus balticus.

2b. Leaves present.

3a. Leaves more than 3 mm wide, resembling iris leaves. Dagger-leaf Rush. Juncus ensifolius.

3b. Leaves more than 3 mm wide and not resembling iris leaves. Long-styled Rush. Juncus longistylis.

Key to Group III Species (Compositae)

Illustrations for this group are in Figure 21 on page

1a. Juice of plants milky; heads with ray flowers only. Section 1, Page

1b. Juice of plants watery; heads with ray and disk flowers or only disk flowers.

2a. Heads with ray and disk flowers.

3a. Ray flowers yellow, orange, or white. Section 2, Page

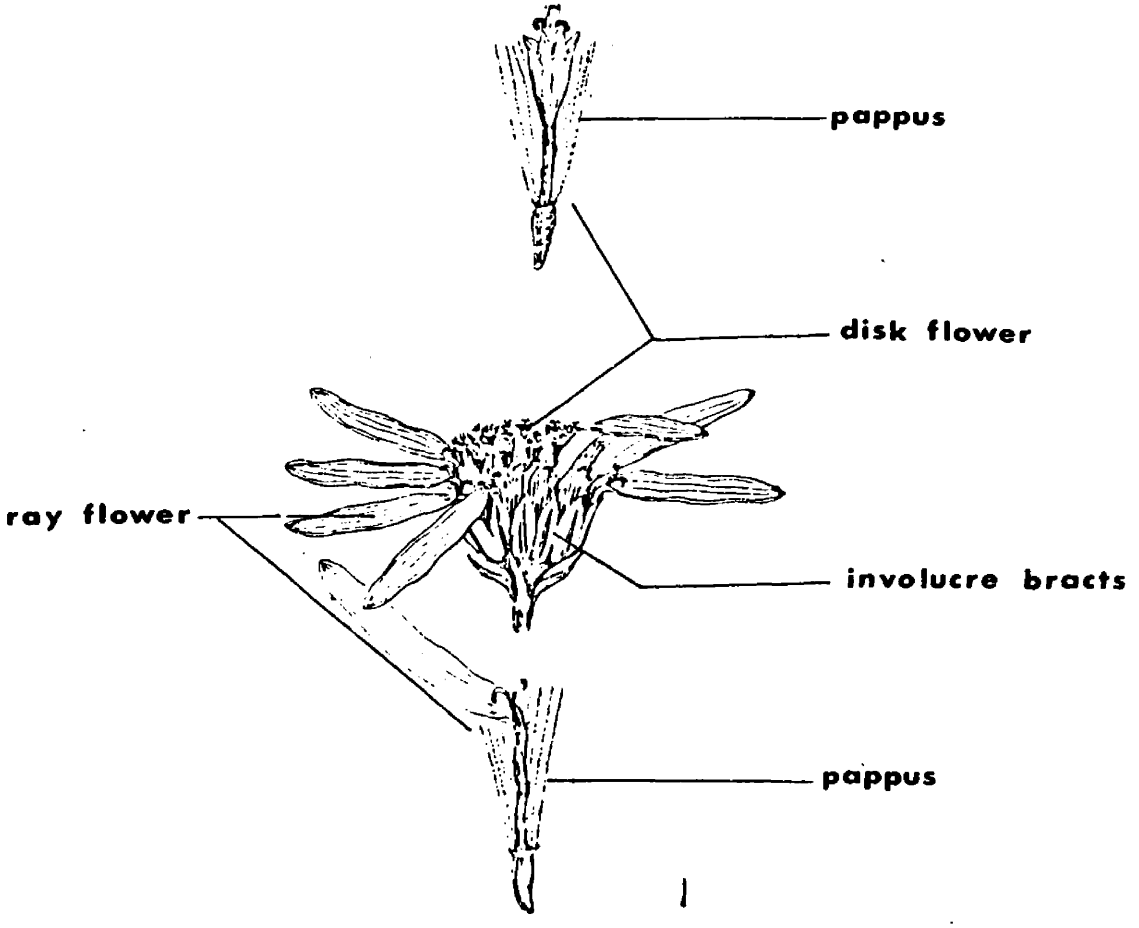
3b. Ray flowers blue or pink. Section 3, Page

2b. Heads with disk flowers only. Section 4, Page

Figure 21

Basic parts of a composite head.

Head of Compositae



Anonymous 1971

Figure 21

Key to Section 1 Species

1a. Flowering stem leafless.

2a. Flowers orange. Orange Agoseris. *Agoseris aruantiaca.*

2b. Flowers yellow.

3a. Leaves with a smooth edge.

4a. Involucral bracts broadest toward the base. Pale Agoseris. *Agoseris glauca.*

4b. Involucral bracts broadest toward the middle. Black-hair Microseris. *Microseris nigrescens.*

3b. Leaf edge with large indentations. Smooth Dandelion. *Taraxacum laevigatum.*

1b. Flowering stem bearing leaves.

5a. Flowering stem bearing 1 head.

6a. Leaves mostly on the flowering stem. Common Salsify. *Tragopogon dubius.*

6b. Leaves mostly basal. Nodding Microseris. *Microseris nutans.*

5b. Flowering stem bearing 1 head.

7a. Leaves smooth-edged.

8a. Flowers white. White Hawkweed. *Hieracium albiflorum.*

8b. Flowers yellow. Houndtongue Hawkweed. *Hieracium cynoglossoides.*

7b. Leaves not smooth edged.

9a. Underside of leaves covered with tangled hairs. Tapertip Hawksbeard. *Crepis acuminata.*

9b. Underside of leaves not covered with tangled hairs. Dandelion Hawksbeard. *Crepis runcinata.*

Key to Section 2 Species

1a. Flowers white; leaves finely dissected. Yarrow. *Achillea millefolium.*

1b. Flowers yellow or orange; leaves various.

2a. Leaves opposite on the flowering stem.

3a. Leaves more than 3 cm broad. Heart-leaf Arnica. Arnica cordifolia.

3b. Leaves less than 3 cm broad.

4a. Heads usually one per flowering stem; plants of dry areas. Hillside Arnica. Arnica fulgens.

4b. Heads more than one per flowering stem; plants of moist to wet areas. Meadow Arnica. Arnica chamissonis.

2b. Leaves alternate on the flowering stem.

5a. Involucral bracts very sticky.

6a. Ray flowers conspicuous. Curlcup Gumweed. Grindelia squarrosa.

6b. Ray flowers inconspicuous. Cluster Tarweed. Madia glomerata.

5b. Involucral bracts not sticky.

7a. Heads less than 10 per flowering stem.

8a. Some basal leaves over 12 cm long.

9a. Leaves arrowhead-shaped. Arrowleaf Balsamroot. Balsamorhiza sagitata.

9b. Leaves not arrowhead-shaped. Entire-leaved Goldenweed. Haplopappus integrifolius.

8b. All basal leaves less than 12 cm long.

10a. Pappus of scales. Wooly Eriophyllum. Eriophyllum lanatum.

10b. Pappus of bristles.

11a. Basal leaves less than 5 mm wide. Wooly Goldenweed. Haplopappus lanuginosus.

11b. Some basal leaves more than 5 mm wide. Singlehead Goldenweed. Haplopappus uniflorus.

7b. Heads more than 10 per flowering stem.

12a. Involucral bracts of different lengths and overlapping.

6b. Petals of ray flowers more than 1 mm wide.

7a. Some outer involucral bracts almost the same length as the inner. Western Aster. Aster occidentalis.

7b. All of the outer involucral bracts less than half the length of the inner. Creeping Aster. Aster chilensis.

Key to Section 4 Species

1a. Plants with sharp spines.

2a. Heads in a tight cluster and surrounded by leaves. Elk Thistle. Cirsium scariosum.

2b. Heads neither in a tight cluster nor surrounded by leaves.

3a. Involucral bracts 5 mm or more wide. Musk Thistle. Carduus nutans.

3b. Involucral bracts less than 5 mm wide.

4a. Plants not branched; terminal head at least 3 cm across when pressed. White Thistle. Cirsium hookerianum.

4b. Plants branched; terminal head less than 3 cm across when pressed.

5a. Plants spreading by rhizomes and forming dense communities. Canada Thistle. Cirsium arvense.

5b. Plants not spreading by rhizomes and forming dense communities. Bull Thistle. Cirsium vulgare.

1b. Plants without sharp spines.

6a. Flowers purple. Spotted Knapweed. Centaurea maculosa.

6b. Flowers not purple.

7a. Leaves deeply lobed or divided.

8a. Leaves green; heads over 5 mm wide.

9a. Plants over 5 dm tall. Common Tansey. Tanacetum vulgare.

9b. Plants less than 3 dm tall. Pineapple Weed. Matricaria matricaroides.

8b. Leaves grayish green; heads less than 5 mm wide.

10a. Plants woody. Big Sagebrush. Artemisia tridentata.

13a. Cluster of heads taller than broad.
Canada Goldenweed. Solidago canadensis.

13b. Cluster of heads as tall as broad.
Missouri Goldenweed. Solidago missouriensis.

12b. Involucral bracts about the same length and not overlapping except for 2 or 3.

14a. Leaves arrowhead-shaped. Seneco triangularis.

14b. Leaves not arrowhead-shaped.

15a. Leaves mostly on the upper portion of the stem.
Tall Butterweed. Senecio serra.

15b. Leaves mostly on the lower portion of the stem.
Lambstongue Groundsel. Senecio integerrimus.

Key to Section 3 Species

1a. Leaves deeply divided and mostly basal. Fernleaf Fleabane.
Erigeron compositus.

1b. Leaves not deeply divided and mostly on the flowering stem.

2a. Some leaves more than 3 cm wide. Showy Aster.
Aster conspicuus.

2b. All leaves less than 3 cm wide.

3a. Heads 1 per stem. Northwest Aster. Aster stenomeres.

3b. Heads more than 1 per stem.

4a. Upper portion of the flowering stem with stalked globose hairs. Thickstem Aster. Aster integrifolius.

4b. Upper portion of the flowering stem without stalked globose hairs.

5a. Involucral bracts densely covered with hairs.
Purple Dasiy Fleabane. Erigeron corymbosus.

5b. Involucral bracts not densely covered with haris though there may be many hairs on their edges.

6a. Petals of ray flowers less than 1 mm wide. The ray flower has 5 fused petals even though they appear as 1.
Oregon Fleabane. Erigeron speciosus.

10b. Plants not woody.

11a. Leaves less than 2 cm long. Fringed Sagewrot. Artemisis frigida.

11b. Leaves mostly over 2 cm long. Cudweed Sagewort. Artemisia ludoviciana.

7a. Leaves smooth edged, not deeply lobed and divided.

12a. Plants woody.

13a. Involucral bracts 4 or 5. Gray Horsebrush. Tetradymia canescens.

13b. Involucral bracts more than 5.

14a. Leaves less than 3 cm long. Green Rabbitbrush. Chrysothamnus viscidiflorus.

14b. Leaves mostly over 3 cm long. Rubber Rabbitbrush. Chrysothamnus nauseosus.

12b. Plants not woody.

15a. Flower heads sticky. Cluster Tarweed. Madia glomerata.

15b. Flower heads not sticky.

16a. Basal leaves white on the lower side and green on the upper. Raceme. Antennaria racemosa.

16b. Basal leaves the same color on both surfaces.

17a. Leaves less than 2 cm long and mostly basal.

18a. Heads elevated on a stem. Rose Pussytoes. Antennaria microphylla.

18b. Heads not elevated on a stem. Low Pussytoes. Antennaria dimorpha.

17b. Leaves mostly over 2 cm long and mostly on the flowering stem.

19a. Involucral bracts white; leaves with one primary midvein. Pearly Everlasting. Anaphalis margaritaceae.

19b. Involucral bracts pink, brown, or whitish; leaves with 3 primary veins. Tall Pussytoes. Antennaria anaphaloides.

Key to Group IV Species

1a. Plants woody.

2a. Leaves and young stems covered with brown scales; flowers not densely clustered. Buffalo-berry. *Shepherdia canadensis*.

2b. Leaves and young stems not covered with brown scales; flowers densely clustered.

3a. Trees.

4a. Leaves with a flat petiole (portion of the leaf between the branch and blade); plants growing in groves; bark smooth. Quaking Aspen. *Populus tremuloides*.

4b. Leaves with a round petiole; plants not in groves; bark on at least the older trees rough. Black Cottonwood. *Populus trichocarpa*.

3b. Shrubs.

5a. Pistillate and staminate flowers without hairs. Black willow. *Salix lasiandra*.

5b. Pistillate and staminate flowers with haris.

6a. Plants in flower after the leaves are well developed. Geyer Willow. *Salix geyeriana*.

6b. Plants in flower before the leaves are well developed.

7a. Hairs on pistillate and staminate flowers straight. Drummond Willow. *Salix drummondiana*.

7b. Hairs of pistillate and staminate flowers curled. Yellow Willow. *Salix rigida*.

1b. Plants not woody.

8a. Receptacle elongate and bearing many pistils above the 5-10 stamens. Sedge Moustail. *Myosurus aristatus*.

8b. Receptacle not elongate.

9a. Plants aquatic.

10a. Plants feathery or lace-like.

11a. Small bladders scattered among the leaves. Common Bladderwort. *Utricularia vulgaris*.

11b. Small bladders absent. American Milfoil. *Myriophyllum spicatum*.

10b. Plants not feathery or lace-like.

12a. Leaves over 5 cm long.

13a. Flowers in ball-shaped clusters.
Narrow-leaved Bur-reed. Sparganium angustifolium.

13b. Flowers not in ball-shaped clusters.

14a. Leaves less than 2 mm wide. Berchtold's Pondweed.
Potamogeton berchtoldii.

14b. Leaves over 4 mm wide. Ribbonleaf Pondweed.
Potamogeton epihydrus.

12b. Leaves less than 2 cm long.

15a. Plants with two kinds of leaves, upper about 3 mm wide and the lower about 1 mm wide. Spring Water-starwort.
Callitriche verna.

15b. Plants with one kind of leaf. Two-edged Water-starwort.
Callitriche anceps.

9a. Plants not aquatic.

16a. Plants parasitic only on lodgepole pine.
American Dwarf Mistletoe. Areceuthobium americanum.

16b. Plants not parasitic.

17a. Leaves 4-6 from each node (point of attachment for leaves and branches).

18a. Flowers white. Northern Bedstraw. Galium boreale.

18b. Flowers greenish.

19a. Leaves 4 per node. Thinleaf Bedstraw.
Galium bifolium.

19b. Leaves 6 per node. Sweetscented Bedstraw.
Galium trifolium.

17b. Leaves 1 or 2 per node.

20a. Stamens of male flowers numerous, pendulous, and resembling a fringe. Western Meadow Rue.
Thalictrum occidentale.

20b. Stamens of male flowers not pendulous.

21a. Plants less than 7 mm tall. Slender Androsace.
Androsace filiformis.

21b. Plants more than 7 cm tall.

22a. Flowers in tall narrow spikes; leaves all basal. Broadleaf Plantain. Plantago major.

22b. Flowers not in tall narrow spikes; leaves on the flowering stem.

23a. Leaves over 2 cm wide. Lamb's Quarter. Chenopodium album.

23b. Leaves less than 2 cm wide. Povertyweed. Monolepsis nuttaliana.

Key to Group V Sections

1a. Floral parts in groups of 3 or 6; leaves with parallel veins; fruit a 3 valved capsule. Section 1, Page

1b. Floral parts not in groups of 3 or 6; or leaves with netted veins.

2a. Floral parts in groups of 3 or 6. Section 2, Page

2b. Floral parts not in groups of 3 or 6.

3a. Flowers with petals completely seperate; sepals may be united.

4a. Flowers with 4 petals and 4 sepals. Section 3, Page

4b. Flowers with 5 or more petals.

5a. Stamens more than 10. Section 4, Page

5b. Stamens 10 or fewer. Section 5, Page

3b. Flowers with the petals at least partially united. Section 6, Page

Key to Section 1 Species

1a. Ovary below the floral parts.

2a. Flowers over 5 cm wide. Rocky Mountain Iris. Iris missouriensis.

2b. Flowers less than 3 cm wide. Common Blue-eyed Grass. Sisyrinchium angustifolium.

1b. Ovary enclosed by the floral oarts.

3a. Flowers blue. Common Camas. Camassia quamash.

3b. Flowers not blue.

4a. Flowers mostly replaced by small bulbs which smell like onions. Geyer's Onion. Allium geyeri.

4b. Flowers not repalced by small bulbs.

5a. Some leaves over 2 cm wide.

6a. Flowers green. Green False Hellebore. Veratrum viride.

6b. Flowers whitish. Starry False Solomon's Seal. Smilacina stettata.

5b. All leaves less than 2 cm wide.

7a. Flowers in dense clusters. Death Camas. Zigadeneus venenosus.

7b. Flowers not in dense clusters.

8a. Flowers yellow and nodding. Yellow Bell. Fritillaria pudica.

8b. Flowers whitish and upright. Mariposa Lily. Calochortus nuttallii.

Key to Section 2 Species

1a. Leaves mostly basal.

2a. Flowers pink. Strict Buckwheat. Eriogonum strictum.

2b. Flowers yellow to white. Sulfur Buckwheat. Erigonum umbellatum.

1b. Leaves mostly on the stem.

3a. Leaves with wavy edges. Curly Dock. Rumex crispus.

3b. Leaves without wavy edges.

4a. Leaves with two prominent projections near the base. Sheep Sorrel. Rumex acetosella.

4b. Leaves without two prominant projections near the base. Few-leaved Dock. Rumex paucifolius.

Key to Section 3 Species

1a. Ovary below the floral parts.

2a. Flowers yellow; leaves basal. Long-leaf Evening-primrose. *Oenothera subacaulis*.

2b. Flowers not yellow; some or all the leaves on the flowering stem.

3a. Petals over 8 cm long. Fireweed. *Epilobium angustifolium*.

3b. Petals less than 8 cm long.

4a. Leaves at least 10 times as long as broad.

5a. Petals about 3 mm long. Panicled Willow-herb. *Epilobium paniculatum*.

5b. Petals less than 2 mm long. Groundsmoke *Gayophytum ramosissimum*.

4b. Leaves less than 5 times as long as broad.

6a. Leaves less than 2 cm long. Glandular Willow-herb. *Epilobium glandulosum*.

6b. Leaves over 3 cm long. Watson's Willow-herb. *Epilobium watsonii*.

1b. Ovary surrounded by the floral parts.

7a. Mature fruits less than 2 times as long as broad.

8a. Leaves mostly basal. Wild Candytuff. *Thlaspi fendleri*.

8b. Leaves mostly on the flowering stem.

9a. Upper leaves encircling the stem. Clasping Pepperweed. *Lepidium perfoliatum*.

9b. Upper leaves not encircling the stem.

10a. Stigma and style extended beyond the tip of the ovary.

11a. Sepals persistent and surrounding the fruit. Pale Alyssum. *Alyssum alyssoides*.

11b. Sepals falling before the fruit develops.

12a. Leaves dissected. Marsh Yellowcress. *Rorippa islandica*.

12b. Leaves with smooth edges.

13a. Stigma and style less than 1 mm long.
Desert Alyssum *Alyssum desertorum*.

13b. Stigma and style about 2 mm long.
Hoary False Alyssum. *Berteroa incana*.

10b. Stigma and style not extended beyond the tip of the ovary.

14a. Ovary about 10 mm long. Fanweed. *Thlaspi arvense*.

14b. Ovary about 3 mm long. Branched Pepperweed.
Lepidium ramosissimum.

7b. Mature fruits more than 2 times as long as broad.

15a. Mature fruits 1 cm or less in length.

16a. Leaves dissected. Richardson Tansymustard.
Descurainia richardsonii.

16b. Leaves with smooth edges.

17a. Fruit pedicels about 1-3 times as long as the fruit. A pedicel is the portion between the fruit and the stem.
Woods Draba. *Draba nemerosa*.

17b. Fruit pedicels about the same length as the fruit.
Alaska Draba. *Draba stenoloba*.

15b. Mature fruits over 1 cm long.

18a. Leaves highly parted or dissected.

19a. Terminal portion of the leaves at least 3 times as large as the lower. American Wintercress.
Barbarea orthoceras.

19b. Terminal portion of the leaves less than 3 times as large as the lower.

20a. Mature fruits spreading. Tumbelmsutard.
Sisymbrium altissimum.

20b. Mature fruits upright.

21a. Leaves divided more than once.
Flixweed Tansymustard. *Descurainia sophia*.

21b. Leaves divided only once. Pennsylvania Bittercress.
Cardamine pensylvanica.

18b. Leaves with a smooth edge or with a few lobes.

22a. Base of the leaves clasping the stem; flowers may be bluish.

23a. Leaves less than 5 mm wide.

24a. Mature fruits upright, spreading, or with dedicels slightly drooping. A dedicel is the portion between the fruit and the stem. Fewleaf Rockcress. Arabis sparsifolia.

24b. Mature fruits with pedicels sharply drooping. Holboell Rockcress. Arabis holboellii.

23b. Leaves over 1 cm wide. Tower Rockcress. Arabis glabra.

22b. Base of the leaves not clasping the stem; flowers white or wellow.

25a. Flowers white. Nuttall Rockress. Arabis nuttallii.

25b. Flowers yellow. Plains Wallflower. Erysimum asperum.

Key to Section 4 Species

1a. Plants growing in water.

2a. Leaves over 10 cm across and floating. Mountain Yellow Pond-lily. Nuphar polysepalum.

2b. Leaves less than 10 cm across, mostly submerged.

3a. Leaves dissected.

4a. Divisions of submerged leaves less than 1 mm across. Coil Buttercup. Ranunculus subrigidus.

4b. Some divisions of submerged leaves more than 1 mm across. Small Yellow Water-buttercup. Ranunculus gmelinii.

3b. Leaves not dissected, with a smooth edge. Spearwort Buttercup. Ranunculus flammula.

1b. Plants not growing in water.

5a. Plants appearing to be leafless when in flower; flowers light pink. Bitterroot. Lewisia rediviva.

5b. Plants possessing leaves when in flower; flowers white, yellow, or red.

6a. Plants woody.

7a. Flowers red; stems prickly. Woods Rose. Rosa woodsii.

7b. Flowers white or yellow; stems not prickly.

8a. Flowers white.

9a. Petals more than 3 mm long.

10a. Petals 8-10 mm long. Serviceberry. Amelanchier alnifolia.

10b. Petals 3-7 mm long. Chokecherry. Prunus virginiana.

9b. Petals less than 3 mm long. White Spiraea. Spiraea betulifolia.

6b. Plants herbaceous.

11a. Flowers white or redish.

12a. Plants over 3 dm tall. Western Baneberry. Actea rubra.

12b. Plants less than 3 dm tall.

13a. Leaves divided into 3 equal segments. Virginia strawberry. Fragaria virginiana.

13b. Leaves divided into more than 3 segments. Prairiesmoke. Geum triflorum.

11b. Flowers yellow.

14a. Leaves completely divided into 4-6 parts which originate at one point.

15a. Hairs on the leaves only on the edges. Varileaf Cinquefoil. Potentilla diversifolia.

15b. Hairs on leaves on all portions but mostly on the underside. Northwest Cinquefoil. Potentilla gracilis.

14b. Leaves divided and parts not originating from one point or leaves undivided.

16a. Leaves divided into more than 50 segments. Gordon's Ivesia. Ivesia Gordonii.

16b. Leaves divided into 10 or less segments.

17a. Plants almost hairless. Sagebrush Buttercup. Ranunculus glaberrimus.

17b. Plants hairy.

18a. Sepals persistent after flowering.

19a. Terminal leaflet of basal leaves much larger than the side leaflets. Largeleaf Avens. Geum macrophyllum.

19b. Terminal leaflet of basal leaves, if present, not much larger than the side leaflets.

20a. Leaflets mostly 7 or 6. Gland Cinquefoil. Potentilla glandulosa.

20b. Leaflets mostly 5 or 3. Norwegian Cinquefoil. Potentilla norvegica.

18b. Sepals persistent after flowering.

21a. Stems very hairy. Macoun's Buttercup. Ranunculus macounii.

21b. Stems with only a few hairs on the upper portion. Little Buttercup. Ranunculus uncinatus.

Key to Section 5 Species

1a. Inflorescence a compound umbel.

2a. Flowers yellow.

3a. Leaflets long and narrow, about 5 cm long. Nineleaf Lomatium. Lomatium triternatum.

3b. Leaflets short, less than 1 cm long. Mountain Lomatium. Lomatium cous.

2b. Flowers white.

4a. Leaflets (segments of the leaf) over 2 cm wide.

5a. Leaflets over 10 cm wide. Cow-parsnip. Heracleum lanatum.

5b. Leaflets less than 10 cm wide. Common Angelica. Angelica arguta.

4b. Leaflets less than 2 cm wide.

6a. Plants very hairy. Large-fruit Lomatium. Lomatium macrocarpum.

6b. Plants without hairs.

7a. Leaves mostly basal. Slender-leaved Licorice-root. Ligusticum tenuifolium.

7b. Leaves mostly on the stem. Yampa. Perideridia gairdneri.

1b. Inflorescence not a compound umbel.

8a. Plants woody.

9a. Leaves holly-like. Oregon Grape. Berberis repens.

9b. Leaves not holly-like.

10a. Plants less than 2 dm tall; leaves leathery.

11a. Leaves over 4 cm long. Common Pipsissewa. Chimaphila umbellata.

11b. Leaves about 2-3 cm long. Menzie's Pipsissewa. Chimaphila menziesii.

10b. Plants over 2 dm tall; leaves not leathery.

12a. Plants with spiny branches.

13a. Flowers in long pendulous clusters. Swamp Current. Ribes lacustre.

13b. Flowers in clusters, but not pendulous. White-stemed Gooseberry. Ribes inerme.

12a. Plants without spiny branches.

14a. Leaves and young stems hariy. Sticky Current. Ribes viscosissimum.

14b. Leaves and young stems not hairy.

15a. Flowers white. Hudson Gooseberry. Ribes hudsonianum.

15b. Flowers pink. Squaw Current. Ribes cereum.

8b. Plants herbaceous.

16a. Leaves fleshy and succulent.

17a. Leaves mostly falling as the flowers mature, basal clusters of leaves usually prominent. Lance-leaf Stonecrop. Sedum lanceolatum.

17b. Leaves not falling as flowers mature, basal clusters of leaves usually not prominent. Yellow Stonecrop. *Sedum stenopetalum*.

16b. Leaves not fleshy and succulent.

18a. Leaves opposite.

19a. Sepals united.

20a. Sepals purple-veined; leaves less than 2 mm wide. Douglas' Silene. *Silene douglasii*.

20b. Sepals not purple-veined; leaves over 5 mm wide. Menzies' Silene. *Silene menziesii*.

19b. Sepals separate.

21a. Sepals hairy.

22a. Petals over 7 mm long. Field Chickweed. *Cerastium arvense*.

22b. Petals less than 7 mm long. Big Chickweed. *Cerastium vulgatum*.

21b. Sepals not hairy.

23a. Leaves less than 1 mm wide.

24a. Plants prostrate. Red Spurry. *Spergularia rubra*.

24b. Plants upright. Ballhead Sandwort. *Arenaria congesta*.

23b. Leaves more than 1 mm wide.

25a. Leaves 4-6 mm wide. Blunteaf Sandwort. *Arenaria lateriflora*.

25b. Leaves less than 4 mm wide.

26a. Petals equal to or longer than the sepals. Longstem Chickweed. *Stellaria longipes*.

26b. Petals shorter than the sepals. Northern Chickweed. *Stellaria calycantha*.

18b. Leaves alternate.

27a. Sepals 2.

28a. Leaves less than 2 mm wide.

29a. Flowers 1 per flowering stem. Pygmae Bitterroot.
Lewisia pygmaea.

29b. Flowers more than 1 per flowering stem.
Narrowleaved Springbeauty. *Montia linearis*.

28b. Leaves more than 2 mm wide.

30a. Leaves 2. Western Springbeauty.
Claytonia lanceolata.

30b. Leaves more than 2. Water Springbeauty.
Montia chamissoi.

27b. Sepals more than 2.

31a. Flowers intermixed with the leaves; leaves mostly on the stem.

32a. Leaves less than 1 cm long. White-margined Knotweed.
Polygonum polygaloides.

32b. Leaves about 2 cm long. Douglas's Knotweed.
Polygonum douglasii.

31b. Flowers above the leaves; leaves mostly basal.

33a. Leaves less than 1 mm wide. Sedge Mousetail.
Myosurus aristatus.

33b. Leaves more than 3 mm wide.

34a. Flowers violet and nodding; petals reflexed.

35a. Leaves hairy. Shootingstar.
Dodecatheon conjugens.

35b. Leaves hairless. Southern Shootingstar.
Dodecatheon pulchellum.

34b. Flowers not violet, upright; petals not reflexed.

36a. Pistil 2 parted; leaves basal.

37a. Leaves about as long as broad and coarsly toothed. Brook Saxifraga.
Saxafraga arguta.

37b. Leaves much longer than broad, not coarsly toothed. Oregon Saxifraga.
Saxafraga oregana.

36b. Pistil not 2 parted; leaves various.

38a. Flowers in a tight terminal cluster, white to cream colored. Western Bistort. Polygonum bistortoides.

38b. Flowers not in a tight terminal cluster, color other than white or cream.

39a. Leaves deeply divided. Sticky Geranium. Geranium viscosissimum.

39b. Leaves not deeply divided if present.

40a. Green leaves absent. Pinesap. Hypopitys monotropa.

40b. Green leaves present.

41a. Leaves leathery and with sharp teeth on their edges.

42a. Some leaves over 4 cm long. Common Pipsissewa. Chimaphila umbellata.

42b. All leaves less than 4 cm long. Menzie's Pipsissewa. Chimaphila menziesii.

41b. Leaves not leathery and with sharp teeth on their edges.

43a. Flowers on one side of the stem. Side-bells Wintergreen. Pyrola secunda.

43b. Flowers on all sides of the stem.

44a. Leaves less than 3 cm wide. Green-flowered Wintergreen. Pyrola chlorantha.

44b. Leaves over 3 cm wide. Wintergreen. Pyrola asarifolia.

Key to Section 6 Species

1a. Plants woody.

2a. Flowers urn-shaped, stamens 8 or 10.

3a. Leaves smooth edged.

4a. Stems prostrate. Kinikinnick. Arctostaphylos uva-ursi.

4b. Stems upright. Smooth Menziesia. Menziesia ferruginea.

3b. Leaf edge finely serrate.

5a. Young stems green. Grouse Whortleberry. Vaccinium scoparium.

5b. Young stems brown.

6a. Some leaves over 1.5 cm long. Huckleberry. Vaccinium globulare.

6b. All leaves less than 1.5 cm long. Vaccinium caespitosum.

2b. Flowers tube or funnel shaped.

7a. Leaves alternate and not smooth-edged.

8a. Flowers white. Sticky Currant. Ribes viscosissimum.

8b. Flowers pink. Squaw Currant. Ribes cereum.

7b. Leaves opposite and smooth edged.

9a. Flowers yellow; leaves over 5 cm long. Twin-berry Honeysuckle. Lonicera involucrata.

9b. Flowers white to pink; leaves smaller.

10a. Flowers in groups of 2.

11a. Ovaries of the 2 flowers appearing to be united. Bluefly Honeysuckle. Lonicera caerulea.

11a. Ovaries of the 2 flowers separate. Roundleaf Snowberry. Symphoricarpos orephilus.

10b. Flowers in clusters of more than 2. Common Snowberry. Symphoricarpos albus.

1b. Plants herbaceous.

12a. Flowers nodding, violet; petals reflexed.

13a. Leaves hairy. Shootingstar. Dodecatheon conjugens.

13b. Leaves without hairs. Southern Shootingstar. Dodecatheon pulchellum.

12b. Flowers upright or nodding and blue; petals not reflexed.

14a. Plants mat forming; leaves scale-like; flowers white. Moss Phlox. Phlox muscoides.

14b. Plants not mat forming, upright; leaves well developed; flowers various.

15a. Flowers bright red. Scarlet Gilia. Gilia aggregata.

15b. Flowers not bright red.

16a. Leaves 2 or more per node (point where leaves and stems are attached to the stem).

17a. Leaves more than 2 per node. Northern Linanthus. Linanthus septentrianalis.

17b. Leaves 2 per node (opposite).

18a. All leaves less than 3 mm wide. Longleaf Phlox. Phlox longifolia.

18b. Some leaves more than 3 mm wide.

19a. Flowers blue or blue gray.

20a. Flowers deep blue; leaves less than 3 cm long. Explorers Gentian. Gentiana affinis.

20b. Flowers blue gray; leaves more than 3 cm long. Purple Frasera. Frasera albicaulis.

19b. Flowers pink, white, or yellow. Pink Microsteris. Microsteris gracilis.

16b. Leaves 1 per node (alternate) or basal.

21a. Flowers in tight ball-like clusters. Waterleaf. Hydrophyllum capitatum.

21b. Flowers not in ball-like clusters.

22a. Flowers blue and at least 5 mm across.

23a. Leaves dissected. Franklin's Phacelia. Phacelia franklinii.

23b. Leaves smooth edged, not dissected.

24a. Most stem leaves less than 3 mm broad. Roundleaf Hairbell. Campanula rotundifolia.

24b. Most stem leaves wider.

25a. Leaves hairy. Greenleaf Bluebell. Mertensia viridis.

25b. Leaves not hairy. Mountain Bluebells. Mertensia ciliata.

22b. Flowers other than blue or if so then less than 5 mm across.

26a. Leaves less than 4; flowers about 1.5 cm across. Dwarf Hesperochiron. Hesperochiron pumilus.

26b. Leaves more than 4; flowers smaller or larger

27a. Leaves dissected. Baby Blue Eyes. Nemophila breviflora.

27b. Leaves smooth edged.

28a. Plants prostrate. Scouler's Plagiobothrys. Plagiobothrys scouleri.

28b. Plants upright.

29a. Flowers over 5 mm across.

30a. Flowers yellow-green; plants usually multiple stemmed. Wester Gromwell. Lithospermum ruderale.

30b. Flowers white to yellow; plants usually single-stemmed. Virgate Phacelia. Phacelia heterophylla.

29b. Flowers less than 5 mm across.

31a. Total length of petals at least 8 mm.

32a. Sepals 8 mm long or longer. Pink Microsteris. Microsteris gracilis.

32b. Sepals less than 8 mm long. Narrow-leaved Collomia. Collomia linearis.

31b. Total length of petals less than 8 mm.

32a. Flowers yellow. Menzies' Fiddleneck. Amsinckia menziesii.

32b. Flowers blue or inconspicuous.

33a. Petals over 1 mm long, blue.

34a. Sepals fused for half of their length. Slender Forget-me-not. Myosotis micrantha.

34b. Sepals fused for less than half their length. European Stick Tight. Lappula echinata.

33b. Petals less than 1 mm long, whitish. Torrey's Cryptantha. Cryptantha torryana.

Key to Group VI Species

1a. Stamens more than 10.

2a. Plants over 6 dm tall. Tall Larkspur. Delphinium occidentale.

2b. Plants less than 6 dm tall.

3a. Plants on the moist floodplain. Slim Larkspur. Delphinium depauperatum.

3b. Plants on the dry portions of the bench. Low Larkspur. Delphinium bicolor.

1b. Stamens 10 or fewer.

4a. Stamens 10.

5a. Leaflets (individual segments of a divided leaf) 3.

6a. Inflorescence about as high as broad.

7a. Flowers about 15 mm long. Longstalk Clover. Trifolium longipes.

7b. Flowers about 10 mm long. White Clover. Trifolium repens.

6b. Inflorescence much higher than braod.

8a. Flowers yellow. Yellow Sweetclover. Melilotus officinalis.

8b. Flowers white. White Sweetclover. Melilotus alba.

5b. Leaflets more than 3.

9a. Plants less than 2 dm tall; inflorescence not surpassing the leaves. Pacific Lupine. Lupinus lepidus.

9b. Plants taller; inflorescence surpassing the basal leaves.

10a. Upper side of the leaves without hairs. Washington Lupine. Lupinus polyphyllus.

10b. Upper side of the leaves with hairs.

11a. Flowers 7-8 mm long. Silver Lupine. Lupinus argenteus.

11b. Flowers 9-10 mm long.

12a. Basal leaves prominent. Wyeth's Lupine. Lupinus wyethii.

12b. Basal leaves not prominent. Silky Lupine. Lupinus sericeus.

4b. Stamens less than 10.

13a. Leaves absent.

14a. Petals fused.

15a. Flower pedicels more than twice as long as the flowers. Tufted Broomrape. Orobanche fasiculata.

15b. Flower pedicels less than twice as long as the flowers. Clustered Broomrape. Orobanche corymbosa.

14b. Petals not fused.

16a. Flowers green. Early Coral-root. Corallorhiza trifida.

16b. Flowers purple. Western Coral-root. Corallorhiza mertensiana.

13b. Leaves present.

17a. Leaves with parallel venation.

18a. Leaves with a white midrib. Rattlesnake Plantain. Goodyera oblongifolia.

18b. Leaves without a white midrib.

19a. Flowers in a spiral arrangement. Hood Ladies' Tresses. Spiranthes romanzoffiana.

19b. Flowers not in a spiral arrangement. White Bog-orchid. Habenaria dilatata.

17b. Leaves without parallel venation.

20a. Plants having a strong mint odor.

21a. Flowers terminal. Nettle-leaf Giant Hyssop. Agastache urticifolia.

21b. Flowers intermixed with the leaves. Field Mint. Mentha arvensis.

20b. Plants not having a strong mint odor.

22a. Petals separate.

23a. Flowers yellow. Nuttall's Violet. *Viola nuttallii*.

23b. Flowers blue or white.

24a. Flowers white of light blue; growing in wet areas. Marsh Violet. *Viola palustris*.

24b. Flowers deep blue; growing in dry areas. Western Violet. *Viola adunca*.

22b. Petals united.

25a. Leaves dissected.

26a. Leaves opposite.

27a. Flowers 7-8 mm long. Sitka Vateriana. *Valeriana sitchensis*.

27b. Flowers about 3 mm long. Marsh Valeriana. *Valeriana dioica*.

26b. Leaves alternate.

28a. Plants aquatic, floating on the water. Lesser Bladderwort. *Utricularia minor*.

28b. Plants not aquatic, growing on land.

29a. Flowers hidden by colored leaves.

30a. Colored leaves yellow-white. Hairy Indian Paintbrush. *Castilleja cusickii*.

30b. Colored leaves yellow and violet. Owlclover. *Orthocarpus tenuifolius*.

29b. Flowers not hidden by colored leaves.

31a. Individual flowers resembling a pink elephant's head. Elephant's Head. *Pedicularis groenlandica*.

31b. Individual flowers not resembling an elephant's head.

32a. Flowers white. Coiled Pedicularis. *Pedicularis contorta*.

32b. Flowers purple. Parry's Lousewort. *Pedicularis parryi*.

25b. Leaves smooth-edged.

33a. Flowers hidden by red colored leaves.
Scarlet Indian Paintbrush. Castilleja miniata.

33b. Flowers not hidden by red colored leaves.

34a. Stamens 2.

35a. Leaves alternate. Purslane Speedwell.
Veronica peregrina.

35b. Leaves opposite.

36a. Some leaves 1-2 cm wide. Veronica americana.

36b. All leaves less than 1 cm wide.
Thymeleaf Speedwell. Veronica serpyllifolia.

34b. Stamens 4-5.

37a. Flowers yellow.

38a. Flowers 2-3 cm long. Yellow Monkey-flower.
Mimulus guttatus.

38b. Flowers about 1.5 cm long.
Musk Monkey-flower. Mimulus moschatus.

37b. Flowers blue or purple.

39a. Flowers about 5 mm long.
Small-flowered Blue-eyed-mary.
Collinsia parviflora.

39b. Flowers larger.

40a. Flowers over 2 cm long. Lemhi Penstemon.
Penstemon lemhiensis.

40b. Flowers smaller.

41a. Flowers less than 9 mm long.
Small-flowered Penstemon.
Penstemon procerus.

41b. Flowers larger.

42a. Some stem leaves over 5 cm long.
Rydberg's Penstemon.
Penstemon rydbergii.

42b. Stem leaves 2-4 cm long.
Alberta Penstemon. Penstemon albertinus.

Key to Group VII Species

1a. Plants less than 2 cm tall; growing in dry sunny areas. Compact Selaginella. *Selaginella densa*.

1b. Plants more than 2 cm tall; growing in moist to wet sunny or shaddy areas.

2a. Plants with a jointed stem; leaves absent. Field Horsetail. *Equisetum arvense*.

2b. Plants lacking an evident stem; leaves conspicuus and originating near the groud surface. Woodsia. *Woodsia oregana*.