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A Guide to the Teller Wildlife Refuge

Susan Keys Thomason

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A GUIDE TO THE TELLER WILDLIFE REFUGE

by

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INTRODUCTION

In October 1985, Otto Teller purchased 275 acres of Bitterroot riverbottom land near Corvallis, Montana. These land purchases were the first transactions in the formation of the Teller Wildlife Refuge. Over the next three years, more parcels of riverbottom and prime farmland were added to the original area. At this time, the total land holdings of the Teller Wildlife Refuge comprise 1,280 acres.

The Refuge includes three properties situated along the Bitterroot River. (See Figures 1 and 2.) The north property includes 262 acres, the main property encompasses 817 acres, and the south property totals 201 acres. The three properties are surrounded by private lands.

In order to preserve this land from development, conservation easements were added soon after the purchases. The Montana Land Reliance holds these easements. In May 1988, Mr. Teller formed a board of directors and organized the Teller Wildlife Refuge, Inc. to manage the land and carry out his goals of wildlife management, sustainable agriculture and environmental education.

This guide is directed toward the general visitor to the Refuge. Along with information on many aspects of the Refuge
Figure 1. Teller property location map
Figure 2. Location of Teller Wildlife Refuge
properties, the guide catalogs the resources present and opportunities available to students and visitors. The guide is divided into five sections. Part 1 includes the historic background of Refuge lands, the geology, early inhabitants and settlement history. Part 2 covers the development of the Refuge, the goals of its managers and the use of conservation easements. Part 3 contains local geographic information, the hydrology, climate and soils of the Refuge. Part 4 is a field guide to the natural areas of the Refuge; species that frequent the Refuge are listed. Part 5 is a teaching guide with suggested lesson ideas and a field trip format. Part 6 is an appendix, which includes plant and bird illustrations, a bibliography and a glossary.
PART 1

HISTORIC BACKGROUND

GEOLOGY

Geology of Western Montana

A long series of geologic events formed the mountains and valleys that make up western Montana. The geologic story of the region involves the theories of plate tectonics, which were developed during the 1960s and 1970s.

There is a small core at the center of the earth. This core is surrounded by a thick, intermediate zone called the mantle (See Figure 3.) The mantle consists of heavy, black rock called periodotite, which is rarely seen on the surface. The outer layer of the mantle is called the lithosphere. The crust of the earth is the outer skin. The crust on the ocean floor, the oceanic crust, is composed of basalt or black lava and is several miles thick. The crust of the continents, continental crust, is much thicker, around twenty-five miles thick in most areas. Continental crust is mostly granite, which is embedded in the lithosphere.

The earth's lithosphere consists of pieces called plates. There are about a dozen large plates and several smaller ones; together they completely cover the earth's surface.
Figure 3. The layers of the earth seen in cross section (Alt 1986:7)
These plates may move farther apart, collide or slide past each other. Plate movement created many of the rocks and landscapes of Western Montana (Alt 1986:2).

The continental crust retains a record of geologic events that have occurred. This record is found also in the younger sedimentary rocks that cover most areas. Sedimentary rocks are those deposited by wind, water or glaciers. The bottommost rocks are called basement rocks because they make up the base of the continental crust and lie directly on the mantle. The basement rocks of Montana crystallized into their present form about 2.7 billion years ago (Alt 1986:6).

The continental crust in Montana has been accumulating younger surface rocks for about 1.5 billion years. Thick deposits of sand and muddy sediments built up for 600 million years, until about 800 million years ago. These deposits are called the Belt formations, named for the Belt Mountains. These Precambrian rocks contain fossils of primitive plants but no animals. Around 800 million years ago a continental fracture established a new western edge for the North American continent. The coastline extended south from northeast Washington through western Idaho and eastern Oregon into the Sierra Nevada of California. This line remained the west coast of North America until 100 million years ago.

During Cambrian and Permian time, 570 million to 240 million years ago, large parts of Montana were underneath a
shallow covering of water. The flooded areas received deposits of sediment that cover the Belt formation and basement rock to depths of several thousand feet. The areas not flooded were islands or coastal plains only slightly above sea level. These Paleozoic deposits contain animal fossils.

The Mesozoic era, 240 to 65 million years ago, was the time of the dinosaurs. The earliest dinosaurs appeared as the Mesozoic era began, and the last species disappeared at the conclusion of the era. During the Mesozoic era, a single super continent formed and then split along the mid-Atlantic ridge. These events started a series of crustal movements in western North America that created the Rocky Mountains (Alt 1986:11).

The plate bearing the North American continent began to move west away from the newly formed Atlantic Ocean. The continent then collided with the floor of the Pacific Ocean. The plate broke along the continent's western margin to form a trench through eastern Washington and Oregon. The floor of the Pacific Ocean began to slide through the new trench and into the mantle beneath western North America. All this began about 175 million years ago. The events forming the Rocky Mountains occurred later, from 90 to 70 million years ago, at the end of Cretaceous time.
The plate collision at the trench off the old West Coast compressed the edge of the North American continent. The sedimentary rocks and continental crust formed thrust faults. This thrusting thickened the western margin of the continent, creating a broad highland. The oceanic crust, which was sinking through the trench, caused molten basalt and flaming hot steam to rise. (See Figure 4.) The thrust faulting was raised farther as heat expanded the rocks at depth. This bulge became unstable, and the sedimentary covering and continental crust began to break off. As the ancient basement magma became molten, it rose into the upper crust and crystallized to form a series of batholiths. A batholith is any large mass of granite. One large batholith is now exposed throughout central Idaho. Its eastern edge forms the Bitterroot Range. This is the Idaho Batholith. The Sapphire Block, an enormous slab of the upper crust about ten miles thick, broke away from the Idaho Batholith and moved fifty miles east into Montana. As the Sapphire Block moved east, the gap behind its trailing edge became the Bitterroot Valley (Alt 1986:16). (See Figure 5.)

Approximately 40 million years ago, the Montana climate became drier. There was less water in the streams and waterways to carry sediment. This dry period lasted until 20 million years ago. The loss of stream flow led to an increase
Figure 4. The formation of a batholith (Alt 1986:12)
Figure 5. The Sapphire and Pioneer Blocks (Alt 1986:15)
in the amount of sediment deposited in the broad valleys of the northern Rocky Mountains.

Crustal movements continued and can be detected by the tilted layers of these sediments. In most of the larger valleys, the sediment is over two thousand feet thick. These layers form the Renova formation in western Montana. The Renova formation is made up of pale grey and tan rocks of mostly sand and silt, along with large amounts of volcanic ash from eruptions in the Western Cascades of Oregon and Washington. Coal seams, which began as deposits of peat in ancient marshes, are present in this formation. Petrified redwood and fossil leaves have also been found. The climate of Montana was dry and cool but not extreme enough to exclude the growth of the redwoods in the mountains.

From 20 million to 10 million years ago, Montana had a tropical climate. This tropical area is represented by a layer of red soil on top of the Renova formation. This layer is of the same composition as modern tropical soils (Alt 1986:22). As the tropical rains began to fall in Montana, streams and larger rivers were formed. The western mountains of Montana were covered with tropical and subtropical hardwoods. The recently formed streams flowed through these forests.

A new dry period began about 10 million years ago. This second arid period was much drier than the first. Montana
became a true desert and remained so until the first ice ages began about 2.5 million years ago. As the streams dried, the broad mountain valleys became undrained desert basins. These second dry deposits are called the Six Mile Creek formation in western Montana. This formation consists of coarse gravel, layers of brown gravel mixed with sand and mud. Most of the Six Mile Creek formation lies on top of the red tropical soils. The Six Mile gravels contain petrified wood but no fossilized leaves. There are scattered bones and teeth from mammals of all sizes, including the early "models" of horses and camels (Alt 1986:25).

The Pleistocene, which began 2.5 million years ago, was the time of the great ice ages. The Pleistocene marks the beginning of the last major phase in the development of the landscape of Montana. The climate was wetter, green plants grew and soil erosion decreased all over Montana. Streams flowed easily across eastern Montana, but not so smoothly in western Montana. The broad valleys in the west had become basins with no outlets. These isolated valleys filled with water, which then overflowed across the lowest border. The water flowing through these spillways eroded them into the canyons that now connect the valleys of western Montana.

The ice ages were the most dramatic of geologic events. Enormous glaciers were formed and grew until each ice age came to a close. Each time the climate warmed, the ice
melted. The specifics of ice age weather are unknown; however, it was wetter and colder than the present climate. Mean annual temperature was probably a few degrees cooler (Alt 1986:27). Our modern landscapes show the effects of the ice. Jagged mountain peaks are caused by glacial sculpture. There were as many as twenty ice ages. Montana shows evidence of two of these episodes, both occurring during the late Pleistocene. In western Montana, ice age glaciation created the serrated peaks of the higher mountain ranges, such as the Bitterroots. These ranges drop off into deeply gouged valleys, which contain deep deposits of glacial sediments.

When the advancing edge of a glacier reaches warmer climates, the front begins to melt as fast as the glacier moves forward. The glacier deposits a load of sediment. Debris directly from glacial ice is called till and is a mixture of material of all sizes. Any deposit of glacial till is a moraine. A mountain glacier deposits lateral moraines along a valley's walls and terminal moraines across the glacier's front. The moraines outline the lower end of the glacier. (See Figure 6.)

During ice age summers great loads of sediment melted out of the ice. Meltwater rivers crossed the moraines and dumped their sediment downstream. These deposits of sand and gravel are called outwash and are found on the floors of mountain valleys. They spread out from terminal moraines forming
Figure 6. The arrangement of a mountain glacier, its moraines and the formation of meltwater streams (Alt 1986:30)

Currently Montana is still in an active geologic phase. In western Montana faults are still moving. This activity causes old mountain ranges to change and new ones to form. Sometime after the events of 50 million years ago, a new generation of faults began to separate rocks of the northern Rockies into blocks. Some moved up to form mountain ranges; others moved down to form broad basins. These movements generate earthquakes. The mountains of southwest Montana are rising along active faults and will continue to do so for some time.

Geology of the Bitterroot Valley

The Sapphire Block, which moved off the Idaho Batholith, is made up of Bitterroot mylonite, an extremely slabby gneiss half a mile thick. The Bitterroot mylonite is interpreted by geologists to have developed at a fault zone deep below the surface. The rocks flowed due to pressure and heat. The slabby gneiss moved like a sliding deck of cards (Alt 1986:131). (See Figure 7.) The surfaces of slabs of mylonite show faint lines and grooves called lineation, which indicate the direction of the rock movement. This rock lies along the east front of the Bitterroot Range, facing the valley. The mylonite continues beneath the Bitterroot Valley and Sapphire Range. (See Figure 8.)
Figure 7. The sliding movement of the Bitterroot mylonite
(Alt 1986:130)
Figure 8. Cross section of the Bitterroot Valley between Victor and Hamilton (Alt.1986:211)
The Sapphire Range is made of Precambrian sedimentary rocks. These Belt formations have little folding or faulting. The range has scattered intrusions of granite related to the Idaho Batholith. While the Sapphire Range lies on the interior of the Sapphire Block, the Garnet, Flint Creek and Anaconda-Pintlar ranges define the boundaries of the block. (See Figure 9.) The Garnet, Flint Creek and Anaconda-Pintlar ranges are made up of the edge of the Sapphire Block and rock that was bulldozed ahead of it (Alt 1986:132).

The serrated skyline of the Bitterroot Range indicates heavy glaciation. The peaks at the northern edge of the range consist of metamorphic rock, while those from Stevensville south are primarily granite. The eastern front of the Bitterroots is a smooth surface tilting about 25 degrees to the east. This smooth surface is well preserved on the lower parts of the range because it was once covered by the sediments of the Renova formation. The Renova sediments were deposited approximately 40 million years ago and are classified as tertiary. These sediments have now been eroded away. South of Hamilton the glaciers emerged from the mountains onto the floor of the valley, which is above the 4,000-feet melting point. They left large moraines. North of Hamilton the valley floor is lower. There, glaciers melted before they emerged from the mountains. In this area a large alluvial fan of glacial outwash spreads down from every
Figure 9. The Sapphire Block, which lies east of the Bitterroot Valley. Mountain ranges lie at its leading edges (Alt 1986:130).
canyon. The lower Sapphire Range was never glaciated. (See Figure 10 and Table 1.)

Between Hamilton and Stevensville the changing flow of the Bitterroot River has formed sloughs or oxbows. These abandoned courses carry river water during peak flows only. In the middle part of the valley, the river deposits a great deal of sediment. As these sediments begin to block the stream's passage, a new channel is formed. This is a typical cycle of streams that carry large amounts of sediment; they have unstable channels. The Bitterroot watershed does not have a great deal of erosion. The sediment, in the form of large and small cobbles and coarse gravels, is brought in as the river fills a depression in the valley created by a dropping fault block between the Hamilton and Stevensville. (See Figure 11.) If the river did not fill the depression with upstream sediment, this section of the valley would be a lake.

EARLY INHABITANTS

Migration and Expansion of Early Peoples

The passage of the first humans from Asia to the New World occurred about 30,000 years ago. This time frame has been determined from geologic records, though scientists are not sure exactly when or where the event took place. During this
Figure 10. Geology of the Bitterroot Valley, Montana (Simons 1981:8)
Table 1. Explanation of Geologic Deposits Shown on Map

**QUARTERNARY**

**Floodplain alluvium:** Unconsolidated sand, gravel and silt beneath the floodplain of the Bitterroot River; includes reworked glacial drift and Tertiary sediments.

**Low terrace alluvium:** Unconsolidated sand, gravel, silt and soil; includes glacial drift and reworked glacial drift and Tertiary sediments.

**High terrace alluvium:** Unconsolidated sand, gravel, some boulders and silt; includes glacial drift, reworked Tertiary sediments and talus deposits.

**Morainal deposits:** Unconsolidated deposits of boulders, cobbles, gravel, sand, silt and clay; occurs at the mouths of some west-side tributary canyons.

**TERTIARY**

**Sedimentary rocks:** Semiconsolidated bedded deposits of sand, silt, clay, ash and some gravel; these rocks probably underlie most of the valley, but are best exposed along high terrace remnants on the east side of the valley.

**PRECAMBRIAN TO TERTIARY**

**Bedrock:** Includes shale, quartzite, argillite and limestone of Precambrian age; granitic rocks of the Idaho Batholith; Tertiary volcanic rocks.

Source: Simons 1981:1
Figure 11. As the block between the active faults drops, the Bitterroot River fills that section of the valley floor with sediments (Alt 1986:213).
period a land bridge, 2,000 kilometers across at its greatest width, allowed the first Americans, Homo sapiens of Asian stock, to walk from Asia to North America. (Jennings 1978:25). Available to east Asian and northeast Asian Siberian peoples, this land bridge led onto a land area called Berengia, which, farther inland, became present-day Alaska. The land bridge disappeared when the glaciers melted and water levels rose. The Bering and Chuk Chi seas now separate the two continents (Jennings 1978:26).

After their arrival on the North American continent, these people could have followed one of two routes south. One path led inland between two glacial masses that were present during that time. The other path followed the coastal water route. Some archeologists believe these early people did not have the capability to travel on water at this time, and so they took the inland route (Jennings 1978:29). This inland route is called the Great North Trail and is thought to have led to Montana along the Rocky Mountain Front and continued through east-central Montana (Bryan 1985:9). It is most likely that hunting pursuits and drifting game herds led to spreading settlements (Jennings 1968:43). These early hunters were called Paleo Indians or Clovis man. Clovis man is named for a fluted stone projectile characteristic of this culture. Some of these projectiles have been found near Townsend,
Montana, and near Wilsall, Montana. The oldest are thought to be 12,000 to 13,000 years old (Bryan 1985:9).

The weather and the vegetation and animal species present on Berengia and the interior of Alaska at that time were similar to those found in present-day northeast Siberia (Jennings 1978:29). The climate was cold and dry. The land was a mixture of arctic steppe, tundra and arctic savanna. The dominant animals were mammoth, bison, horse and giant antelope; caribou and musk-oxen also lived on the tundra. South of the glacial ice masses and west of the Mississippi, the environment was not very different from what it is today. At the glacier's edge there were tundra and forest. The plains were covered with savanna, a grassland studded with trees. On the southern third of the continent, springs, lakes and streams were abundant (Jennings 1978:30).

Because of the familiarity of their surroundings, the new arrivals were able to use their technology and previously developed survival techniques. Stone tools were imported from Asia. The Paleo Indians were primarily hunters. They wandered in seasonal patterns, frequently returning to favorable hunting locations (Jennings 1978:63). The gathering of vegetation was minimal until 7,000 to 6,000 B.C. (Jennings 1978:34). They pursued big game, some species of which are now extinct. Caribou, mammoth, musk ox and long-horned bison were hunted in the northern regions, while on the southern
plains, horses, wolves, peccary and giant armadillos were
were sought (Jennings 1978:36). (See Figure 12.) Mammoth and
long-horned bison were the preferred game. Mass kill
techniques, such as canyon traps, were used. Archeologists
have found buffalo hunt remains near Clancy, Montana, dated
at 10,000 years ago. Changing environmental conditions led to
the disappearance of many species. As animal populations
decreased, the Clovis people disappeared. Later, prehistoric
or Meso Indians came into Montana, probably from the
Southwest. They were foragers and small game hunters who
lived in Montana's western valleys.

Environmental changes began to occur around 10,000 B.C. A
warming trend brought a decrease in available moisture.
Climatic and vegetational changes occurred fairly abruptly.
The glaciers that had existed in the Rocky Mountains began to
melt; lakes disappeared. The general trend leading up until
today involved the drying of the land and climate on the
plains and western North America. There were animal
extinctions worldwide, and human populations had to adapt to
avoid the same fate.

About 2,000 years ago a new group of prehistoric people
came into the Montana region from the south and west. The
Late Hunters are in many ways the direct ancestors of
contemporary Indians (Bryan 1985:9). These people lived on
the bison populations that had reestablished on the plains
Figure 12. Pleistocene fauna: bison, mammoth, caribou and musk-ox (Turner 1979:129)
and in the river valleys. By about 500 B.C., in the northwest United States, there were trends towards increased population with intensified subsistence activity and a growth in social complexity and interaction.

The Plateau area of eastern Washington and Oregon, Idaho and extreme southwest Montana is an area dominated by the Columbia and Fraser river systems. The woods and sagebrush-grasslands of this region were exploited by the native populations for game, edible roots and plants. The rivers of this Plateau area, with their annual run of salmon, were the primary focus of life (Jennings 1978:151). Salmon were taken during their spawning run and stored for winter use. The riverside villages were made up of five to ten large semi-subterranean earth lodges. During the spring and fall the villages were deserted, as the Indians ranged away from the river to gather vegetation and hunt (Jennings 1978:184). In western Montana, the Bitterroot River did not have salmon runs although the river had a good population of native cutthroat trout.

Native Americans

The American Indian is the descendant of the American continent's founding populations. The different cultures now present achieved their distinctness after their establishment in the New World. The American Indian physiological type
developed in response to various environments and evolutionary processes. Native American susceptibility to Eurasian diseases is one indication of this group's long isolation from the Old World (Jennings 1978:39).

Salish-speaking people occupied the northern Plateau region, reaching as far south as the Columbia River at one point. These people were the predecessors of the Flathead Indians who eventually lived in western Montana. Several other language groups also lived in this area. The round subterranean lodges used in this region varied in diameter from ten to forty feet, depending on the number of families who utilized them. The lodges were entered through the smokehole in the earth-packed log roof, and a notched log was used as an inside staircase (See Figure 13.) A second type of house was constructed of bark and was partially covered with dirt. These dwellings resembled a high-pitched roof set at ground level. They were sometimes forty feet in length with several families living in compartments off the main corridor. These homes were dismantled in the spring or after a death within. Tipis covered with reed mats were used on summer gathering trips. Dugouts or bark canoes served as transportation. Overland, women and pack dogs carried the load (Turner 1979:198).

Early clothing for men consisted of a breechcloth with fur or buckskin leggings. Robes of rabbit skin or woven grass
Figure 13. Subterranean lodges and bark canoe used by the Salish-speaking people (Turner 1979:198)
were also worn. The women wore skin dresses. The Salish tribes were particularly noted for their coiled cedar-root baskets, which were tall and rectangular or oval. They used mats of reed or grass for many purposes. Root staples were gathered by women and children; men hunted for birds, rabbit, beaver and marmot. Deer were relished when they could be driven over a cliff. The dietary mainstay was salmon. Platforms were built over the river for dipnetting or spearing. Women were kept away from the river because of a fear of ritual contamination; they performed the splitting, drying and cooking of the fish.

The villages or hamlets were guided by a father figure, while war leaders were elected during conflicts. Organized religious observances were not prominent. The Plateau culture that existed at the time of the white man's arrival was simple and receptive to outside influences (Turner 1979:199). The Plateau tribes had already been in contact with other cultures. The addition of the horse gave these people access to the buffalo. The traveling and trading that followed allowed cultures to mix. White penetration of the area began toward the end of the eighteenth century, in the form of the Hudson's Bay Company and Northwest Company fur traders (Turner 1979:200).
Montana Tribes

All of the Montana Indian tribes migrated into this region, most within the last three hundred years. They came to the area in search of hunting grounds or because they were pushed here by other groups. The boundaries of the tribes were not fixed. Each claimed the use of certain lands for hunting with stronger tribes dominating their neighbors. They freely invaded one another's territories. The artificial boundaries later imposed by whites meant nothing to the migratory tribes. The region called Montana was visited by neighboring tribes from many surrounding areas (Argenbright 1981:4). Plateau neighbors of the Flatheads came from the west and crossed the Bitterroot passes to reach the plains and hunt buffalo. The Nez Perce crossed Lolo Pass and traveled through the Bitterroot.

The only Indians who lived in Montana before 1600 were the Plateau Indians in western Montana. The best known are the Flatheads, who belonged to the Salishan language group. The Flatheads were the easternmost of all the Salishan tribes. Prior to the invasion of other tribes after 1600, the Salish lived in the Three Forks area and ranged east to the Big Horn Mountains. By the 1700s the Shoshoni had forced them to
retreat westward into the mountains (Argenbright 1981:2). Their homeland centered on the Bitterroot Valley by the time Lewis and Clark visited in 1805.

Bitterroot Valley Tribes

During the millennia between the end of the Ice Ages and arrival of white men in the Americas, those nomads whom we call Indians had discovered two empty continents and had settled their habitable places, including the Bitterroot Valley. The tribe that settled it were called the Flathead, or its French equivalent, by the explorers of the Northwest (Stevensville Historical Society 1971:34).

The label Flathead was a misnomer; the Flathead did not practice head shaping as did some of the related coastal tribes. Members of the Flathead tribe prefer to be known as the Salish. This name is taken from their mother tongue and means "the people." The Salish believe the name Flathead was given to them because they place one hand, palm flat, against the top of their heads when speaking with another person to show that they are paying attention.

Before the Salish settled in the Bitterroot, they were one of several tribes to live on the Columbia Plateau. They were nomadic river folk who followed the tributaries of the Columbia River, fishing, taking native roots and small game animals in the time before the introduction of the horse and gun. The inland Salish gradually migrated up the Columbia River to the Clark Fork. They lived in the valleys including
the Bitterroot. Their main encampment was near present-day Stevensville (Stevensville Historical Society 1971:37). For a time the Salish even ranged east to the prairies. There they picked up some of the culture and habits of the Plains tribes.

The Salish were known as peace-loving people. Trappers and explorers spoke of their generosity, loyalty and bravery. They were also described as good horsemen, orators and warriors. Their ill nature was reserved for their hereditary enemies, the Blackfeet, with whom they were constantly at war.

The Salish believed that natural objects in the world around them had supernatural powers. The sun was the creator, and the earth was the mother on which they subsisted. Animals, certain trees and rocks had magical powers that helped them against adversaries. The Afterlife was a place of lasting summer where game was plentiful (Bitterroot Valley Historical Society 1982:32). The white men found the Salish interested in Christianity. This interest was probably due to the tribe's need for allies against their more numerous and better-armed Blackfeet neighbors (Argenbright 1981:2).

Horses were acquired by the Salish from other tribes as early as the mid-1700s. The Shoshonian tribes obtained horses through Southwest trading and began dispersal of the horse in the Northwest. These mustangs were the descendants
of Spanish horses. After the arrival of horses, the Salish tribe took on the traits of the Plains tribes. The Salish traveled across the Continental Divide once or twice a year to hunt buffalo, elk and antelope on the plains. There were two roads to buffalo country from the Bitterroot Valley, north to Missoula and along the Clark Fork and Blackfoot rivers, or south through Ross' Hole and over the Continental Divide to the Big Hole (Bitterroot Valley Historical Society 1982:29). (See Figure 14.) They traveled east twice yearly in June or July and again in October (Cappious 1939:20). It was necessary to join forces with the Nez Perce at these times so the two tribes could provide protection for each other against the Blackfeet, who dominated the plains. Their survival depended on the hunting of game and the gathering of food, which was stored for winter use.

The tribe moved about according to the seasons, hunting and harvesting. Buffalo was especially important. They used the hide for tipi covers and clothing and moccasins, the horns and bones as tools, the tails for rope, and the hooves for glue (Bitterroot Valley Historical Society 1982:28). Bighorn sheep, black bear, moose, mule deer, white-tailed deer, coyote, wolf, lynx and elk were also hunted for hides and food. Small mammals such as beaver, muskrat, raccoon and skunk were taken along with cutthroat trout, whitefish, squawfish and suckers (Ward 1973:12).
Figure 14. Routes to buffalo country
Women and children worked through the seasons gathering food plants and drying them. The bitterroot was an important staple. Couse, blue camas, wild carrots, balsam root, young shoots of the bracken fern and cattails were also eaten (Bitterroot Valley Historical Society 1982:30). Berries were the tribe's main fruit. They gathered raspberries, strawberries, thimbleberries, serviceberries, elderberries, huckleberries, chokecherries, Oregon grape and snowberries (Ward 1973:12). These were dried and ground, mixed with pulverized meat and melted fat, then formed into cakes called pemmican.

Food was boiled by dropping hot stones from the fire into woven baskets full of water or cooked by steaming over a fire pit covered with leaves and soil. Various trees and bushes were utilized in tool production. Arrow shafts, sweat lodge frames and lodge poles were made from many types of wood. Cedar and spruce were used in basket and mat weaving. Many plants were used for perfumes or dyes. Kinnick kinnick was dried and smoked as tobacco. Other plants were used as preservatives and medicines (Stevensville Historical Society 1971:5).

Trading also provided metal articles to replace many handmade tools. Baskets were replaced by kettles and pails. Clothing decorations from nature gave way to beads brought by the Hudson's Bay and Northwest trading companies; porcupine
quills, fish vertebrae, bear claws, elk teeth and bone beads had been used before (Bitterroot Valley Historical Society 1982:32). With the coming of the Jesuit fathers and the establishment of St Mary's Mission in 1841, the old ways were slowly replaced and white settlers increased in number.

Between 1812 and 1820, an Iroquois Indian named Big Ignace La Mousse came to the Bitterroot Valley with twenty of his people. The Iroquois settled among the Salish and told the Bitterroot tribe of the Catholic religion and the Jesuit "blackrobes" who taught this faith (Stevensville Historical Society 1971:38). The Salish decided to invite their own "blackrobe" to the valley. Over the next several years men were sent east to St. Louis, Missouri, to communicate this desire to the bishop there. Many of these emissaries were not heard from again, but this did not deter the Salish. On their final trip, the messengers met Father Pierre De Smet by chance near Council Bluffs, Iowa. Although they went on to St. Louis, Father De Smet followed and gained permission to go back with the Salish.

Young Ignace led Father De Smet west. In 1840 they met a large encampment of the Salish, Nez Perce, Pend o'reilles and Kalispell tribes waiting at the headwaters of the Snake River. Father De Smet baptized six hundred members of the tribes. The group then moved on into the Bitterroot Valley. Father De Smet returned to St. Louis to raise funds and
gather more priests and laypeople. Back in Montana in 1841, he built St. Mary's Mission. Father Anthony Ravalli joined Father De Smet in 1845. Father Ravalli worked among the Salish as a physician and surgeon until his death in 1884. The mission's activities fluctuated with the local population of Indians, and it was abandoned as an Indian mission after the Salish had been removed to the Jocko Valley in 1891.

Chief Charlot was head of the Salish tribe during the tribe's last years in the Bitterroot Valley. Up until the 1870s the white settlers and the Salish had lived peacefully. There was enough land, and the settlers enjoyed the protection the tribe provided them (Chaffin 1971:86). A treaty had been made between Governor Isaac Stevens of Washington Territory and the local tribes in 1855. This document enlisted their help in protection of the settlers from the Blackfeet.

Another treaty was signed in the Bitterroot Valley on July 16, 1855, when Stevens met with the tribes. This second treaty relinquished the Salish rights to 23,000 square miles of land in the valley and spoke to the creation of a reservation (Cappious 1939:27). It had been decided that settlers in the valley needed all the land for farming and the Salish were not farmers. The Indians were to receive payment and the construction of schools, a blacksmith shop, a sawmill and a flour mill on the reservation. This treaty
included Article XI, which stated that a site in the Bitterroot Valley would be surveyed as a possible reservation site. The Senate ratified this treaty and Article XI on March 8, 1859 (Cappious 1939:28). The tribe resisted in 1871 when they received the order to move to the Jocko Valley. They were unwilling because Article XI to the treaty had not been fulfilled. No survey was made of the Bitterroot Valley for possible reservation sites there.

In 1872 President Ulysses S. Grant sent a commission to the valley to persuade Chief Charlot to move peacefully. Chief Charlot wanted only a small area of the valley within the original home range of his tribe, which numbered just a few hundred by 1884 (Chaffin 1971:86). While Chief Charlot remained with his people at the fort in Stevensville, the number of white settlers increased. After the matter came before Congress in 1885 and the special commissioners concluded Charlot had the right to remain in the valley, the Indians were given supplies for farming (Cappious 1939:30). However, they were not successful as farmers and their hunting lands had disappeared. The terrible living conditions of his people finally broke Chief Charlot's determination not to move from the valley. He had traveled to Washington, D.C., on behalf of his people but gave up his resistance in the end. The Indians moved to the Jocko Valley Reservation in 1891.
**RECENT HISTORY**

Early Explorers and Settlers

On Friday, September 6, 1805, Meriwether Lewis and William Clark crossed the Continental Divide from the headwaters of the Missouri River and began their journey into the Bitterroot Valley. They were on their way to the headwaters of the Columbia River. The explorers camped with the Flathead Indians near the site of present-day Grantsdale. They left the valley a few days later but came back to the Bitterroot on their return trip the next July. At this time the travelers split up. Lewis went downriver towards Missoula while Clark journeyed up the Bitterroot Valley and camped near the site of present-day Corvallis. They celebrated the Bitterroot's first Fourth of July in 1806. Clark's party traveled on an Indian trail to the west fork of the Bitterroot and camped near Sula before leaving the valley through Gibbon's Pass on July 6 (Cappious 1939:9).

After Lewis and Clark's visit, Canadian trappers and Iroquois Indians traveled in the vicinity. Between 1820 and 1835, employees of the Hudson's Bay Fur Company visited the valley to trade with the Indians. In the 1840s, Jesuit fathers De Smet and Ravalli established St. Mary's Mission. The mission was sold to Major John Owen in 1851 (Cappious 1939:11). He added a trading post with a wooden stockade. This fortification was thought necessary due to raids made by the Blackfeet Indians.
Major Owen hoped to make the fort the social and economic center of the valley. He imported agricultural machinery, built a grist mill, bred livestock, imported high quality grains, grew an orchard and even built a library. The fort became the center for many pioneer festivities and an important stopping place for all travelers and immigrants to the valley. The fort was "a place of refuge and the only permanent post within one hundred miles of wilderness" (Cappious 1939:13). During the 1850s, Owen acted as special agent to several local tribes. In this position he advocated government agricultural aid for the Indians. His success and influence faded by the early 1870s. Owen experienced financial troubles and suffered from alcoholism. He died in Philadelphia in 1889 (Cappious 1939:15).

John Owen started the economic beginnings of the Bitterroot Valley.

Fort Owen at Stevensville has been called the greatest historical monument in the Northwest, but it is not so much a monument as a symbol of a pioneer's ineffectual struggle against the forces of destiny, the tragedy of individual defeat, but a social and economic victory. Although today the decaying ruin of the old fort is the only tangible monument that remains of his labor, the agricultural beginnings and the civilizing influence that Major Owen implanted in the Bitterroot have been carried on by other sturdy pioneers (Cappious 1939:15).
After the fort was established many settlers came, including Nell McArthur, an old Hudson Bay trader; Henry Brooks; Isaac Stevens, the future governor of the Washington Territory; C.P. Higgins, who later founded Missoula; and the Chaffin family.

The Chaffin Family

The headquarters of the Teller Wildlife Refuge is located at the original homestead of the Chaffin family. The Chaffins left Fort Scott, Kansas, in the spring of 1863, originally heading for the gold fields of California. En route, the family decided to separate from the main wagon train and head up to Bannock, Montana. They arrived in Bannock in September of the same year.

This first family group was made up of Balaam Chaffin, his two daughters and one son. Another son, Elijah Chaffin, and his wife, Margaret, followed the family to Bannock upon hearing of his father's death in 1864 (Chaffin 1971:13).

James Mitchell, the brother of Margaret Chaffin, kept a diary of this second family odyssey into the western states. "It was on May 14, 1864," Mitchell wrote, "when we started across the plains to seek a home in the West." Mitchell described the attire of the homesteaders: homemade suits and heavy boots for the men, calico dresses, hoop skirts and
bonnets for the women. "Each family was outfitted with flour, cornmeal, lard, bacon, beans, rice and dried fruit. Our equipment for defense was short, as it was in time of the Civil War and the government would not permit much to be sold. We had no rifles only colt revolvers in our outfit," he continued (Chaffin 1971:30).

The original train of one hundred wagons split in Kansas, with half heading for Oregon on the California Trail and the other half toward Arizona along the old Sante Fe Trail. The Oregon-bound caravan followed the Republican River in Kansas, then the Old Fox Trail, reaching Fort Kearney, Nebraska, on June 7, 1864. They spent the Fourth of July resting at Chimney Rock. Leaving Nebraska at Scottsbluff, the wagon train reached Fort Laramie several days later and next entered the Black Hills. (The Black Hills referred to in Mitchell's diary may be a different geographical region than today's Black Hills.) As the party left the Black Hills, they came upon a massacre site. A group of wagons, which had left the train two days before, had been surprised by Indians. The men had been killed and the women and children captured. Two days later, the Chaffin party was approached by a group of around twenty Indians armed with bows, arrows and spears. James Mitchell's group avoided bloodshed as "the Indians seemed to want only our horses and drove off eleven head...." (Chaffin 1971:34).
Mitchell's diary describes another part of their journey.

The real hardships of the trip came at the Platte River. We had to take the wagon boxes from the running gear and cork them up tight to make boats of them. We were three days getting across.... We made boats by putting four boxes together to form a square.... We could not take heavy loads, so the business of getting across the river, about three-fourths of a mile, was a protracted one (Chaffin 1971:34).

Mitchell's diary also includes the final leg of their journey during which Elijah Chaffin captained seven wagons that left the main group and traveled on to Bannock, arriving in September of 1864.

When the time came to leave Bannock, Oregon was to be the next destination. Again circumstances did not allow these plans to be fulfilled. A young itinerant farmer and miner by the name of John A. Slack convinced the Chaffin sons to winter in the lush Bitterroot Valley before heading farther west. His advice was taken, and a small community was established near the present site of Corvallis, Montana (Chaffin 1971:17). This temporary cluster of sod-roofed log cabins and wagons was called Chaffinville.

The young man who persuaded the Oregon-bound Chaffins to spend the winter in the Bitterroot Valley met them as their wagon caravan pulled into Bannock. Slack had come from Baltimore to Bannock by steamer, horseback and freight boat in the 1850s. He had spent 1862 farming and mining in the
valley. Slack spoke of the valley's fertile soil, clear water and snowcapped mountains. His persuasive attitude was a decisive factor in the vote of the family to travel first to the Bitterroot. Slack accompanied the wagon caravan and became a settlement builder alongside the Chaffins. He officially became a family member five months after the Bannock meeting when he married Polly Mary Chaffin in Chaffinville on February 18, 1865. Three years later Polly and John Slack established their farm next to Margaret and Elijah Chaffin's property.

Elijah did spend a year in Oregon but returned to Montana and built a permanent residence in the summer of 1866. The site chosen for the Bitterroot Valley homestead was made up of rich bottomland with timber and rolling foothills upon which grew a great variety of vegetation including sagebrush, bunchgrass and, in the spring, the Bitterroot wild flowers with their lovely pink blossoms (Chaffin 1971:24). Rose Hull, the sister of Elijah's wife, Margaret, joined the family in 1869. She described her first sight of the Bitterroot Valley in her journal.

We were surrounded by the Bitterroot Range, whose mountains with their purple shadows, topped with snow-capped peaks, interspersed with numerous canyons, were a beautiful sight. We followed the Bitterroot River, catching the gleam of its restless waters as it wound its way down to join the Missoula, and at last we arrived, weary, dirty and happy at the home of my sister Margaret (Rhodes 1989:5).
The Chaffin family and the other settlers established a close-knit community, centered two miles north-northwest of present-day Corvallis. The Chaffin's new home, corral and stock refuge became the site of one of the first dairy farms in the two-year-old Montana territory. The products were sold in Stevensville and Deerlodge, shipped by wagon or pack horse once a month.

In the years after the arrival of the original Chaffin wagon trains in the Bitterroot Valley, many other family members joined the community. Elijah Chaffin, as leader of those first wagons, cannot take all the credit for creating the rush of settlement that followed. According to "family fireside stories" remembered by Glenn Chaffin, his grandfather Elijah gave credit to the "women folk," for it was their letters back home to the Midwest, praising their new homeland that urged others to share it (Chaffin 1971:38). Two additional Chaffins and three Mitchells came to the Bitterroot Valley.

Elijah Chaffin, the commander of the wagon train and the leader of this new Bitterroot Valley community, was described as a man with a singleness of purpose and a strong will, perhaps with a streak of stubbornness. (See Figure 15.) His exceptional height of six feet and seven or eight inches matched his forceful personality. Elijah was a reliable farmer and became one of the earliest fruit growers in the
Figure 15. Photograph of Elijah Chaffin and sketch of his original log home dated 1885 (Chaffin 1971)
valley. He purchased apple, pear and cherry grafts in Oregon and established an orchard. He also enjoyed growing smaller fruits such as gooseberries, raspberries, currants and strawberries (Chaffin 1971:59). The progressive leadership provided to the family and friends who had followed him out west made the Chaffin homestead the hub of the community.

The Missoula County census in the year 1870 indicated that the five Chaffin brothers and their many relatives were prospering (Chaffin 1971:40). Each family had a log cabin dwelling and had chosen acreage for their livestock and farming endeavors. Their livelihoods consisted of the dairy business and raising cattle, hay and grain.

The first real road up the Bitterroot was an old stage coach trail established in 1867. The road led from Missoula through the Miller Ranch on Lower Miller Creek to the Bitterroot River and down to Lolo. After passing the little town of Carlton, the road traveled south to Fort Owen in Stevensville and then went on ten miles to the settlement of Chaffinville (Stevensville Historical Society 1971:234). (See Figure 16.) In 1872, an irrigation channel, named the Independent Ditch, was built by many in the community to allow the farmers to raise wheat on their ranches (Chaffin 1971:41). These were the first steps to greater development of the valley.
THE BITTERROOT VALLEY
1864 to 1870

Figure 16. Bitterroot Valley (Chaffin 1971)
Teller Wildlife Refuge
As the communities grew into towns, first stores, then schools increased in number. By the summer of 1879, the unnamed hamlet located two miles south and one mile east of the original settlement of Chaffinsville had grown to two stores, two saloons and a blacksmith shop. The community could also advertise a Chinese laundry, jewelry store, photography gallery and drug store. The Missoula County recorder was called in to recommend a survey and platting for a townsite, which occurred on September 1, 1879 (Chaffin 1971:95). Named by an itinerant Frenchman, the town became known as Corvallis, "heart of the valley" (Stevensville Historical Society 1971:234). The Bitterroot Valley was part of Missoula County until the formation of Ravalli County in 1893.

A unique friendship developed in the small Bitterroot Valley communities between Elijah Chaffin and Father Anthony Ravalli. Father Ravalli was a Jesuit missionary from Ferrara, Italy, who had joined Father De Smet at St. Mary's Mission in 1845. He was skilled in architecture and medicine and ministered to the Salish Indians for many years. Father Ravalli considered the Chaffin house his second home. Both Elijah Chaffin and Father Ravalli were disturbed by the government's revocation of the tribe's treaty rights. They hoped to forestall the movement of the Bitterroot tribe to
the Flathead Reservation in the Jocko Valley, but both men
died before this could be accomplished (Chaffin 1971:46).

Elijah Chaffin died in 1888. His wife, Margaret, had passed
away thirteen years earlier during childbirth. Elijah's son,
Moses Chaffin, inherited the original Chaffin-Mitchell
homestead. Moses and his wife, Mary Ellen, moved into the
house the year after they were married in 1893 and lived
there for sixty-three years. Their daughter, Lorene Howe, and
her husband, Milton, became the next of Elijah's offspring to
dwell in the homestead (Chaffin 1971:103). The house today
looks much as it has for the last century. The main structure
was built in 1867 with an addition in 1880. (See Figure 17.)
John and Polly Slack's house still stands near the Chaffin
home. Glenn Chaffin, who recorded his family's history in The
Last Horizon, lived in the Slack's house for many years.

Farming History

Agriculture was the first and still is the primary
occupation in the Bitterroot Valley. Father De Smet was the
first farmer on his land at St. Mary's Mission. The Virginia
City, Bannock and Kootenai mines provided markets for the
farm commodities produced by increasing numbers of settlers
(Cappious 1939:72). The Homestead Act of 1862 brought many
settlers into the Bitterroot Valley although this area was
not officially open for another ten years. At first many of
The Elijah Chaffin residence as it appears today. The two story section is log beneath the siding, built in 1867. The lower addition was built in 1880. It is now the home of a granddaughter and her husband, Lorene and Milton Howe. 1970

Figure 17. Chaffin residence today (Chaffin 1971)
the homesteaders settled near Stevensville due to the presence of St. Mary's and Fort Owen. The settlers were allowed 160 acres of land through the 1862 Act. After living on the land for five years and making improvements, they gained title to the property for a small fee per acre. Claims were filed at the government land office in Missoula and at the Missoula County Courthouse. The Homestead Act was later amended to grant more acreage.

The pioneers came up the Missouri by boat and then across the land in wagons or on horseback (Stevensville Historical Society 1971:89). The majority of the Bitterroot Valley's early settlers came from the South and Middle West. Most of them had farmed small plots of land, raising corn, wheat, cattle, pigs and fruit trees. The elevation of the valley, more than 3,000 feet, and a difference in soil type caused some difficulties for the new arrivals. At these elevations, frost was a threat to spring plantings and fall harvests. The aridity of the soil was also a challenge to crop production (Chaffin 1971:58).

The Big Red Apple Boom began during the late 1800s and lasted into the early years of the twentieth century. Apple grafts were imported from Plymouth, Massachusetts. By 1885 there were apple orchards throughout the valley. The MacIntosh apples grown were exported all over the world (Chaffin 1971:60). Fruit production has nearly faded from the
valley. Growing apples was a highly specialized industry, and it did not last in the Bitterroot Valley through the inevitable "bust" following the initial "boom."

Now the land is used primarily for agriculture and livestock. Beef cattle, dairy cattle, sheep, pigs, horses and chickens have been the main commodities through this century. Much of the good land in the valley has been improved. Hay, feed grains or silage crops are grown, along with potatoes and alfalfa. On the high benches of the eastern side, dryland wheat and barley farming occurs. The lower mountain slopes are used for grazing (Stevensville Historical Society 1971:11).
PART 2

REFUGE HISTORY

FORMATION OF THE TELLER WILDLIFE REFUGE

The foundation for the Teller Wildlife Refuge was laid in the mid-1980s when Otto Teller purchased the first properties that were to form the land base for the Refuge. Mr. Teller subsequently purchased adjacent and nearby parcels to enlarge his holdings. As of 1991, the Refuge comprises over 1,280 acres of riverbottom and farmland, and encompasses the original Elijah Chaffin and John Slack homesteads. Conservation easements protect all of the area from further development and subdivision. The Refuge is managed as a wildlife refuge and also as a nature retreat. The property is one of Montana's first privately owned and managed wildlife refuges. The easements protect unique riparian zones along the creeks of the Refuge, agricultural land and its stretch of the Bitterroot River bottoms.

Otto Teller, a resident of Glen Ellen, California, is a long-standing conservationist and founding member of Trout Unlimited. He has operated an organic farming operation at The Oak Hill Farm in Glen Ellen since 1947 and is actively interested in the development of sustainable agriculture and
organic farming in both Montana and California. He markets the fruit, flowers and vegetables grown on his California farm while managing the land to preserve soil, water and wildlife habitat. Mr. Teller has been an advocate of chemical-free agriculture and farmland preservation for over forty years.

Protection of fish and wildlife and their habitats are all important to Mr. Teller, and his work has been recognized by the Montana State Fish and Game Commission, the Trout and Salmon Foundation and many other organizations. He has worked with the federal, state and local environmental agencies and organizations to protect fisheries in Montana, Oregon, California and Washington.

Mr. Teller spent his youth on an Ohio farm. His belief in conservation evolved in these rural surroundings. In 1927 he traveled to California to attend college. After World War II he spent many summers and autumns in the Bitterroot Valley. During these years, Mr. Teller became aware of the problems with trout habitat due to siltation from road construction and poor forest management. His efforts began with his assistance in the creation of Trout Unlimited, which protects trout and the watersheds that create trout streams. He was a founding board member and became president in 1971.

During his life Mr. Teller has encouraged and guided many environmental organizations. He has served as director-at-
large for the Montana Land Reliance, a private land trust that holds the conservation easements on Refuge lands. Through his work with land trust organizations in Montana and California, Mr. Teller has conveyed to landowners the value of protecting agricultural land and wildlife habitat. He has placed easements on both the Teller Wildlife Refuge and Oak Hill Farm in California. In 1989, Mr. Teller and the Montana Land Reliance received the American Farmland Trust Agricultural Conservation Award in the category of Model Land Protection Projects. This award honors individuals and organizations whose outstanding achievements have set an example for other conservationists and who have contributed to public understanding for the need to conserve American agricultural resources.

The Wilderness Society, Nature Conservancy, Northern Rockies Action Group, National Resources Defense Council, and American Farmland Trust have all benefited from Mr. Teller's assistance and leadership. He has studied forest management practices, attended Senate and Forest Service hearings and testified before Congress to make important issues known. These issues include the overcutting of our forests and the resulting damage to rivers and streams as well as the detrimental, long-term effects of this damage to local economies.
Mr. Teller has worked privately and publicly to make a difference in the way our environment is managed. He has combined his personal vision with his knowledge, energy and abilities to further environmental interests. Mr. Teller's influence in the Bitterroot Valley will be recognized as the Teller Wildlife Refuge is preserved for the continuing welfare of the wildlife and plant species there and the education and enjoyment of future generations.

CONSERVATION EASEMENTS

Conservation easements are the latest conservation tool being used by landowners who want to preserve valuable natural areas and agricultural land for posterity. Easements have been used to protect forests, islands, farmland and prairie, urban parks and gardens across the country. Conservation easements have existed for one hundred years but more recently took hold with the formation of The Trust for Public Land in the 1970s. Their use grew first on the East and West coasts, where development pressure is greatest (Segell 1988:224). In the western United States easements are also used effectively to preserve open space, save historical ranches and protect wildlife ecosystems.

A conservation easement is an interest in a property, deeded to a conservation organization or government entity. Easements may be administered by land preservation trusts,
historical preservation trusts and state, local governmental or private organizations (Grandstaff 1989:27). Each type of agency has its own preservation concerns, and landowners can find an agency whose conservation goals fit theirs. The staff of the land trust works with landowners, providing legal advice, tax advice and long-term property planning. The easement prohibits the use of that property in ways that are not compatible with conservation or preservation interests. The landowner who has made the easement donation continues to hold the property. The property may be sold or divided under the conditions of the easement grant. The easement goes with the deed, and future landowners are bound by its restrictions. Agricultural or recreational uses, including hunting and fishing, may be unaffected by easements while subdivision and nonagricultural or commercial uses are prohibited (Montana Land Reliance 1981:1).

The primary benefit of a conservation easement is the protection given to the land against development pressures and potential destructive uses. The landowner can be sure the property's use will remain within the confines of the easement's restrictions for future generations. The open space, beauty and productivity of the land can be preserved. There can be substantial tax benefits to the landowner if certain legal requirements are met. These tax benefits take the form of property tax relief and income tax benefits. The
land is devalued when it is permanently taken off the market for development, and taxes are assessed on the remaining use of the land (Grandstaff 1989:27).

The terms of the conservation easement are determined by the landowner and the land trust organization. Every easement is different. The terms may vary depending on the property, the landowner and the conservation purposes desired although there are certain criteria set by law. Conservation easements exclude the construction of buildings or commercial enterprises, dumping of waste or trash materials, and any other activities that result in significant soil erosion, water pollution, loss of aesthetic value or degradation of habitat for fish, wildlife or plant species. Public access is usually not addressed. The easement does allow the construction of buildings, fences, and other improvements necessary for agriculture that are compatible with the conservation objectives. A conservation easement does not need to include an entire property; a landowner may reserve a part of the area for development (Montana Land Reliance 1981:3).

The unique requirements of the conservation easement on the Teller Wildlife Refuge properties include a ban on the use of all agrichemicals (pesticides or herbicides) for any reason. This is an unusual requirement as most easements are set up to protect agricultural land, and chemicals are frequently
used to reduce noxious weeds and replace natural processes. On Refuge lands, weeds are reduced by manual and biological controls. Biological weed controls exist in the form of insects that damage plants. The Montana State University Agricultural Experiment Station, located in Corvallis, is currently studying the effects of root-feeding moths and seed-reducing flies in controlling spotted knapweed on the Refuge. Knapweed is a persistent noxious weed that is a widespread problem in the Bitterroot Valley. It was probably introduced into Montana as a contaminant of hay or alfalfa seed from eastern Europe or Asia in the 1900s (Montana Land Reliance 1990:19)

The MSU Agricultural Experiment Station is working on the establishment and dispersal of species that reduce the vigor and seed production of spotted knapweed. The Agapeta zoegana is a species of moth that has a root-feeding caterpillar. The Teller Wildlife Refuge is the first site where this species has been documented as established. Two types of seed-reducing flies have been widely introduced in Montana. The effect of these flies has not been studied on the Refuge, but coexistence of the species has been shown to reduce seed production by 50%. A new species of seed-head attacking moth has been tried on the Refuge; however, it is poorly established at most sites due to its inability to withstand Montana winters. Another new species of root-feeding weevil
has been released into the area for two years. Its establishment has not yet been confirmed. The release and study of these insects is part of a seventeen-year project run by the MSU Station.

The Montana Land Reliance, which holds the conservation easements on the Teller Wildlife Refuge, was founded in 1978. It is a private, nongovernmental, nonprofit organization governed by a board of directors. The directors are all Montanans, mostly farmers and ranchers. The Montana Land Reliance is concerned about the future of agriculture in the state because of its effect on local economies. Agriculture is the base for many local businesses, and it supplies valuable open space, which is important to wildlife, recreation and tourism. Open space is also important to valley residents for aesthetic reasons (and peace of mind). The Montana Land Reliance is working to preserve the ecological health of lands in the state by the use of good conservation and management practices. This stewardship will ensure wildlife values, food resources and the long-term strength of the agricultural economy.

Currently 100,000 to 200,000 acres of Montana farmland are lost each year to subdivisions and industrial development (Montana Land Reliance 1981:5). The goals of the Montana Land Reliance include the reversal of current trends by working with landowners to preserve ecologically significant land,
providing research and educational services and developing programs and techniques to preserve agricultural resources and the agrarian way of life. Private landowners must be reached because they determine the use of most of the land in the state. These owners are making decisions for future generations.

The best land in the state passed into private ownership with the arrival of the homesteaders. Today these are the properties that are most susceptible to development and change. When land is taken out of its traditional uses, there is usually a loss of wildlife habitat and scenic open space. By using conservation easements, private and public landowners can manage the areas that are left and ensure permanent protection of habitat. In many cases private action to protect land matches a public wish to preserve unique regions.

GOALS OF THE REFUGE

Restoration of Natural Diversity

Although knapweed fields, overgrazed pasture and degraded riverbottom land currently dominate much of the Refuge, the land has promise for the future. Once home to many generations of the Chaffin family, the Refuge's recovering landscape is now home to scores of wildlife species including white-tailed deer, pheasant, duck, geese, beaver, great
horned owls, osprey, blue heron and trout. Many transient birds also visit the Refuge. The Bitterroot River runs through the west end of the property, and clear streams and underground springs provide an abundance of water. One of the Refuge goals is to restore and enhance in their natural ecosystems, when practical, all species of animals and plants that are endangered or threatened with becoming endangered. This goal goes beyond the preservation of lands and wildlife with a commitment to the reestablishment of natural and historic landscapes and to the animals that once inhabited them.

The Refuge will be developing a long-range plan to restore overgrazed lands to their natural state through a variety of methods. The guidelines will determine correct location, density, timing, technique, maintenance and monitoring of plant restoration efforts. Definitive plans and clear objectives will help the Refuge measure the project's success and serve as direction for future preservationists.

Although much of the knowledge used in plant community restoration was gained through mine reclamation, the principles learned are applicable elsewhere. The restoration plan involves the comparison of existing communities and habitat types, species list and composition with historic communities, habitat types and known species compositions. Areas are prioritized based on their potential for success,
and then site preparation, planting methods, protection and maintenance are determined. This work can be done by volunteers and university students with funding assistance obtained through state programs. Although proper restoration and management are long-range projects, the successful results mean a return to plant communities that existed in the area before man arrived.

In addition to the restoration of native communities, the maintenance of heirloom seed varieties also takes place at the Refuge. Garden City Seeds leases Refuge land to propagate heirloom plant species. These are varieties that are more than one hundred years old and are no longer available from commercial sources. Garden City Seeds cooperates with seed foundations and private seed-savers to maintain a diverse selection of cultivated varieties that have adapted to the local climate. Every small region has valuable cultivars maintained by small farmers and gardeners. Collecting and cataloguing these species benefit future generations. They may be used to breed resistance into currently valued high-yielding hybrids. Older plant varieties had lower yields but were able to resist disease and insects (Lakes 1988:B-1). Garden City plans to expand seed plots at the Refuge. The seeds will provide a broader gene pool for agriculture, and the plants will provide winter food for geese and deer, and cover for pheasants.
Planting crops and cover for wildlife, and building nesting boxes for waterfowl and coverts for rabbit and grouse are other plans for the property's enhancement.

Development of Sustainable Agriculture

Soil erosion, rising fuel costs, chemical pollution and a loss of agricultural land are causing a crisis for agriculture in the United States and around the world. Sustainable agriculture is an alternative that offers ecologically sound food production while responding to local conditions and human needs. Sustainable agriculture emphasizes minimum tillage, tree crops, perennial plants and soil-building combinations of grasses, legumes and nitrogen-fixing trees and shrubs (Tilth 1982:11). The maintenance of diversity and complexity is stressed. The natural cycles of plants, animals, soil, water and climate are integrated into farming plans. Systems are designed to take advantage of the attributes of each site. Sustainable agriculture can restore the health of the land, build stable communities and provide a model to others.

Sustainability is achieved when the methods of production improve the land and resources are used efficiently to accomplish this improvement. The system should be diverse and rely primarily on renewable resources for the maintenance of soil fertility. If sufficient organic matter is recycled and
nitrogen-fixing bacteria are utilized, the productivity of the system will remain.

Grasses play an important role in building and maintaining soil fertility. The periodic return of the land to grasses will retain fertility and rebuild needed organic matter (Tilth 1982:60). Toxicity hazards are reduced or eliminated.

An effective sustainable system is aesthetically pleasing and enhances the landscape. Plant and animal diversity is preserved through a system of checks and balances that allow regulation and growth of all species. Tillage practices, livestock numbers, the use of manure to improve the soil, crop rotation and the creation of windbreaks all contribute to a successful sustainable system. Windbreaks and shelterbreaks reduce wind force, provide protected areas and reduce erosion. A sustainable farming plan developed with these principles in mind models a natural ecosystem. Sustainability, the ability to continue permanently, depends on how accurately nature is duplicated (Tilth 1982:28). A portion of the land should be left as natural habitat, and, ideally, a farm would contain within itself all it needs for maintenance.

The Refuge hopes to use sustainable agricultural practices as an educational process for the Refuge staff and cooperating farmers. A goal of the Refuge staff is to encourage area farmers to try sustainable agriculture by
assisting them with weed control and tillage operations. The farm plan for the Refuge properties considers management goals such as the use of the land primarily as a wildlife refuge, the need to operate with minimum financial output and low risk, and the desire to motivate area farmers. It is hoped that income will be generated to use for conservation projects, fencing of riparian areas, and habitat and stream restoration. Although flexibility is needed when dealing with areas designated for wildlife, the Refuge does have the potential to produce income, using agricultural practices compatible with a wide range of management goals.

Certain fields owned by the Refuge are farmed by area farmers on crop/share leases. Hay is produced for sale, and grain strips are left standing for wildlife. Soil tests determine what types of organic inputs are needed (manure, compost, rock phosphate, etc.). Other fields have been set aside for the Agricultural Research Station and Montana State University Extension work. Small central fields will be used for wildlife islands and experimental crops such as buckwheat, black medic and berseem clover. Knapweed, thistles and other noxious weeds will be controlled with both manual and biological controls. While the only grazing allowed on the Refuge is for the purpose of weed control, there are plans to explore the role of appropriate grazing systems to maintain nutrient cycling and plant successions.
Development of Educational Opportunities

The Teller Wildlife Refuge exists as an educational resource for all ages and many professions. The Refuge is a field trip destination for school children from Corvallis to Missoula and serves as the headquarters for The Environmental Writing Institute. Recently the University of Montana and Montana State University have arranged to conduct courses in cooperation with the Refuge, utilizing the property for the study of private land conservation, sustainable agriculture and wildlife management. This guide is an outgrowth of the Refuge's collaboration with the University of Montana in Missoula.
PART 3

LOCAL GEOGRAPHY

HYDROLOGY

Hydrology of the Bitterroot Valley

The peaks of the Bitterroot and Sapphire mountain ranges outline the borders of the Bitterroot River watershed, 2,800 square miles in all. The Bitterroot River is formed at the confluence of the East and West forks of the Bitterroot at the southern end of the valley. The river flows northward along the valley bottom to meet the Clark Fork in Missoula, approximately 65 miles from the confluence of the forks. Elevations are 4,000 feet at Connor and 3,200 feet at Lolo. The elevation of Refuge lands ranges from 3,410 to 3,490 feet. The gradient averages twelve feet per mile (Uthman 1988:5). The Bitterroot River and its forty-eight tributaries in combination with storage reservoirs and irrigation canals provide the valley with a continuous water supply. (See Figure 18.) Between Darby and Florence, five major tributaries enter from the Sapphire Mountains and twenty from the Bitterroot Mountains.

Painted Rocks Reservoir was built in 1940 and is located on the West Fork of the Bitterroot. It was constructed for
Figure 18. Major tributaries of the Bitterroot River (Simons 1981:23)
irrigation purposes. During the last fifteen years water has also been purchased to augment low flows and improve trout habitat. Lake Como was constructed in 1909. It provides water for irrigation mainly on the east side of the valley. Twenty-six small dams are currently in operation in the Bitterroot and Sapphire mountains (Simons 1981:49)

The fundamental source for all water supplies in the valley is precipitation in the form of snowfall and rainfall. All the water in demand is provided by watersheds that surround the valley. More than 95% of the valley's total annual precipitation falls on mountain forests, two-thirds in the form of snowfall. The management of the forestland is of great concern due to the impact of this management on the health of the watershed. Precipitation in the Bitterroot drainage varies a great deal and is strongly controlled by elevation. The mountainous areas receive the most precipitation with the Bitterroot Range receiving up to 100 inches per year and the Sapphires around 50 inches per year (Senger 1973:11).

The mountains receive the bulk of their precipitation in December and January. The snowpack that accumulates through the winter melts with springtime's warmer temperatures and becomes the main source of streamflow in the drainage. Valley locations receive only 12 to 14 inches of precipitation per year. May and June are the wettest months; July and August
are the driest. The inflow of the East and West forks of the river, the eastside and westside streams and the precipitation received annually in the valley bottomlands add up to 2,100,000 acre feet. (See Figure 19.) The average annual water budget shows that 71% of the average annual precipitation is automatically lost to the atmosphere through evapotranspiration. The remaining 29% of annual precipitation leaves the area as stream discharge. Over half of the annual water discharge occurs during May and June (Senger 1973:4). (See Figure 20.)

Most evapotranspiration takes place on forested lands, occurring on the surface of tree leaves and needles, which intercept snow and rain before they hit the ground. Trees also absorb water from the soil and then return it to the atmosphere through photosynthesis. Evapotranspiration loss is figured by subtracting outflow at the mouth of the Bitterroot River from total inflow into valley bottomlands. All losses from irrigation, domestic use and vegetation are considered. Annual irrigation diversions occur during June and early July; 600,000 acre feet are withdrawn for crops while only 5,000 acre feet are used for domestic, livestock and industrial purposes (Senger 1973:11). Approximately two-thirds of the irrigation needs are supplied from tributaries while one-third comes from the Bitterroot River (Senger 1973:53). These surface water sources provide nearly all
Figure 19. Annual average water budget, Bitterroot River Drainage (Simons 1981:17)
Figure 20. Mean monthly flows for the Bitterroot River near Darby (Modified from Senger 1975)
irrigation water with groundwater supplying only a small percentage of acreage.

The return flow is the difference between total diversions and evapotranspiration losses. The return flow rejoins streamflow and also infiltrates into the groundwater, recharging the supply. Groundwater recharge occurs in the spring as water from the Bitterroot River and its tributaries seeps into the ground (Senger 1973:7). Discharge occurs during late summer and fall.

Groundwater is one of the most valuable but least understood natural resources. Although often viewed as a reservoir, groundwater also transmits water. It acts as a integral part of the surface water system by regulating streamflow. The Bitterroot Valley is underlain by great thicknesses of unconsolidated sediments made up of coarse gravel, sand, fine silts and clays. These sediments are the result of erosion of the surrounding mountain ranges occurring over geologic time. Groundwater accumulates in empty spaces between the individual grains of the sediments. An aquifer is a layer of sediments that yields water in usable quantities. Groundwater in the Bitterroot Valley moves downslope toward the river. Its movement is slow compared to surface water movement. The slope of the water table is steepest near the western margins of the valley and nearly level along the valley floor.
Demands on land and water resources in the valley have increased dramatically with rapid population growth. The population of Ravalli County nearly doubled between 1960 and 1980. There is increased use for municipal and recreational purposes. The need to boost productivity on remaining agricultural lands and maintain the area's economic base also expands water usage (Senger 1973:1). Water is used for forage crops, grains, potatoes and fruit. Beef and dairy cattle are also important users of water.

Development of irrigation in the valley has been haphazard. Bottomlands were developed first; then, irrigation extended onto the benches and farther up the valleys of river tributaries. Lack of planning resulted in a complicated system of ditches. Inefficient distribution leads to late season water shortages. There is no overall shortage, but a need to distribute the water more effectively (Senger 1973:55). Senior water rights belong to property owners on bottomlands where good aquifers could provide the water needed. This would leave the streamflow for use by owners of highlands who cannot reach groundwater (Simons 1981:53).

The most common recreational uses of water include boating, swimming, water skiing, floating and fishing. These activities do not require the withdrawal of water. Conflicts occur between the use of reservoirs for recreation and
irrigation because water drawdowns reduce recreational opportunities.

A pressing controversy caused by water quantities in the Bitterroot is the maintenance of trout fisheries. Many streams become totally dewatered in late summer due to irrigation diversions. When this occurs, the aquatic food chain is broken and the fish are lost. It takes several years with adequate water quantities for the streams to regain their fish populations. Good water quality and channel characteristics such as food production and the presence of spawning sites and resting places are all requirements of fish habitat (Senger 1973:65). When irrigation water is returned to a stream, it brings increased sediment and nutrient levels. These characteristics along with low flows decrease dissolved oxygen. Low dissolved oxygen levels may threaten fish survival. Reserving stream flow for fish is a beneficial use under the Montana Water Use Act. The Department of Fish and Game also may reserve streamflow by securing a permit through the Montana Department of Natural Resources and Conservation. At the present time all streams in the Bitterroot Valley have rights filed in excess of mean annual stream flows (Senger 1973:68). As a result, sportsmen, irrigators, conservationists and the public work together to decide how the fishery should be maintained and how water water uses are balanced.
Demands on the water include wildlife needs, domestic and agricultural needs, and recreational aspects of the river. Since 1984, water users in the Bitterroot Valley have cooperated to ensure protection of the health of the river and all users' rights. The results of this rare cooperative effort are the appointment of a water commissioner and the establishment of minimum in-stream flows to keep the river at a safe level for fish (Grandstaff 1988:1). In 1989 a contract between the Department of Natural Resources, the Department of Fish, Wildlife and Parks, and irrigators gave the irrigators this responsibility for a portion of Painted Rocks Reservoir's water (Rhodes 1989:1). The Bitterroot Valley is one of few places where such cooperation has benefited the interests of all.

The Bitterroot River is a braided stream that flows through coarse glacial sediments. The coarse alluvium is composed of gravel, cobbles and sand, and the banks are composed of finer materials. The river shifts its sediments every spring during peak flows and cuts new channels (Senger 1981:xi). The erosive energy of the water cuts into channel banks. This localized erosion causes portions of the bank to slough into the river. Bank instability results in channel splitting, lateral migration of the channel and flooding.

The Bitterroot River has experienced substantial channel alteration in past years. Climatic and hydrological changes
as well as human activities cause channel instability. River bank alteration, flood plain development, logging methods and road construction cause erosion. Irrigation practices, range management, grazing practices and fires also affect the river. Channel stability can be increased by education, consistent management, the use of groundwater for irrigation, and the limitation of floodplain activities and human interference.

Hydrology of the Refuge

The Refuge properties contain rich water resources including approximately four miles of the Bitterroot River, about three-quarters of a mile of Gird Creek and two irrigation channels diverted from Willow Creek, totaling 1-1/2 miles in length. The water in the irrigation channels has been diverted from creeks in the Sapphire foothills and is returned to the streamflow. The water table is quite high on Refuge lands due to the location of the properties along and near the Bitterroot River. The groundwater subirrigates many acres and provides water for a number of small ponds.

Specifically, the main property has portions of one stream, called Gird Creek, and one unnamed creek, which flows from a spring pond. Both flow into the Bitterroot River, and both were used for irrigation before the formation of the Refuge. The banks of these creeks are fairly well vegetated and show
some signs of beaver activity. Brook trout have been observed in the smaller spring creek, and native cutthroat were planted there successfully in 1989. Water conditions, streambed sediments and the presence of water cress beds are conducive to the development of an excellent trout fishery and should be monitored.

North property water resources include about one-half mile of the Bitterroot River, one-half mile of the Supply Ditch and a small spring creek. About one mile of the Bitterroot River flows through the south property. All three sections of the Refuge have backwater sloughs, which were at one time main channels of the river.

Water quality samples taken from the Bitterroot River upstream and downstream of the Refuge have found the waters to be of very good quality. The results indicate that the river is a slightly alkaline, calcium carbonate stream with low nutrient levels. All waters in the Bitterroot Valley are classified as B-1. This classification signifies suitability for drinking, culinary and food processing purposes after conventional treatment, bathing, swimming and recreation. The growth of salmonid fishes and other aquatic life such as waterfowl and furbearers, and agricultural and industrial use are included as suitable (OEA Research 1988:13).
GEOGRAPHY

Geography of the Bitterroot Valley

The Bitterroot Valley lies between the Columbia Plateau and the Northwestern Plains, north of the Great Basin. The geographical position of the valley is unique. Mountains surround the valley on three sides. The valley widens at Lolo and opens into a flat as it nears Missoula. The one hundred mile-long Bitterroot Valley is bounded on the west by the steep-walled Bitterroot Range and on the east by the more gently sloping Sapphire Range. The Bitterroots rise 6,000 feet above the valley floor. Several peaks in the Bitterroot Range are above 9,000 feet. Trapper Peak, the highest, reaches 10,131 feet in elevation. The Sapphires range in elevation from 6,000 to 8,870 feet above sea level. (These mountains were named for the sapphires found there, which are still mined at a site near Skalkaho Pass.)

Three major passes enter the valley through the Bitterroots: Lolo Pass, Nez Perce Pass and Lost Horse Pass. Skalkaho Pass and Sula Peak Pass are entrances to the valley through the Sapphire Range. Other paths into the valley include the Salmon River Valley to the south, Lost Trail Pass, Gibbons Pass to the southeast and the Clark Fork's drainage to the north (Ward 1973:8).

Periods of glaciation have left their mark on the valley. Three separate glacial periods occurred with long warm periods in between. During the last of these, the valley of
the Clark Fork River was crossed and obstructed by ice. The resulting flood is known as Lake Missoula. The lake was 1,000 feet deep over the present site of Missoula, and water spread into all connecting valleys. At one time the entire Bitterroot Valley was under this glacial lake. Wave cuts from Lake Missoula occur up to 4,200 feet on both sides of the valley (Ward 1973:9). Old shorelines can just be distinguished on hills such as Chaffin Butte near Corvallis.

Glacial moraines are the signatures of glacial ice movements. There are moraines along the east and west sides of the valley. Many are located at the mouths of various creeks. These mountain streams carried heavy loads of boulders, gravel and sand, which were piled up at the canyon mouths and then fanned out onto the valley floor. This process formed the low, finger-shaped hills that venture out into the valley (Stevensville Historical Society 1971:2). High terraces exist between the smaller valleys of these tributaries while lower terraces reach down toward the broad and irregular flood plain of the Bitterroot River. The river has cut and recut its channel. It is braided in places and holds generally to the foot of the Bitterroot Mountains.

Geography of the Refuge

The Teller Wildlife Refuge is located in Ravalli County near Corvallis, Montana. Its three properties are situated
along the Bitterroot River and have elevations between 3,410 and 3,490 feet above sea level. Hamilton, Montana, is five miles south of the Refuge, and Missoula is forty miles north. The Bitterroot and Sapphire mountain ranges begin to rise about ten miles to the west and east respectively. The north property includes 262 acres and is approximately one and one-half miles away from the main property. The main property, which encompasses the Chaffin and Slack family homesteads, is made up of 829 acres. The south property totals 201 acres. (See Figure 21.)

The properties are irregularly shaped and are surrounded on all sides by private lands. The Refuge lands lie in the valley bottom on the flood plains and low terraces of the river. The land has many swales and sloughs, which are low lying and wet. Abandoned and active water channels cross the properties. Gravel bars are found near the river and throughout the Refuge, evidence of past stream courses. The flood plains next to the river are unstable and nearly every year are at least partially covered with water during the peak flows of May and June, which are the result of snowmelt. The low terraces are slightly higher than the flood plains and are generally above the spring overflows. The terraces form large islands between the streams and channels. They have generally level but irregular surfaces due to the numerous swales, sloughs and channel cuts.
Figure 21. Teller Wildlife Refuge properties (Montana Land Reliance 1991:4)
CLIMATE

The Bitterroot Valley is known for its temperate climate, mild winters and cool pleasant summers, very little wind and light precipitation. The valley's protective ring of mountains creates a climate unusual at this northern latitude. People fondly call the Bitterroot "Montana's Banana Belt." Conditions in the valley are less extreme than they are in locations east of the Continental Divide. There are few winter days with below-zero temperatures, and the valley bottoms receive little snowfall.

The average number of days per year with below-zero temperatures is less than ten. The average frost-free season is 110 days and extends from late May to mid-September (Western Agricultural Research Center, 1989). The Bitterroot Mountains receive more rain and snow than the Sapphires or the valley bottom. The rain pattern has two peaks: there is a period of high rainfall in May and June as there is on the Great Plains and another in the fall similar to that in the Pacific Northwest. Winter and spring seasons have mostly cloudy weather while summers are characterized by clear skies and sunshine. Thunderstorms occur during the summer months. As autumn advances, rain and snowfalls increase and remain fairly steady until late spring.

Lying 600 miles east of the Pacific Ocean, the Northwest's chief rain source, the valley is not lush. Major mountain
ranges lie between the valley and the ocean and receive most of the moisture carried by the air masses as they move inland. Much of the water vapor condenses on the western slopes of the mountains of Washington and Idaho. By the time this air reaches the Bitterroot Range, it is dry.

Occasionally the valley receives continental polar air moving south from the Canadian Arctic. This air comes over the Rocky Mountains or down from Kalispell, Montana, causing blizzards and below-normal temperatures. If the cold air moves up from the south, it is not as cold but drops heavy snows (Stevensville Historical Society 1971:42). There are chinooks in summer and winter; these forceful winds come down from the slopes of the valley's western canyons. Inversion fogs occur in late fall and early winter. Cold air masses come into the valley followed by layers of warmer air on top. If winds are lacking to mix the layers, the cold air continues to cool, drawing moisture from the river and creating low-lying clouds.

Each area of the valley has its own microclimate, its own local weather. The shape of the foothills and location of the canyons affect the weather. As elevation increases on either side of the valley, amounts of rainfall and snowfall increase, the average temperatures dip and the growing season shortens. The south end of the valley is slightly warmer than the downstream, or north, portion of the valley.
The Western Agricultural Research Center in Corvallis, one mile east of the Refuge headquarters, has gathered climate data since 1965. Their records indicate an average annual temperature for the area of 46.19° F. Average January temperature is 28.4° F, and average July temperature is 66.4° F. Seasonal temperature and precipitation records taken over the past twenty-five years indicate the average winter temperature is 26.9° F, with an average of 1.91 inches of precipitation. Average temperature in the spring months is 47.5° F, with an average of 3.01 inches of precipitation. In the summer, temperatures average 65.0° F, and an average of 3.48 inches of precipitation is received. Autumn temperatures average 45.2° F, and an average of 2.64 inches of precipitation falls (Western Agricultural Research Center, 1989). Annual precipitation recorded near the Refuge properties is 11.17 inches of rain with 27.3 inches of snowfall (OEA Research 1988:5).

Climate data from Hamilton, located south of the Refuge, and Stevensville to the north indicate average minimum temperatures of around 33° F and 30° F respectively; average maximums are 59° F and 58°F. The highest recorded temperatures reached 103° F and 102° F; lowest recorded temperatures dipped to -39° F and -37° F (Ward 1973:10). Valley precipitation levels range from 12 to 16 inches (OEA Research 1988:5).
SOILS

The earth's covering of soil has been compared to the peel of an orange. Although there is great variety in this covering all over the earth's surface (Brady 1974:8), soil supplies the six factors needed for plant growth by providing water, air, mechanical support for roots, heat for chemical reactions and seventeen nutrients needed for growth. Soil texture and structure are the two most important physical properties of soils. Soil texture is concerned with the size of the mineral particles present and the proportions of particles of various sizes within the soil. Examples of soil textures are sands, clays and loams. (See Table 2.) Soil structure refers to the arrangement of soil particles into groups called aggregates. Soil structure affects density, porosity and water movement (Brady 1974:42).

Soils are formed by the weathering of rock caused by changes in temperature, erosion, and plant and animal decomposition. These forces combine to break rock into smaller fragments and slowly form soil. Environmental factors that influence soil formation include parent material, vegetation, climate, topography and the length of time the soils have weathered.
Table 2
Sediment Particle Sizes

<table>
<thead>
<tr>
<th>Soil Textural Class</th>
<th>Large Particles (in inches)</th>
<th>Small Particles (in millimeters)</th>
<th>Small Particles (in microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large cobbles</td>
<td>10 - 5</td>
<td>2 - 1</td>
<td>62 - 31</td>
</tr>
<tr>
<td>Small cobbles</td>
<td>2 - 2.5</td>
<td>1 - .5</td>
<td>31 - 16</td>
</tr>
<tr>
<td>Very coarse gravel</td>
<td>2.5 - 1.3</td>
<td>.5 - .25</td>
<td>16 - 8</td>
</tr>
<tr>
<td>Coarse gravel</td>
<td>1.3 - 0.6</td>
<td>.25 - .125</td>
<td>8 - 4</td>
</tr>
<tr>
<td>Medium gravel</td>
<td>0.6 - 0.3</td>
<td>.125 - .062</td>
<td>4 - 2</td>
</tr>
<tr>
<td>Fine gravel</td>
<td>0.3 - 0.16</td>
<td></td>
<td>2 - 1</td>
</tr>
<tr>
<td>Very fine gravel</td>
<td>0.16 - 0.08</td>
<td></td>
<td>1 - .5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.5 - .24</td>
</tr>
</tbody>
</table>

Source: Farnes 1972:75
Soil formation is a slow process. Parent material accumulates from the breakdown of bedrock in place or from the deposition of material weathered from rock by water, wind and ice. After or during parent material accumulation, organic matter is added, first by bacteria and fungi, later by trees, grasses and other plants.

Soil descriptions and soil survey maps are needed for the determination of zoning, land use, building sites and crop production. This information enables soil scientists to set limitations on the use of soils for cropland, pasture, wildlife, recreation and development. Soil surveys classify, locate on a map and describe the nature of soils as they occur in the field. The soils are classified into series on the basis of their characteristics.

Drainage refers to the frequency and duration of periods when the soil is free of water saturation. Drainage of the land promotes conditions favorable for plants and soil organisms. Good drainage allows oxygen and carbon dioxide to diffuse to and from the plant roots. Removal of water is as important to plant growth as providing water when soil moisture is low (Brady 1974:530).

Soils in the Bitterroot Valley range from silt loams to cobbly sands to thin mountain soils. The soils differ widely in fertility, physical and chemical properties and productivity. These differences are the result of the varied
environments in which the soils formed. There are level, deep and productive areas and rugged mountains lands fit for recreational or wildlife use only. Silt loams are found on the valley floor (Department of Agriculture 1959:11).

The Refuge properties are located on the floodplains and river terraces. The slope of the ground ranges from level or nearly level to gently sloping. At one time the soils on the Refuge were subject to frequent flooding. At the present time, with the increase in water regulation in the valley, the property sees very infrequent flooding. The local irrigation systems seem to affect groundwater levels more than the nearby Bitterroot River. Seasonal fluctuations in depths to groundwater are caused by irrigation practices.

The soils were developed in the river gravels. The river brought in coarse material, which lies near the bank and is sandier. The finer particles are located farther from moving water over old stream beds. The slow-moving backwaters have silt loams associated with them. The changing channel created a complex mixing of soil types on the Refuge, which are associated in intricate patterns. Almost all of the fields have more than one soil type present. The soils of the Refuge all have dark surfaces, high in organic matter. Chamokane and Slocum soils predominate. The soils present are generally best suited for pasture, range, woodland and wildlife.
Drainage, either too much or too little, and seasonal flooding are limitations for use.

The soils most suited for cultivation are the Grantsdale, Slocum and Corvallis series. These soils, G2n, S2g and C3p respectively, are located near the Refuge headquarters. They are suitable for most crops and presently produce alfalfa and wheat, oats or barley on a rotational basis. All other soils on the Refuge have limitations that eliminate cultivation although there are small areas of Corvallis (C3p), Hamilton (HF) and Grantsdale (G2n) soils that are suitable for dryland farming. The largest areas on the Refuge, due to its riverbottom location, have Chamokane complex (Ca) and Riverwash (Ry) soil types. The Chamokane complex soil and related soil types are infertile and shallow with low moisture-holding capacity. The Riverwash areas are gravel bars recently deposited adjacent to the river channel.

Table 3 lists the different soil types present on the Refuge. The soil textures, drainages and depths are given. Figure 22 is a map of soil types. Figure 23 is a cross section of the main property of the Refuge. Water table level is indicated by the sloping dotted line.
Table 3
Soils of the Refuge

<table>
<thead>
<tr>
<th>Map Symbol</th>
<th>Soils of valley fans &amp; terraces</th>
<th>Soils of the floodplains &amp; low terraces</th>
<th>Soils of the floodplains &amp; low terraces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hf</td>
<td>Hamilton-Corvallis silt loam</td>
<td>silt loam</td>
<td>sandy loam</td>
</tr>
<tr>
<td>G2n</td>
<td>Grantsdale loam</td>
<td>gravelly sandy loam</td>
<td>fine sandy loam</td>
</tr>
<tr>
<td>C3p</td>
<td>Corvallis silt loam</td>
<td>gravelly loamy sand</td>
<td>gravelly loamy sand</td>
</tr>
<tr>
<td>Dc</td>
<td>Dominic gravelly loamy sand</td>
<td>gravelly loamy sand</td>
<td>gravelly loamy sand</td>
</tr>
<tr>
<td>G2p</td>
<td>Grantsdale shallow loam</td>
<td>shallow loam</td>
<td>shallow loam</td>
</tr>
<tr>
<td>Ca</td>
<td>Chamokane complex sandy loam</td>
<td>sandy loam</td>
<td>sandy loam</td>
</tr>
<tr>
<td>Cb</td>
<td>Chamokane fine sandy loam</td>
<td>sandy loam</td>
<td>sandy loam</td>
</tr>
<tr>
<td>Cc</td>
<td>Chamokane gravelly loamy sand, shallow</td>
<td>somewhat excessive</td>
<td>gravelly loamy sand, shallow</td>
</tr>
<tr>
<td>Cd</td>
<td>Chamokane loamy, fine sand</td>
<td>gravelly loamy sand</td>
<td>gravelly loamy sand</td>
</tr>
<tr>
<td>Ce</td>
<td>Chamokane loamy sand, sandy loam, shallow</td>
<td>well to mod.</td>
<td>gravelly loamy sand, shallow</td>
</tr>
</tbody>
</table>

Surface Texture: silt loam, loam, gravelly loamy sand, fine sandy loam, sandy loam, loamy sand, gravelly loamy sand, shallow.

Drainage: well to mod., somewhat excessive, mod. well, somewhat excessive, well drained, somewhat excessive, well to mod.

Limitations to Agricultural Use:
- Suitable for all cult. crops, highly erosive but level
- Suitable for all crops
- Very productive
- Not productive for farming, low moisture-holding capacity
- Suited to most crops
- Not suitable for cultivation, droughty and infertile
- Low moisture-holding capacity, good for small grains
- Very low carrying capacity
- Too loose and droughty for cultivation, Shallow and droughty with low moisture-holding capacity
### Table 3 (cont.)

<table>
<thead>
<tr>
<th>Map Symbol</th>
<th>Soil Series Name</th>
<th>Surface Texture</th>
<th>Drainage</th>
<th>Depth to Gravel (in inches)</th>
<th>Limitations to Agricultural Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2g</td>
<td>Slocum</td>
<td>loam</td>
<td>moderately well drained</td>
<td>20-36</td>
<td>Dry enough for cultivation</td>
</tr>
<tr>
<td>S2k</td>
<td>Slocum</td>
<td>loam</td>
<td>imperfect</td>
<td>20-36</td>
<td>Slightly saline</td>
</tr>
<tr>
<td>S21</td>
<td>Slocum, poorly drained variant</td>
<td>loam</td>
<td>imperfect to poorly drained</td>
<td>20-36</td>
<td>Saturated most of the year</td>
</tr>
<tr>
<td>S2m</td>
<td>Slocum</td>
<td>sandy loam, gravelly sandy loam</td>
<td>mod. good to imperfect</td>
<td>less than 20</td>
<td>Mostly in swales, drainage varies</td>
</tr>
<tr>
<td>S2n</td>
<td>Slocum, shallow muck complex</td>
<td>highly organic</td>
<td>poorly drained</td>
<td>varies</td>
<td>Too rough to cultivate, associated with marshes</td>
</tr>
<tr>
<td>Ry</td>
<td>Riverwash</td>
<td>gravel bars</td>
<td>next to river channel</td>
<td></td>
<td>Recently deposited, barren</td>
</tr>
</tbody>
</table>

Source: United States Department of Agriculture 1959
Figure 22. SOILS OF TELLER WILDLIFE REFUGE (Montana Land Reliance 1990:8)
Valley fans and terraces
Low terraces and floodplains

Figure 23. Water table levels on the Teller Wildlife Refuge (Groundwater is influenced by irrigation practices in the valley.) (Thomason 1991)
PART 4
FIELD GUIDE

The Refuge managers hope to rehabilitate much of the Refuge's land. The Wildlife Biology Program at the University of Montana was asked to assist in this work by assessing the Refuge, its wildlife and resources. Faculty and students from the university, supervised by Dr. Lee Metzgar, director of Wildlife Biology, studied the Refuge. The information used to develop a management plan came from investigations in the spring and summer months of 1988 and 1989. The assessment included the analysis of degraded conditions and the potential of the area for wildlife production. Use of the Refuge as an educational facility was also considered. The information in this field guide has been obtained from the University of Montana's study of the Refuge.
HABITAT TYPES AND SUBTYPES

Aerial photographs and land surveys were conducted, and the results identified three major habitat types and eighteen subtypes. Figure 24 shows the location of these habitats. These were determined using dominant overstory and understory species. There are three habitat categories: open fields, wetland or riparian habitats and forest overstory habitats.

Open Field Habitat Subtypes

The Open Field Habitat is divided into ten habitat subtypes:

Subtype 2: Bluegrass grassland with occasional ponderosa pine. Also present are intermediate wheatgrass, lupine and sedges with shrubs of alder, woods rose and gooseberry.

Subtype 7: A spotted knapweed overstory with little Centaurea biebersteinii undergrowth.

Subtype 8: Wheatgrass and alfalfa are dominant. Other plants present include bluegrass, timothy, common yarrow, dandelion, musk thistle and patches of knapweed.

Subtype 9: Grazed, moist field containing mostly sedges and rushes, some alfalfa present.

Subtype 10: Pasture of orchardgrass and alfalfa.

Subtype 11: Spotted knapweed dominates with patches of orchardgrass, wheatgrass and alfalfa.

Subtype 12: Smooth brome is dominant, interspersed with sedges and bluegrass. Common yarrow and dandelion are the forbes present.

Subtype 13: Large patches of spotted knapweed with wheatgrass in between. Wooly mullen is present.

Subtype 14: Cultivated field of foxtail and alfalfa. Orchardgrass, bluegrass, dandelion and mustard are also present.
Figure 24. Habitat Subtypes

Key

Type #/Habitat
1. Cottonwood/snowberry
2. Bluegrass grassland
3. Marsh complex
4. Wet lowland
5. Ponderosa pine/snowberry
6. Shrubland
7. Dominant knapweed
8. Wheatgrass/alfalfa
9. Foxtail/sedge/rush
10. Orchardgrass/alfalfa
11. Knapweed/orchardgrass/alfalfa
12. Sedge/bluegrass
13. Knapweed/wheatgrass
14. Foxtail/alfalfa
15. Wheatgrass
16. Shrubby riparian
17. Sedge riparian
18. Cattail riparian

(Wildlife Assessment 1990:9)
Open Field Habitat Subtypes (cont.)

Subtype 15: Unmowed cultivated field of foxtail and alfalfa with some orchardgrass, bluegrass, dandelion and mustard.

Wetland/Riparian Habitat Subtypes

The Wetland/Riparian Habitat is divided into four habitat subtypes:

Subtype 3: Shallow marsh ponds surrounded by a sedge/rush community. Patches of cattail and common reed are present with water birch, willow and alder at the pond edges.

Subtype 16: Shrubby riparian area along irrigation ditches. The dominant overstory includes tanzy, woods rose and snowberry. Knapweed, wooly mullen, dandelion, common reed, lupine and sedges are also present.

Subtype 17: Sedge riparian with no shrubs.

Subtype 18: Cattail riparian habitat.

Forest Overstory Habitat Subtypes

The Forest Canopy Habitat areas are divided into four habitat subtypes:

Subtype 1: Open black cottonwood dominates the overstory with small numbers of ponderosa pine. The understory is fairly open. The main understory species are snowberry and bluegrass. Woods rose, chokecherry, gooseberry and spotted knapweed are also present. Dry, disturbed sites present in this habitat subtype mostly contain spotted knapweed and mustards.

Subtype 4: Wet lowland area with an overstory of willow, black cottonwood, dogwood, alder and water birch. The understory is composed of various sedges, rushes and common reed. The dry islands present are covered with bluegrass, sedges and rushes. This area includes small creeks and ponds with adjacent sedges and rush communities. Beaver activity causes this area to change frequently.
Forest Overstory Habitat Subtypes (cont.)

Subtype 5: Ponderosa pine dominates the overstory with interspersed black cottonwood. The understory consists mainly of snowberry and bluegrass. Woods rose, chokecherry and spotted knapweed are also present.

Forest Overstory Habitat Subtypes (cont.)

Subtype 6: Black cottonwood dominates the overstory with interspersed ponderosa pine. These sites have a very dense shrub understory, including snowberry, woods rose, hawthorne, chokecherry and a small population of willow.

PLANTS

Plants Collected on Teller Wildlife Refuge

<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SCIENTIFIC NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder</td>
<td>Alnus incana</td>
</tr>
<tr>
<td>Alyssum</td>
<td>Alyssum desertorium</td>
</tr>
<tr>
<td>Bitterroot</td>
<td>Lewisia rediviva</td>
</tr>
<tr>
<td>Buckhorn</td>
<td>Rhamnus alnifolia</td>
</tr>
<tr>
<td>Bulrush</td>
<td>Scirpus acutus</td>
</tr>
<tr>
<td>Cheatgrass</td>
<td>Bromus tectorum</td>
</tr>
<tr>
<td>Cutleaf daisy</td>
<td>Erigeron compositus</td>
</tr>
<tr>
<td>Dandelion</td>
<td>Taraxacum officinale</td>
</tr>
<tr>
<td>Eastwood willow</td>
<td>Salix eastwoodiae</td>
</tr>
<tr>
<td>Elk sedge</td>
<td>Carex geyeri</td>
</tr>
<tr>
<td>False flax</td>
<td>Camellina microcarpa</td>
</tr>
<tr>
<td>False lily of the valley</td>
<td>Smilacina stellata</td>
</tr>
<tr>
<td>Golden currant</td>
<td>Ribes aureum</td>
</tr>
<tr>
<td>Gooseberry</td>
<td>Ribes setosum</td>
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<tr>
<td>Harebell</td>
<td>Campanula rotundifolia</td>
</tr>
<tr>
<td>Hawthorne</td>
<td>Crataegus douglasii</td>
</tr>
<tr>
<td>Horsetail</td>
<td>Equisetum laevigatum</td>
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<tr>
<td>Horsetail</td>
<td>Equisetum palustre</td>
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<tr>
<td>Jacob's ladder</td>
<td>Polemonium micranthum</td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>Poa pratensis</td>
</tr>
<tr>
<td>Lupine</td>
<td>Lupinus argenteus</td>
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<tr>
<td>Microtsteris</td>
<td>Microsteris gracilis</td>
</tr>
<tr>
<td>Pepper grass</td>
<td>Lepidium perfoliatum</td>
</tr>
<tr>
<td>Pincushion cactus</td>
<td>Opuntia fragilis</td>
</tr>
<tr>
<td>Plains cottonwood</td>
<td>Populus trichocarpa</td>
</tr>
<tr>
<td>Ponderosa pine</td>
<td>Pinus ponderosa</td>
</tr>
<tr>
<td>Purple violet</td>
<td>Viola adunca</td>
</tr>
</tbody>
</table>
Plants Collected on Teller Wildlife Refuge (cont.)

Rocky Mountain juniper  Juniperus scopulorum
Sagebrush buttercup  Ranunculas glaberrimus
Sandbar willow  Salix exioua
Sandberg grass  Poa sandbergii
Serviceberry  Amelanchier utahensis
Shepherd's purse  Capsella bursa-pastoris
Snowberry  Symphoricapos albus
Storksbill  Erodium cicutarium
Strawberry  Fragaria virginiana
Tanzy mustard  Descurainia sophia
Timothy  Phleum pratense
Wild plum  Prunus americana
Willow herb  Epilobium suffruticosum
Winter cress  Barbarea orthoceras
Woods rose  Rosa woodsii
Wooly mullen  Verbascum thapus

Source: Teller Wildlife Refuge Wildlife Assessment and Recommendations, Wildlife Biology Program, University of Montana, 1990:10

The Bitterroot (Lewisia rediviva)

Many flowers, because of their beauty, symbolic attributes or associations, have been given places of honor in legends and songs. They have also been chosen as emblems of the lands where they grow. Over the years, various states have chosen floral emblems. The United State has a great number of native species. Certain states, such as Montana, have a wide variety of habitats in which flower species may grow. Montana's borders include desert, prairie and subalpine areas. When a state flower was being selected, a species that grew abundantly here but was limited elsewhere needed to be found. The bitterroot (Lewisia rediviva) was chosen as Montana's
state flower in 1894 for its characteristics including blooming season, vigor and adaptability.

Captain Meriwether Lewis brought the first knowledge of the bitterroot plant to the field of botany. President Thomas Jefferson requested that Lewis note the food plants used by the Indians and the dates of the plants' flowering and growth as he traveled through the West. One hundred and fifty species were collected by Lewis and safely transported back East by horseback and stagecoach. In this shipment was a bitterroot specimen gathered July 1, 1806, near the mouth of Lolo Creek, twelve miles south of present-day Missoula. The scientific name of the bitterroot was chosen in honor of Lewis. *Rediviva* means living again or restored to life and indicates the plant's ability to live without water and revive after being dried and even pressed.

The bitterroot grows in sunny areas of well-drained, dry, stony soils at altitudes of two thousand to three thousand feet. It has a very short root stalk, and leaves and flowers form during the growing season in thickly clustered, irregular rosettes that are three to four inches in diameter. In the spring many cylindrical leaves grow from the stalk and lie close to the ground. Flowers form in the center of the leaf cluster. As the flowers bud and bloom in late May through early July, the leaves wither and disappear. The
fleshy root of the plant may fork into several branches. The roots are white inside with a brownish-black outer layer.

The blossoms of the bitterroot open at dawn under the sun's rays. The rose-pink petals are eight to fourteen in number. Their color fades as the blossoms age. As the flowers drop off and blow across the ground, the seeds of the plant are dispersed.

Native legend says the bitterroot sprang from water drops shaken from the coyote's fur as he rescued the wolf from the Missoula River. The coyote gathered the plant and taught his children how to use it.

When Lewis and Clark arrived in the valley in 1805, they found the Flathead Indians using the bitterroot for food. The roots were collected and boiled. The Indians carried the plant on their journeys to eat and trade for furs.

The bitterroot was gathered in the spring, usually in May after the leaves had disappeared but before the blossoms had opened. The digging was done by women and children, using sharp, curved sticks. Soil was shaken from the roots before they were placed in sacks. Every spring the Salish came north and pitched their camp at the area's largest bitterroot digging grounds, which were near Fort Missoula.

To prepare the bitterroot as food, the brown outer coating was removed and the remaining material was spread on clean fabric to dry. The inner root became dry and brittle. If
kept dry, it could be stored for up to two years, becoming less bitter over time. When placed in boiling water, the root softened and could be made into a paste. The cooked root would be eaten plain or with huckleberry sauce or meat gravy. Bitterroot was not an everyday meal. It was carried on trips because it was lightweight and highly nutritious.

Trading posts were established after Lewis and Clark's visit. The plant was soon known to French Canadian hunters, who gave it the name "racine amere," which, freely translated, means bitter root. Many mountain men made use of the bitterroot; however, these early explorers never gathered it themselves but secured it from the Indians they traded with.

The Bitterroot Range, the Bitterroot River and the Bitterroot Valley were named first by the same trappers and hunters who called the area "racine amere" country. The first surveyors were guided by these men. As a result, the names the mountain men used became established and went down on the official maps of the mountains, river and valley. There are two known sites on the Refuge where bitterroot is found.
FISH HABITAT AND SPECIES

The Wildlife Assessment Team assessed the current abundance and distribution of fish in the spring of 1988 by electroshocking one hundred-meter stretches of streams on the Refuge. The electroshocking produced fifty individual fish. Fish from three game species were encountered: rainbow trout, mountain whitefish and brook trout. Two non-game species, redside shiners and longnose suckers, dominated the samples with longnose suckers being the only species collected at all locations. One largescale sucker and northern squawfish were found.

Fish Species Collected and Expected on the Refuge

<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SCIENTIFIC NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Species Collected</strong></td>
<td></td>
</tr>
<tr>
<td>Eastern brook trout</td>
<td>Salvelinus fontinalis</td>
</tr>
<tr>
<td>Largescale sucker</td>
<td>Catostomus marocheilus</td>
</tr>
<tr>
<td>Longnose sucker</td>
<td>Catostomus catostomus</td>
</tr>
<tr>
<td>Mountain whitefish</td>
<td>Prosopium williamsoni</td>
</tr>
<tr>
<td>Northern squawfish</td>
<td>Ptychocheilus oregonesis</td>
</tr>
<tr>
<td>Rainbow trout</td>
<td>Salmo gairdneri</td>
</tr>
<tr>
<td>Redside shiner</td>
<td>Richardsonius balteatus</td>
</tr>
<tr>
<td><strong>Species Expected</strong></td>
<td></td>
</tr>
<tr>
<td>Brown trout</td>
<td>Salmo trutta</td>
</tr>
<tr>
<td>Bull trout</td>
<td>Salvelinus confluentus</td>
</tr>
<tr>
<td>Longnose dace</td>
<td>Rhinichtys cataractae</td>
</tr>
<tr>
<td>Peamouth chub</td>
<td>Mylocheilus courinus</td>
</tr>
<tr>
<td>Western slope cutthroat</td>
<td>Salmo clarki</td>
</tr>
</tbody>
</table>

Source: Teller Wildlife Refuge Wildlife Assessment and Recommendations, Wildlife Biology Program, University of Montana, 1990:18
BIRD HABITAT AND SPECIES

Waterfowl

Habitat area identification, nest searches, artificial nests, observations of nest structures and waterfowl counts were the methods used to identify waterfowl species and make management recommendations. The areas that were identified as heavy waterfowl use areas were designated as primary habitat. In 1988, waterfowl were abundant in the north central marsh and the southwest corner of the main property. In 1989 waterfowl used these same areas and also used ponds located in the southeast part of the property, the northeast irrigation ditches and Willow Creek.

In 1988 there was one active Canada goose nest, and three pairs of geese exhibited nesting behavior along the Bitterroot River. None of the observed nests was successful. In 1989 three goose nests were found, one on an island in the north Willow Creek area and two in trees along the northern boundary between the central irrigation ditch and the Bitterroot River. (See Figure 25.) One mallard nest was found in the southwest marsh. One hooded merganser was seen with her brood on the southern end of Willow Creek.
Figure 25. Waterfowl
nest locations and
artificial nest
locations

Key

1980 nest locations

▲ Goose nest
□ Duck nest
▲ Artificial nest

1989 nest locations

▲ Goose nest
□ Duck nest
+ Artificial nest

(Wildlife Assessment 1990:9)
Non-game and Upland Game Birds

Species lists of non-game and upland game birds were compiled through searches during several days in April and May of 1988 and 1989. The species sighted during these studies and the additional species expected to be seen are listed in the bird species list that follows.

The Refuge sees a diversity of raptors. Nests located during the searches include two great horned owl nests, one long-eared owl nest, one northern harrier nest, one red-tailed hawk nest and two American kestrel nests. One osprey nest was found as well as one pileated woodpecker cavity.

Crowing counts were conducted to determine pheasant population trends and territories. Pheasant count results showed the presence of thirteen cocks in 1988 and eleven cocks in 1989.
Birds of the Refuge

The following list includes species expected to be seen on the Refuge, those sighted in 1988 or 1989 by the Wildlife Assessment Team and the Refuge staff and those known to nest on the Refuge. It also indicates the habitats where each species is most likely to be found.

Habitats
(These habitats are described at the beginning of the Field Guide.)

F-Forest Overstory. These areas include habitat types:
  1  cottonwood/snowberry
  4  wet lowland
  5  Ponderosa pine/snowberry
  6  shrubland

G-Open Areas. These areas include habitat types:
  2  bluegrass grassland
  7  dominant knapweed
  8  wheatgrass/alfalfa
  9  foxtail/sedge/rush
 10  orchardgrass/sedge/rush
 11  knapweed/orchardgrass/alfalfa
 12  sedge/bluegrass
 13  knapweed/wheatgrass
 14  foxtail/alfalfa
 15  wheatgrass

W-Wetland/Riparian. These areas include habitat types:
  3  marsh complex
 16  shrubby riparian
 17  sedge riparian
 18  cattail riparian, all ponds, the Bitterroot River
<table>
<thead>
<tr>
<th>SPECIES</th>
<th>HABITAT</th>
<th>NESTING</th>
<th>1988</th>
<th>1989</th>
</tr>
</thead>
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<tr>
<td>BITTERNS-HERONS-IBIS</td>
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</tr>
<tr>
<td>American bittern</td>
<td>W</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Great blue heron</td>
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<td>*</td>
<td>*-black-crowned</td>
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<tr>
<td>Night heron</td>
<td>W</td>
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<td>White-faced ibis</td>
<td>G,W</td>
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<td>BLACKBIRDS-ORIOLES</td>
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</tr>
<tr>
<td>Bobolink</td>
<td>G</td>
<td>*</td>
<td>*</td>
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<td>Brewer's blackbird</td>
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<td>Brown-headed</td>
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<tr>
<td>Cowbird</td>
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<td>Common grackle</td>
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<td>Northern oriole</td>
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<td>*</td>
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<td>Red-winged blackbird</td>
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<td>Western meadowlark</td>
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<td>Yellow-headed blackbird</td>
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<td>BLUEBIRDS-THRUSHES</td>
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<td>Mountain bluebird</td>
<td>G</td>
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<tr>
<td>Swainson's thrush</td>
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<td>Townsend's solitaire</td>
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<tr>
<td>Varied thrush</td>
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<tr>
<td>Veery</td>
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<td>SPECIES</td>
<td>HABITAT</td>
<td>NESTING</td>
<td>1988</td>
<td>1989</td>
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<td><strong>CHICKADEES-NUTHATCHES-CREEPERS</strong></td>
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<tr>
<td>Black-capped chickadee</td>
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<tr>
<td>Brown creeper</td>
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<td>Pygmy nuthatch</td>
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<td>Red-breasted nuthatch</td>
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<td>White-breasted nuthatch</td>
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<tr>
<td><strong>CRANES</strong></td>
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</tr>
<tr>
<td>Sandhill crane</td>
<td>G,W</td>
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<tr>
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</tr>
<tr>
<td>American dipper</td>
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<tr>
<td><strong>DOVES-CUCKOOS</strong></td>
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<tr>
<td>Black-billed cuckoo</td>
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<tr>
<td>Mourning dove</td>
<td>F,G</td>
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<td>Rock dove</td>
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Sighted by Wildlife Assessment Team
Refuge staff sightings 1987-1990
## SPECIES HABITAT NESTING 1988 1989

### LOONS-GREBES
- **Common loon** W
- **Eared grebe** W
- **Horned grebe** W
- **Pied-billed grebe** W * *
- **Red-necked grebe** W *
- **Western grebe** W *

### OSPREYS-EAGLES-HAWKS
- **American kestrel** G Yes * *
- **Bald eagle** F,G,W * *
- **Cooper's hawk** F * *
- **Ferruginous hawk** F,G * *
- **Golden eagle** G * *
- **Gyrfalcon** *
- **Merlin** G *
- **Northern goshawk** F *
- **Northern harrier** G,W Yes * *
- **Osprey** G,W Yes * *
- **Peregrine falcon** G,W *
- **Prairie falcon** G *
- **Red-tailed hawk** F,G Yes * *
- **Rough-legged hawk** F,G *
- **Sharp-shinned hawk** F,G *
- **Swainson's hawk** G

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Sighted by Wildlife Assessment Team
Refuge staff sightings 1987-1990

Sighted by Wildlife Assessment Team
Refuge staff sightings 1987-1990

1988 1989

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Sighted by Wildlife Assessment Team

Refuge staff sightings 1987-1990

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Sighted by Wildlife Assessment Team
Refuge staff sightings 1987-1990

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<tr>
<td>Common goldeneye</td>
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Sighted by Wildlife Assessment Team

Refuge staff sightings 1987-1990

1988 1989
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<tr>
<th>SPECIES</th>
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<th>NESTLING</th>
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<tr>
<td>Greater scaup</td>
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<td>Greater white-fronted goose</td>
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<td>Green-winged teal</td>
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<td>Harlequin duck</td>
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<td>Nashville warbler</td>
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<td>Lewis' woodpecker</td>
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<td>Northern flicker</td>
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<td>1989</td>
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<tr>
<td>-------------------------</td>
<td>---------</td>
<td>---------</td>
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<td>Pileated woodpecker</td>
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<td>Red-naped sapsucker</td>
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<td>Marsh wren</td>
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<tr>
<td>Winter wren</td>
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SMALL MAMMALS

Signs, sightings and trappings made possible identification of some of the small mammals present on the Refuge. Mist netting was used to capture and identify one genus of bat, and during the 1989 study, yellow-bellied marmot communities were mapped by locating burrowing sites. A location of burrowing sites was called a colony if active burrows were found within five feet of each other. (See Figure 26.) The Refuge contains abundant non-game small mammals; out of the twenty-nine species known to exist in the Bitterroot Valley, eleven were positively identified on the Refuge.

These species include porcupine, yellow-pine chipmunks and flying squirrels in the forest regions. Columbian ground squirrels and northern pocket gophers inhabited the open grassland. Fifteen active and four non-active yellow-bellied marmot colonies were found. Deer mice primarily occupy forest areas while meadow voles occur in open areas. Habitats with cottonwood, snowberry and knapweed produced the highest trapping success for deer mice while areas with knapweed, bluegrass, orchardgrass and alfalfa were most productive for the trapping of meadow voles. (See Figure 27.) Yellow-pine chipmunks were found in cottonwood and snowberry habitats while shrews were found in knapweed.
Figure 26. Marmot colony locations
This map shows the location of active and inactive marmot colonies.

Key

# Active marmot colony
& Inactive marmot colony

(Wildlife Assessment 1990:26)
Figure 27. Habitats of the two dominant small mammal species. Deer mice occurred in the areas shown as ■■, and meadow voles were numerous in the crosshatched area □□. Both species occurred in the areas shown as □□.

(Wildlife Assessment 1990:68)
### Small Mammals Present or Expected in the Bitterroot Valley

<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SCIENTIFIC NAME</th>
<th>IDENTIFICATION METHOD</th>
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<tr>
<td>Big brown bat</td>
<td><em>Eptesicus fuscus</em></td>
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<tr>
<td>Bushy-tailed woodrat</td>
<td><em>Neotoma cinera</em></td>
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<tr>
<td>California bat</td>
<td><em>Myotis californicus</em></td>
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<tr>
<td>Columbian ground squirrel</td>
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<td></td>
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<tr>
<td>Common (masked) shrew</td>
<td><em>Sorex cinereus</em></td>
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<tr>
<td>Deer mouse</td>
<td><em>Peromuscus</em></td>
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<td>Hoary bat</td>
<td><em>Lasiurus cinereus</em></td>
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<tr>
<td>Little brown bat</td>
<td><em>Myotis lucifugus</em></td>
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<tr>
<td>Long-eared bat</td>
<td><em>Myotis evotii</em></td>
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<tr>
<td>Long-tailed vole</td>
<td><em>Microtus longicaudus</em></td>
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</tr>
<tr>
<td>Masked bat</td>
<td><em>Myotis leibii</em></td>
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<tr>
<td>Meadow vole</td>
<td><em>Microtus pennsylvanicus</em></td>
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<tr>
<td>Montane vole</td>
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<td>Mtn. cottontail rabbit</td>
<td><em>Sylvagus nuttallii</em></td>
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<td>Northern flying squirrel</td>
<td><em>Glaucomus subrinus</em></td>
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<td>Northern pocket gopher</td>
<td><em>Thomomys talpoides</em></td>
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<td>Northern water shrew</td>
<td><em>Sorex palustris</em></td>
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<td>Pigmy shrew</td>
<td><em>Microsorex hovi</em></td>
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<td>Porcupine</td>
<td><em>Erithizon dorsatum</em></td>
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<td>Red squirrel</td>
<td><em>Tamiasciurus hudsonicus</em></td>
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<tr>
<td>Red-tailed chipmunk</td>
<td><em>Tamias ruficadus</em></td>
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<td>Silver-haired bat</td>
<td><em>Lasionycteris noctivagans</em></td>
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<td>Vagrant shrew</td>
<td><em>Sorex vagrans</em></td>
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<td><em>Plecopterus townsendii</em></td>
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<tr>
<td>Western jumping mouse</td>
<td><em>Capus princeps</em></td>
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<td>Yellow-bellied marmot</td>
<td><em>Marmota flaviventris</em></td>
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<tr>
<td>Yellow-pine chipmunk</td>
<td><em>Tamias amoemus</em></td>
<td>S/T</td>
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<tr>
<td>Yuma bat</td>
<td><em>Myotis yumonensis</em></td>
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</table>

S=Sighting  
T=trapping  
N=netting  

CARNIVORES AND OTHER FURBEARERS

Tracking sites baited with eggs and sardines allowed the assessment team to find furbearer and carnivore sign. Sightings and the presence of scat, tracks and dens found during other survey work were included in the data. Eleven species were found, and at least four other species are probable residents or transients. The most common furbearers are red fox, striped skunk, mink, longtailed weasel, beaver, muskrat, domestic dog and domestic cat. The confirmed and probable species list follows.

Carnivores and Other Furbearing Species of the Refuge

Common name, scientific name, status and evidence of presence are included.

Badger, *Taxidea taxis*; confirmed presence: skull
Beaver, *Castor canadensis*; confirmed resident: sightings, tracks, scat, lodges and dams, tree damage. Beaver are common along Willow Creek but also have been sighted in irrigation ditches.
Black bear, *Ursus americanus*; probable transient
Bobcat, *Felis rufus*; probable transient
Coyote, *Canis latrans*; confirmed presence: tracks, scat
Domestic cat, *Felis cattus*; confirmed presence: tracks, sightings
Domestic dog, *Canis familiaris*; confirmed presence: tracks, sightings
Long-tailed weasel, *Mustela frenata*; confirmed resident: tracks
Mink, *Mustela vison*; confirmed resident: tracks, sighting (1988), scat
Mountain lion, *Felis concolor*; probable transient
Muskrat, *Ondatra zibethicus*; confirmed resident: sightings, houses. Muskrats have been observed in all the major waterways.
Raccoon, *Procyon lotor*; confirmed resident: tracks. Tracks were observed on the banks of all major waterways.
Carnivores and Other Furbearing Species of the Refuge (cont.)

Red fox, Vulpes vulpes; confirmed resident: sightings, tracks, scat, dens. Fox were observed near the spring and in several fields.
River otter, Lutra canadensis; probable or possible resident
Striped skunk, Mephitis mephitis; confirmed resident: sightings, tracks, scat, dens. Skunks are widespread and common throughout the refuge.

RESIDENT: Those species whose home range requirements are met by the Refuge and/or the immediate surrounding areas.
PRESENT: Those species whose home range requirements are not met within the Refuge, that are long ranging or that are feral and stray domestic animals.
TRANSIENT: Those species that are not common in the valley but that may be sighted occasionally.

Source: Teller Wildlife Refuge Wildlife Assessment and Recommendations, Wildlife Biology Program, University of Montana, 1990:75

DEER

White-tailed deer are found throughout the Bitterroot River bottomlands on the Refuge properties. This species has adapted to the increase in farming and development in the valley through its ability to utilize more and different types of plant species. Therefore, white-tailed deer have survived and reproduced on the Refuge. The mule deer has not been able to adapt in the same way due to its limited diet, and its numbers have been greatly reduced.

Drives, spotlighting and manager estimates allowed for determination of white-tailed deer numbers on the Refuge. During a drive, members maintained visual contact with adjacent people in the line. The line moved forward, and members counted deer that ran through the line or ran ahead
past counters posted ahead of the line. Two lines were established and the drive ended when the lines met. The drives occurred between 11 a.m. and 3 p.m. when most deer are bedded in heavy cover. For spotlighting, the roads of the Refuge were driven between the hours of 11 p.m. and 1 a.m.

An average of twenty deer were found during the two drives in 1988 with variation expected due to bedding in dense cover and movement across Refuge boundaries. In 1988 the spotlight counts averaged 29.2 deer with a maximum of thirty-two. These numbers corresponded well with observations made by the Refuge manager. Observers positively identified eleven male deer during the survey activities.

A deer hunting program was established in 1988. During the 1988 and 1989 hunting seasons, twenty deer were taken each year. In 1990, thirty-six deer were taken. However, deer numbers remain stable, indicating an increase in the deer population on Refuge lands. (See Table 4.)
Table 4

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<td>04/30/88</td>
<td>Day drive</td>
<td>19-23</td>
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<td>05/14/88</td>
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<td>05/12/88</td>
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<td>29.2 (1.9)</td>
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<td>05/14/88</td>
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ELK, MOOSE AND BLACK BEAR

As Lewis and Clark traveled across present-day Montana, they reported that wildlife was less abundant in the western mountain ranges and valleys while vast herds of buffalo and elk were seen on the prairie (Mueschel 1971:69). In the decades since, hunting and loss of habitat have reduced even further the small populations of big game animals Lewis and Clark noted. Today elk are seen in the valley primarily during the winter months. The Lee Metcalf Refuge, located approximately thirteen miles north of Corvallis, frequently has elk visit during the winter while the only recent elk sighting on the Teller Wildlife Refuge occurred in 1987 when a cow and calf were spotted several times.

Sightings of moose and bear have not been recorded on the Refuge properties in the past ten years although black bear sign has been noted. Black bear and moose are probably occasional visitors on the Refuge.

AMPHIBIANS AND REPTILES

Mention of native and introduced amphibian and reptile species should not be neglected. Recent evidence has shown that certain species such as the spotted frog are indicators of environmental change. The species list included here shows species that have been sighted and those that are most likely present on the Refuge.
Reptiles and Amphibians of Western Montana

<table>
<thead>
<tr>
<th>COMMON NAME</th>
<th>SCIENTIFIC NAME</th>
<th>Sighted by refuge manager</th>
<th>Most likely present</th>
<th>Historical range—probably not current residents due to habitat alteration</th>
<th>Found in western Montana, but not on Refuge</th>
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<tbody>
<tr>
<td>Bullfrog</td>
<td>* Rana catesbeiana</td>
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<tr>
<td>Bull snake</td>
<td>* Pituophis melancleneus sayi</td>
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<tr>
<td>Leopard frog</td>
<td>Rana pipiens</td>
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<tr>
<td>Pacific tree frog</td>
<td>Hyla regilla</td>
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<tr>
<td>Western Painted turtle</td>
<td>* Chrysemys pita</td>
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<tr>
<td>Prairie rattlesnake</td>
<td>* Crotalus viridus</td>
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<tr>
<td>Red-eared slider</td>
<td>* Pseudemys</td>
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<tr>
<td>Red-sided garter snake</td>
<td>* Thamnophis sirtalis parietais</td>
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<td>Rubber boa</td>
<td>* Charina bottae</td>
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<tr>
<td>Spotted frog</td>
<td>* Rana pretiosa</td>
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<tr>
<td>Tailed frog</td>
<td>* Ascaphus truei</td>
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<tr>
<td>Western long-toed salamander</td>
<td>* Ambystoma macrodactyly</td>
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<tr>
<td>Western skink</td>
<td>* Eumeces skiltonianus</td>
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<tr>
<td>Western terrestrial garter snake</td>
<td>* Thamnophis elegans</td>
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<tr>
<td>Western toad</td>
<td>* Bufo boreas</td>
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<tr>
<td>Western yellow-bellied racer</td>
<td>* Coluber constrictor mormon</td>
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CONCLUSION

The Teller Wildlife Refuge, located on nearly 1,300 acres of riverbottom and farmland in the Bitterroot Valley, includes the historic Chaffin homestead. The land has creeks and streams, marshes, a pond and a length of river. White-tailed deer, red fox and striped skunks are residents. They are joined by great-horned owls, pheasant, geese and osprey. Hundreds of other birds visit and rest at the Refuge. Occasionally elk and moose pass through.

This unique resource has become available to the public through the generosity and foresight of Otto Teller. The Bitterroot Valley is changing rapidly. Open space will soon be a precious commodity. Mr. Teller has placed conservation easements on the properties of the Refuge to protect the land from subdivision and development, and to preserve it for the future. Mr. Teller chose the Montana Land Reliance to hold the easements. The Reliance is concerned with preserving the long-term health of the farmland and ranch land, and, in turn, protecting the health of the agricultural economy.

Mr. Teller has put into practice his ideas on chemical-free farming and the protection of wildlife. Special projects in sustainable agriculture and holistic management are
encouraged on the Refuge properties. The Teller Wildlife Refuge is a place where ideas can be put into motion, especially ideas that lead to the benefit of the environment and the conservation of wildlife.

The Refuge serves as an educational resource for landowners, farmers, university students, school children and the general public. Environmental writing workshops are offered. Field trips and walking tours can be scheduled. Visitations are accessible to all. Mr. Teller's vision has become a reality in the Teller Wildlife Refuge. His investment will result in immeasurable benefits for all Montanans.
This guide has been compiled to help visitors learn about the origins of the Refuge, and the history of the land and the people who lived here. The guide also includes sections on the wildlife that inhabit the land, what species may be found and where they might be located. It is hoped the information not only will be helpful to visitors but also can be used to educate school children in western Montana.

In the school setting, the guide could be used as a basis for a series of lessons. The separate sections of the guide may be integrated into secondary school units on topics such as the geology and history of western Montana, Montana homesteaders, the Bitterroot watershed and wildlife biology. Demonstrations can clarify certain concepts for students. Discussions, role playing and written assignments require students to use the information presented in the lesson. Their learning can be increased from the level of knowledge to application or synthesis. Examples of lesson plan ideas follow.
One demonstration that may be used during a high school lesson in geology or earth science is called a Cake Demo for Introductory Geology. After students have read the Geology section of the guide, this specially made layer cake may be used to show large-scale geologic processes. Four to six different-colored layers, each between one-half and two centimeters thick, are baked separately. Icing is applied between the layers. Blocks are cut out of the cake; these layered blocks can be used to show horizontal beds. Cutting down into the cake will show downcutting stream erosion. Folds are simulated by raising the center of a rectangular piece of cake, allowing the block to sag below the raised center. Block faults and thrust faults are demonstrated by lifting and lowering two separate blocks. Intrusions or the formation of batholiths can be shown by injecting icing into a block of cake.

A role-playing exercise used at the middle school or high school level will get all students involved. The following problem and task should be outlined for students after they have learned about the Bitterroot River and the hydrology of the valley. Each student is assigned a role. Students prepare to play their roles through research and discussion.
Role-playing Problem

A real estate developer from California has bought some land surrounding a tributary of the river that supplies your community's water. This land is very scenic and much in demand for homesites. The development plan calls for one-acre lots that extend to the high water mark. In addition, all homeowners will own the tributary bottom. This will prevent tributary access by non-landowners. Your community has not been bringing in much money in tax dollars. A development like this will increase the tax base, providing more money for schools, roads and other public works. The local economy is depressed because of a slump in the timber and building industries. The development could bring in much-needed jobs for the community. The area under consideration has excellent potential as a trout fishery and is prime wildlife habitat.

Student Task

At a community-planning council meeting, the council will hear testimony from both sides as to the need and advisability of this development. The planning council will then vote on whether or not to change the zoning regulations from wildlife/agriculture use to residential use. Should the zoning change, the development will proceed.
Student Roles

Mr. Henry Hassleman, Aqua-develop: This is the development company that is attempting to develop the riverfront property.

Dr. Byron Blue, university hydrologist: Dr. Blue studies water problems in the Rocky Mountains. He is concerned about water quality in the river with all of the new homesites. The homesites are planned to have septic systems, not the city sewer system.

Elsie Greenfield, chairman, Greenbelt Coalition: This group is planning a corridor along either side of the river to remain as parkland for residents of the community.

Elton Beckmann, owner, Sani-System, Inc.: This is the company that sells sanitary waste systems (septic systems) to homeowners.

Prospective Home Buyers: There is quite a large group of individuals who are interested in these homesites. Most of the lots will be quite expensive, and, as a result, the buyers will have to have sizable yearly incomes.

Mike McCaffery, representative of the local Union of Home Builders: This union represents workmen in the building trades.

Sam Newman, president of the local Chamber of Commerce: Mr. Newman represents the business interests of the community.

Planning Commissioners: This group is made up of five elected officials:
   Karen Krebsbach, chairman - a realtor
   Matthew Maloney - a high school social studies teacher
   Betty Bartholomew - a housewife
   Sidney Certified - a restaurant owner
   George Blest - a lawyer

Marty Spicer, spokesperson for the local lumber mill: The lumber mill is a major employer in the community.

Rodney Swell, president, Ducks Unlimited: This organization is dedicated to the preservation of habitat for ducks and other waterfowl. It is supported by dues and donations from sportsmen.
Sidney Bockflaut, school superintendent: Mr. Bockflaut is concerned that the student population of his district will be affected by the development.

Seth McFerson, owner, Angler's Roost: Mr. McFerson is owner of a bait and tackle shop for fishermen. It is located near the mouth of the tributary where the development will be located.

Claudia Glitz, owner, Skyblue Sapphires: Ms. Glitz has wanted to develop her mine into a tourist attraction for several years. The planning board has repeatedly turned down her request for a zoning change.

Douglas Doright, representative from Fish and Game: This state government organization oversees wildlife habitat.

Sonja Knudsen, chairman, Community Development Agency: This is an advisory agency that assists the Planning Commission in attracting new industries or businesses to the community.

Alexis Busby, chairman, Aspen Grove Hikers: This organization has a membership of fifty devoted to hiking as a hobby.

Mr. and Mrs. Alvin Sharp, parents of school-age children: They worry that extra children from the development will change the rural nature of the school system.

Doris Almsted, city-county treasurer: The treasurer's office is very aware that this community is in need of a new tax base.

Smokey Wall, owner, Ghostranch Dude Ranch: The dude ranch has used riverbottom land for pack trips and hunting trips for the past fifty years.

Buck Combine, small rancher: Mr. Combine has ranted his forty acres near the river for the past thirty years. His land was willed to him by his father. It has been in his family for three generations. He could gain by selling his land to the developer, but he and his family are reluctant to give up the ranch that has been in the family all these years.
A writing assignment related to the study of the homesteaders would work well in a history or English class. The history of the Chaffin family's homesteading experience could begin this unit. One lesson plan idea would require students to read a historical novel about homesteaders and then use library resources to research that period in the nation's history or that particular cultural group of homesteaders. Books that could be used include *Giants in the Earth* by O. E. Rolvagg, *O Pioneers!* and *My Antonia* by Willa Cather, or *Snow in the River* by Carol Brink. Library resources would include books, magazine articles located through the *Reader's Guide to Periodical Literature* and *American Heritage Magazine*, and encyclopedias.

The best way to educate students about the Refuge would be to have classes visit the properties. A field trip would allow the students to gain hands-on experience. Possible activities include a tour of habitat types, a study of riparian zones, or a nature walk or scavenger hunt for younger children. Exercises in sensory awareness or studies of animal behavior are fun and educational.

While students are asked to find or identify specific items, they are instructed not to disturb the object, plant or animal. The tasks outlined for the observation exercise may include finding five items in nature that are a certain
color. The assignment may require the students to find plants with leaves of a specific shape or size, or items that have smooth, soft or scratchy surfaces.

Students in the higher grades who have access to the Refuge may actually conduct a study of a certain bird or animal species. They might want to plant several experimental plots and study the growth of seeds in different types of soils, or compare the productivity of different types of seeds. The design and construction of nesting boxes and a study of the species who use them could be undertaken. These older students could design their own activities, depending upon their interests and abilities.

Examples of three lesson plan ideas for grade school children follow. These are adapted from Talking to Fireflies, Shrinking the Moon: A Parent's Guide to Nature Activities by Edward Duensing.

Tracking Animals

Begin to teach the fundamentals of tracking by having students follow their own footprints. Find an area that is flat with soft soil and little vegetation, for example, the school yard or a baseball diamond. Have students mark their starting point, walk a short way and return to the spot where they started. The students should notice that their tracks
are the most visible when the track lies between them and the sun. This is the first rule of tracking: Keep the trail you are following between the sun and yourself.

Ask students to identify each track before they move onto the next. The tracker should remain behind or beside the last track seen so it is not destroyed. Make sure the students notice the partial tracks made. Human tracks may cause the ground to flatten. Pebbles are forced into the ground. Dislodged objects and overturned stones are important. Another clue to human footprints is the unnatural pattern left by sneakers, hiking boots or other footwear. The crescent-shaped heel depression is another frequent sign. Other clues include bent vegetation, broken twigs and scuff marks.

If the next track seems invisible, instruct the students to face the direction the next track should be in, kneel down and put one ear to the ground. Closing the uppermost eye will give the student the perspective that will allow invisible tracks to show up. Use of a tracking or measuring stick also helps locate the next track. The students will use the stick to find the average distance between tracks. Standing near the last step, the student will swing the stick in an arc, noting the radius of the step distance. This arc should help focus the tracker on new clues.
Once the students become familiar with tracking human footprints, teach them to identify the prints of the larger mammals. Tracking will allow them to become familiar with animal behavior and have a first-hand experience in studying wildlife.

Sense Enhancement

Teaching sense enhancement is one way to help children appreciate the natural world. Teaching students to use their eyes in new ways will allow them to see new details in their surroundings (Duensing 1990: 130). Wide-angle vision occurs when the student looks straight ahead while being conscious of everything within the field of vision. Objects off to the side become conspicuous, and motion is easier to detect. Once something unusual is detected, the eyes can focus on it. Wide-angle vision will allow students to see more wildlife.

Narrowing the field of vision is called tight framing. Have students scan an area and talk about everything they see. Next, have them scan the area through a tube made by curving the fingers of one hand into a loose fist. Many details will be apparent. Animals and flowers will be easier to see. Have students tighten their fists and narrow their range of vision further. Even smaller details will be revealed such as insects and spider webs.
The sense of hearing can also be directed to stimulate awareness in students. In an outdoor setting, ask students to close their eyes and pick out a soft, steady sound such as the wind rustling leaves. Next, have them cup one hand behind an ear. This technique should allow students to hear sounds more easily and locate the source of a sound. The first identified sounds can be analyzed, and a single sound may be found to be made up of several different sounds (Duensing 1990: 133). Using the cupped-ear technique will make students aware of the importance of listening, not only in the natural world but in other environments as well.

Fishwatching

If there is an opportunity to take students to a pond or stream, they can learn the tricks of fishwatching. This involves a knowledge of light refraction, which is taught in elementary science classes. When fish look up to the surface of the water directly overhead, they see a transparent hole. The refraction of light hitting the water carries images downward, giving the fish a periscopic view of the world. Fish can see directly overhead and down to about a 20-degree angle above the water. Fishermen will crouch down below this angle to avoid being seen as they approach. Suggest that students experiment with this theory from a fish's point of view the next time they go swimming.
Water refraction can be demonstrated in the classroom by placing a penny in a bowl partially filled with water. Have a student lower his or her head until the penny disappears below the rim of the bowl. While the student remains in the same position, slowly add water to the bowl, and the penny will come back into view.

Other tips to improve success when fishwatching include approaching softly, keeping the sun at your back and learning to look through the surface glare, and getting as high as possible above the water. To motivate students and keep their interest, identify ahead of time places where fish are likely to be.
Alder
*Alnus incana*

Bitterroot
*Lewisia rediviva*
Cheatgrass
\textit{Bromus tectorum}
(introduced)

Cutleaf Daisy
\textit{Erigeron compositus}
Dandelion
Taraxacum officinale
(introduced)

Elk Sedge
Carex geyeri
Golden Currant
Ribes aureum

Harebell
Campanula rotundifolia
Horsetail
Equisetum laevigatum

Kentucky Bluegrass
Poa pratensis
Rocky Mountain Juniper
Juniperus scopulorum

Sagebrush Buttercup
Ranunculas glaberrimus

Sandbar Willow
Salix exigua
Serviceberry
*Amelanchier utahensis*

Shepherd's Purse
*Capsella bursa-pastoris*
(introduced)
Snowberry
*Symphoricarpos albus*

Storksbill
*Erodium cicutarium*
(introduced)

Timothy
*Phleum pratense*
(introduced)
Wild Plum
*Prunus americana*

Winter Cress
*Barbarea orthoceras*

Woods Rose
*Rosa woodsii*
Great Blue Heron

Brewer's Blackbird

Red Winged Blackbird

Yellow Headed Blackbird

American Robin

Black Capped Chickadee
Brown Creeper

Red Breasted Nuthatch

White Breasted Nuthatch

Sandhill Crane

Mourning Dove

American Goldfinch
Spotted Sandpiper

Wilson's Phalarope

White Crowned Sparrow

Bank Swallow

Barn Swallow

Cliff Swallow
Tree Swallow  
Blue Winged Teal

Canada Goose  
Green Winged Teal

Mallard  
Snow Goose
Wood Duck  
Hooded Merganser  
Black Headed Grosbeak  
Western Tanager
Warbling Vireo

Common Yellowthroat

Cedar Waxwing

Turkey Vulture

Yellow Warbler

Downy Woodpecker
Pileated Woodpecker

House Wren
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Simons, Daryl; Li, Ruth-Ming; Ellis, Shelley; and Schall, James D. *A Feasibility Study for a Streambank Stabilization Program for the Bitterroot River.* Helena, Mont.: Department of Natural Resources and Conservation, Water Resources Division, 1981.


GLOSSARY

Alkaline - water with pH greater than 7.4

Alluvial soil - sediments deposited by running water, ordinarily occurring on floodplains and at the base of ridges and slopes

Alluvial terrace - deposits of alluvial soil that mark former floodplains. A floodplain may have several sets of alluvial terraces at different elevations and of different ages (the higher the elevation, the older the age).

Alluvium - sediments deposited on land by streams and rivers

Backwater areas - seasonal or permanent water bodies found in the lowest parts of floodplains, typically circular or oval in shape

Basalt - common, black volcanic rock (igneous)

Batholith - large mass of granite with an area greater than forty square miles

Climax community - vegetation that has attained a steady state with its environment; in the absence of excessive disturbance, the species present form persistent populations

Crowing count - taken in the spring in the early morning by driving along roads in an area and stopping to listen to pheasant calls. Calls are counted over a set period of time. Data allows for estimating and comparing population numbers.

Fault - fracture in the earth's crust along which the opposite sides slip past each other

Flooded - a condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks or runoff from adjacent uplands

Floodplain - an alluvial plain caused by the deposition of alluvial material farther than the stream bank

Forb (pl forbes) - a herbaceous plant, usually broadleaved, that is not a grass or grass-like plant
Granite - coarse-grained igneous rock composed of feldspar and quartz

Habitat type - an aggregation of all land areas potentially capable of producing similar plant communities at climax

Mist netting - fine netting that is strung up between trees of poles. Birds become entangled and are removed for identification and banding, and then released.

Overstory - taller vegetation, usually tree species

Oxbow lake - a meander channel of a stream or river that is formed by breaching of a meander loop during flood stage. The ends of the cutoff meander are blocked by bank sediments.

Pond - body of water encircled by wetland vegetation. Wave action is minimal, allowing emergent vegetation to establish.

Saline - soil or water containing enough soluble salt to be detrimental to the average plant

Sedimentary rock - deposited material such as sand, clay, mud or gravel that has hardened into rock

Thrust fault - gently dipping fracture along which rocks above the fracture surface move up over those beneath

Understory - vegetation close to the ground, including shrubs, grasses and forbes

Water table - the high level of the zone of water saturation in soils, at least 15 cm. (6 in.) thick, and persisting for more than a few weeks
SUGGESTED READING LIST


Cooking Camas and Bitter Root. Harry Holbert Turney-High. 2 pp.


