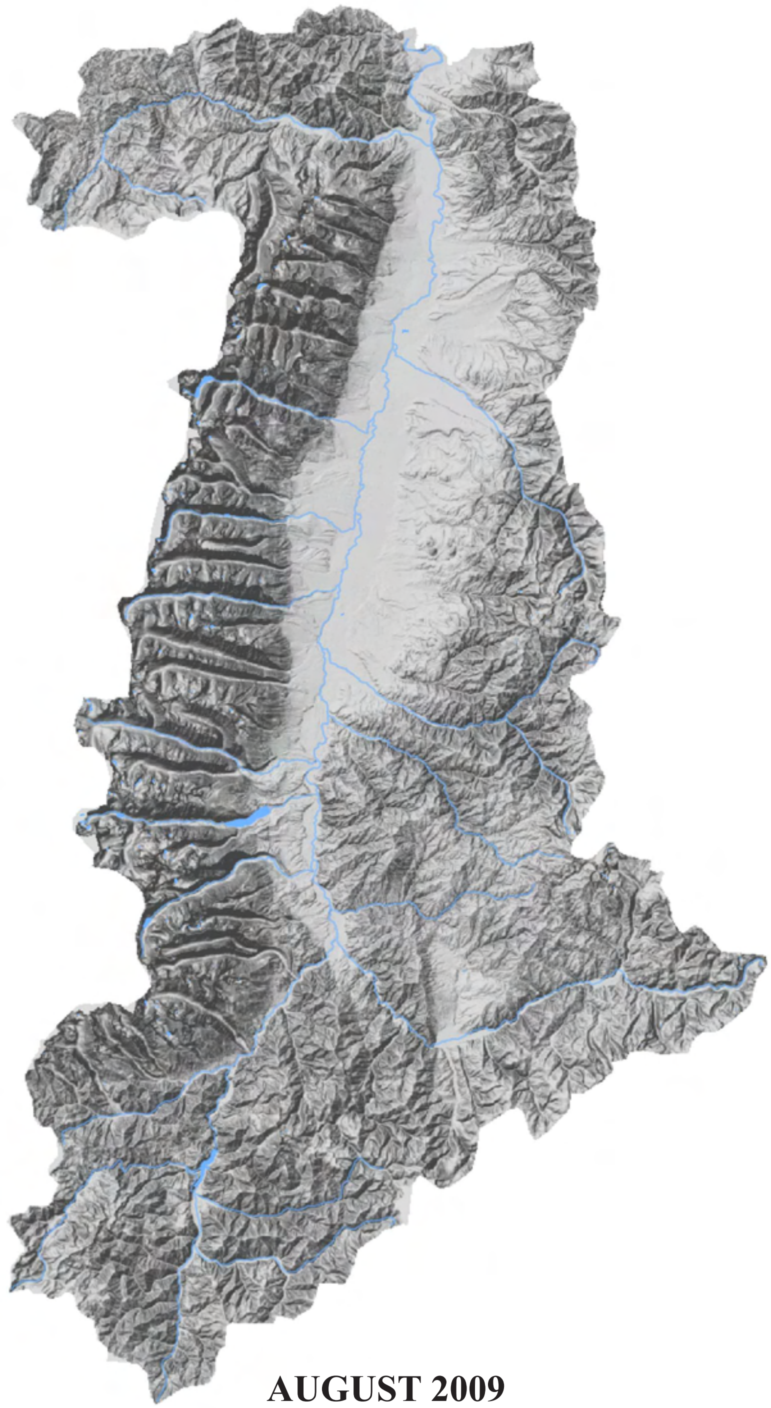
BITTERROOT RIVER SUBBASIN ASSESSMENT FOR FISH AND WILDLIFE CONSERVATION



AUGUST 2009

A report prepared for the
Northwest Power and Conservation Council

This Page Intentionally Blank

RESERVATION OF RIGHTS

Citation: Northwest Power and Conservation Council. "Bitterroot River Subbasin Plan." In Columbia River Basin Fish and Wildlife Program. Portland, Oregon, 2009.

Lead:

Montana Water Trust, Missoula, MT

Authors:

Bitter Root Water Forum, Hamilton, MT;
Geum Environmental Consulting, Inc. Hamilton, MT
Will McDowell, Missoula, MT

GIS Work:

Montana Water Trust, Missoula, MT
Geum Environmental Consulting, Inc. Hamilton, MT

Partners in Plan Development and Implementation

Montana Water Trust
Bitter Root Water Forum
Bitterroot National Forest
Lolo National Forest
Montana Department of Fish, Wildlife, and Parks
Montana Department of Natural Resources and Conservation
Bitter Root Land Trust
Five Valleys Land Trust
Montana Audubon
Bitterroot Audubon
Bitter Root Trout Unlimited
Rocky Mountain Elk Foundation
Trout Conservancy of Montana
Teller Wildlife Refuge
Clark Fork Coalition
Lolo Watershed Group

Table of Contents

Table of Tables

Chapter 2

Chapter 3

Chapter 4

Table of Figures

Chapter 2

Chapter 3

Chapter 4

This Page Intentionally Blank

Chapter 1 Introduction

This assessment synthesizes existing information about the environmental conditions and fish and wildlife populations of the Bitterroot River Subbasin. It is the first step in the development of a subbasin plan, which upon completion, will be reviewed and adopted as part of the Northwest Power and Conservation Council's Columbia River Basin Fish and Wildlife Program. The primary purpose of the subbasin plan is to help direct Bonneville Power Administration funding of projects that protect, mitigate, and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydrosystem.

1.1 Subbasin Assessment Overview

This subsection provides an overview of each chapter. Chapter 1 provides an introduction to the assessment, including the purpose, description of the assessment area, and the document's scope and approach. Chapter 3 provides a subbasin characterization that includes data on climate, geology, soils, hydrology, biomes and vegetation, land use and ownership, and the ecological context of the subbasin relative to the Columbia River basin. It describes the historical and current habitats found in the subbasin and includes a discussion on plant communities and plant species of special interest. Chapter 4 characterizes the current and historical conditions related to fish and wildlife species in the subbasin. Specifically, it describes aquatic focal species and terrestrial target species. In the case of aquatic species, two focal species were selected and their status and limiting factors were analyzed in detail. Terrestrial target species were grouped by broad habitat categories, which are the units of analysis for terrestrial species. Chapter 4 identifies the limiting factors for each aquatic focal species and target wildlife habitat.

1.2 Scope and Approach

This assessment addresses all vertebrate fish and wildlife found currently or historically within the Bitterroot Subbasin. Invertebrates and plants were not assessed in detail; however, aquatic invertebrate species with formal conservation status in the State of Montana are addressed, and vegetation is addressed broadly in terms of biomes, habitat categories, and specific habitats pertinent to aquatic and terrestrial species.

All information used in this assessment was gathered from existing sources, primarily technical literature and online databases. On some topics local experts, particularly agency biologists from Montana Fish Wildlife and Parks (MFWP) and the U.S. Forest Service (USFS), were consulted. The Interactive Biodiversity Information System (IBIS) databases maintained by Northwest Habitat Institute were consulted, but information provided by MFWP, the Montana Natural Heritage Program (MNHP), and Montana Partners in Flight Bird Conservation Program (PIF) were used more specifically as these sources were more up to date and accurate relevant to species information specific to the Bitterroot Subbasin.

The intent of this assessment is to provide a logical framework for evaluating current conditions and developing future objectives and strategies to protect, mitigate, and enhance fish and wildlife populations in the subbasin. To that end, the assessment proceeds from a general characterization of the landscape and a review of biomes and habitat characteristics, to an analysis of the status of key species, the status of habitats (for terrestrial species), and the status of aquatic habitat units (12-digit hydrologic unit code numbers or 6th-field HUCs) for aquatic species.

1.3 Chapter 1 References

NPCC. 2008. Northwest Power and Conservation Council website, Accessed July 2008 at: www.nwcouncil.org/library/2001/2001-20.htm

NPCC: Northwest Power and Conservation Council website [Internet]. Portland. [cited July 2008]. Available from www.nwcouncil.org/library/2001/2001-20.htm

Chapter 2 Subbasin Characterization

This chapter describes the Bitterroot Subbasin's climate, geology, soils, hydrology, vegetation, current and historical land uses, land ownership, and ecological context within the Columbia River basin.

2.1 Subbasin Description and Location

The Bitterroot Subbasin has an area of 2,889 square miles and is located entirely in Ravalli and Missoula Counties in the Rocky Mountains of western Montana. The Bitterroot Mountains along the Idaho border form much of the southern and western boundary, while the crest of the Sapphire Mountains forms the eastern boundary. The Bitterroot River, which flows through the center of the subbasin, is a tributary to the Clark Fork of the Columbia River in western Montana. Its principal tributaries include the East Fork of the Bitterroot River, the West Fork of the Bitterroot River, Burnt Fork Creek, and Lolo Creek. From the confluence of the East Fork and West Fork just south of Darby, Montana, the river flows northward 84 river miles to its confluence with the Clark Fork River near the western edge of the City of Missoula, Montana (Figure 2.1).

Most of the subbasin is steep, mountainous, and heavily forested, but there is a broad central valley used primarily for agriculture. The majority of the lands are managed by the U.S. Forest Service's Bitterroot (BNF) and Lolo National Forests (LNF). Agricultural valley lands are primarily in private ownership.

The subbasin is part of the Clark Fork-Pend Oreille River Basin and is identified by the United States Geological Survey (USGS) 8-digit HUC number 17010205.

Figure 2.1. Location of major streams, towns, and roads within the Bitterroot Subbasin.
Data Sources: USGS (2000) National Hydrography Dataset.

2.2 Ecoregions and Ecological Units

Ecoregions represent areas with similar ecosystems and that are similar in their type, quality, and quantity of environmental resources—including fish and wildlife. The Bitterroot Subbasin includes three U.S. Environmental Protection Agency (EPA) third-level ecoregions: the Northern Rockies (15); the Idaho Batholith (16); and the Middle Rockies (17) (Omernik 1987) (Figure 2.2).

The Bitterroot Subbasin is a transition zone between the moist Northern Rockies and the drier Middle Rockies. The majority falls within the Middle Rockies area, except the East and West Forks uplands, which are an eastern extension of the Idaho Batholith, and Lolo Creek, which is largely in the Northern Rockies ecoregion, a Pacific-climate-influenced area.

The Ecoregions of Montana have been recently reorganized, providing Level IV ecoregions at a more refined level within the Level III types (Woods et al. 2002). The Bitterroot, with its valley prairies and mountain conifer forests, includes four predominant Level IV ecoregions. Bitterroot-Frenchtown Valley (17s) and Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains (17x) are both elements of the Middle Rockies ecoregion. Glaciated Bitterroot Mountains and Canyons (16e) and Eastern Batholith (16a) are mostly part of the Idaho Batholith ecoregion. Other Level IV ecoregions of minor importance include High Idaho Batholith (16h), Lochsa Uplands (16b), St. Joe Schist-Gneiss Zone (15p), Alpine Zone (17h) of the Idaho Batholith ecoregion and Grave Creek Range-Nine Mile Divide (15a), which coincides with the Northern Rockies ecoregion (Figure 2.3, Table 2.1).

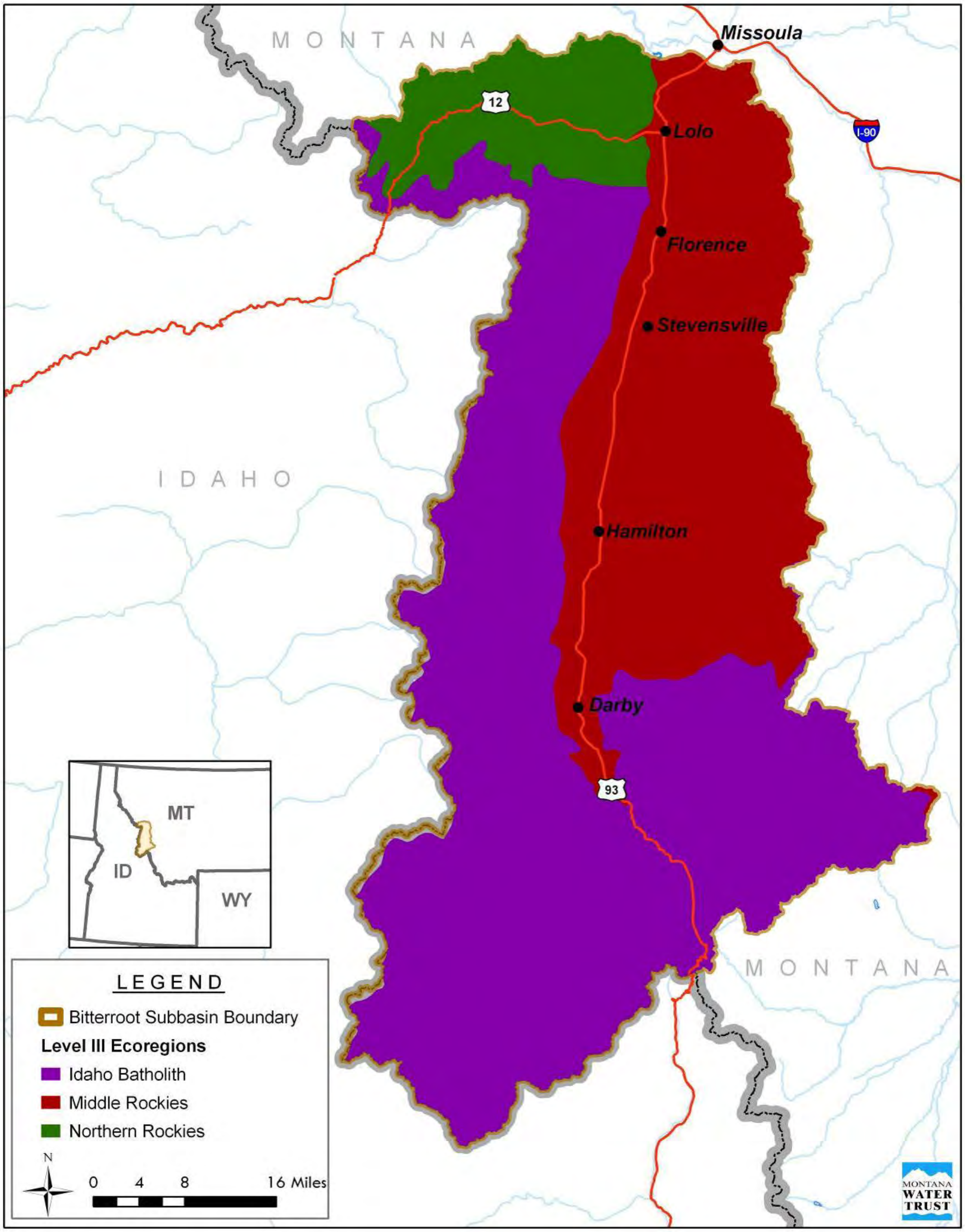


Figure 2.2. Level III ecoregions of western Montana found within the subbasin.
Data Sources: U.S. Environmental Protection Agency (2002).

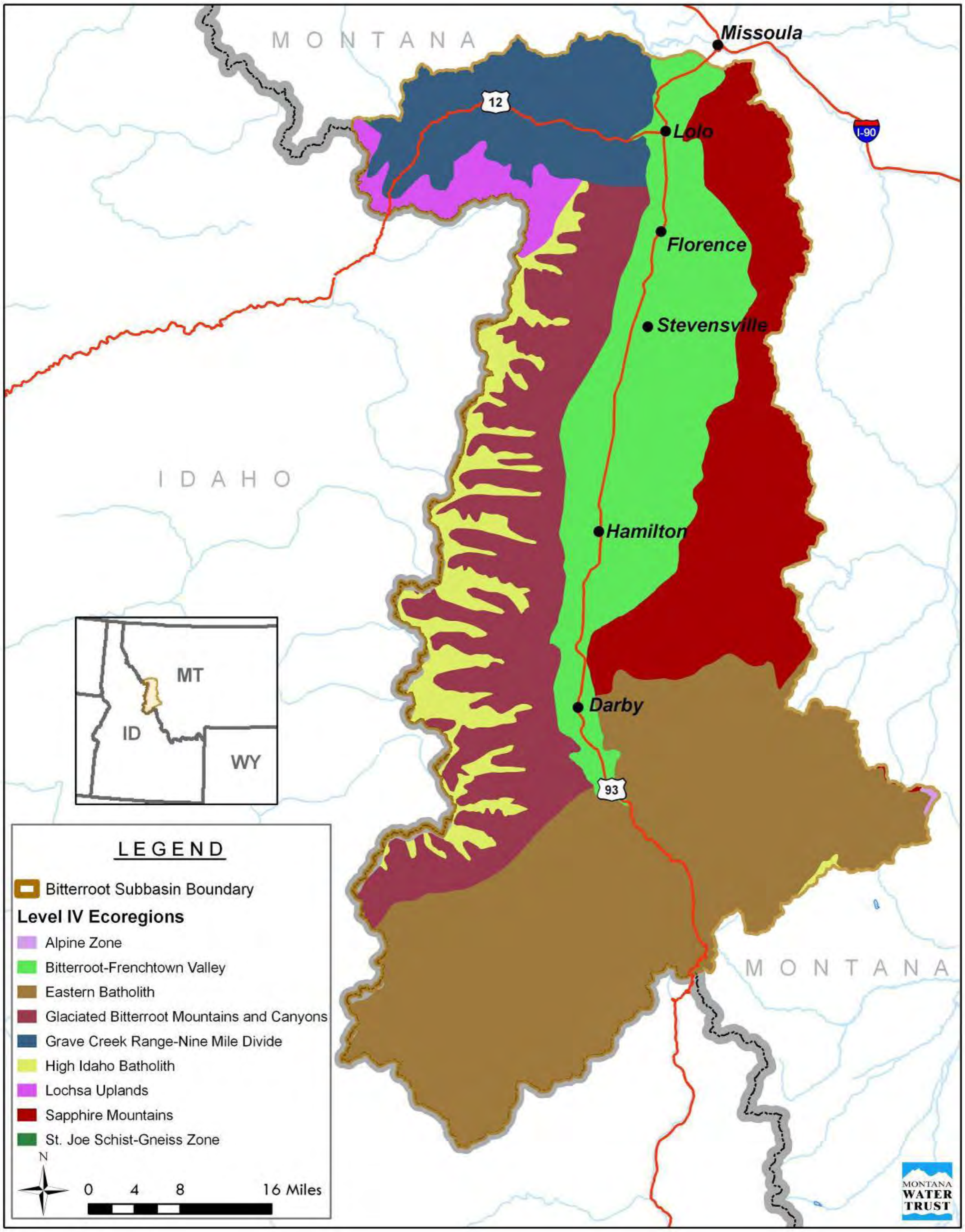


Figure 2.3. Level IV ecoregions of western Montana found within the Bitterroot Subbasin.
Data Sources: Environmental Protection Agency (2002).

Table 2.1. Level IV Ecoregion descriptions for western Montana found within the Bitterroot Subbasin.

Level IV Ecoregion	Description	Potential Natural Vegetation
Bitterroot-Frenchtown Valley (17s)	Sheltered intermontane valley with floodplains, terraces, hills, fans, and thick Quaternary deposits. End moraines of alpine glaciers deposited south of Hamilton. High stream flows occur during spring when mountain snow melts. Small side channels, sloughs, oxbow lakes, and riparian hardwood forests characterize the Bitterroot River floodplain. Mostly below 4,000 feet.	Foothill prairie: also riparian hardwood forests, and shrub wetlands.
Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains (17x)	Partially glaciated. Forested hills and mountains are underlain by various types of rock, including Precambrian Belt formation. Lakes occur in knob and kettle moraines and cirques. Found in Sapphire Mountains at 4,000 to 7,500 foot elevation.	Subalpine fir, Douglas-fir, and ponderosa pine forests. Also lodgepole pine (sub-climax).
Glaciated Bitterroot Mountains and Canyons (16e)	Glaciated, faulted, forested, north to south trending mountains underlain by the Cretaceous Idaho Batholith. Jagged peaks, cliffs, lakes and distinctive, nearly parallel ice-gouged canyons on west side of Bitterroot Subbasin. Wetlands occur. Surface waters have very low alkalinity. Climate influenced by moist Pacific air in winter, precipitation approaches 70 inches, higher than nearby areas. Elevations to nearly 9,500 feet.	Subalpine fir, Douglas-fir, Engelmann spruce, larch and ponderosa pine forests. Some moist forest species (western cedar, yew) persist.
Eastern Batholith (16a)	Partially glaciated. These forested mountains are underlain mostly by intrusive Cretaceous igneous rocks, including abundant granitics. High elevation lakes occur. Surface waters have low alkalinity. Dominates the East Fork and West Fork areas in southern Bitterroot Subbasin from 4,500 to 9,000 feet elevation.	Subalpine fir, Douglas-fir, and ponderosa pine forests. Also lodgepole pine. Some prairie & shrublands on drier slopes.
High Idaho Batholith (16h)	Wet, exposed and glaciated, with jagged peaks, tarns, and rockland. Often snow-packed with a high annual precipitation. Soils are stony and shallow. Includes alpine areas, subalpine parkland, and high, open, wind-blown forests. Located above 16e, up to over 10,000 feet elevation along Idaho border.	Whitebark pine and subalpine fir in high forests. Tundra, alpine grassland, sub-irrigated meadows, and wetlands above treeline.
Grave Creek Range-Nine Mile Divide (15a)	Partially glaciated. Northwest-southeast trending, forested mountains are mostly covered by deposits of volcanic ash and underlain by Precambrian Belt formations. Found only in Lolo Creek drainage in Bitterroot Subbasin. Ranges from 3,200 to 6,500 elevation.	Subalpine fir, Douglas-fir, grand fir, ponderosa pine forests.
Lochsa Uplands (16b)	Dissected and underlain by granitic rocks and mantled by volcanic ash deposits that increase the fertility and water retention in upland soils.	Grand fir and Douglas-fir are common, Englemann spruce and subalpine fir grow at high elevations, and cedar-hemlock-pine forests occur on north-facing slopes and in canyons.

From: Woods et al. (2002)

2.3 Climate

The Bitterroot Subbasin is in a transitional area between the moist, Pacific-influenced mountains to the west along the Idaho/Montana border, and the dry, mild summer-cold winter climate common to the rest of southwestern Montana. Annual precipitation is highly correlated to elevation, as is winter snowfall. The western perimeter of the watershed (Lolo Creek and Bitterroot Mountains) accumulates significantly higher amounts of precipitation than areas of similar elevation in the rest of the basin (Table 2.2 and Figure 2.4) and therefore contributes a large portion of the total basin precipitation and runoff. The valley area of the subbasin where all the agricultural acreage is located is a semi-arid zone with only 10 to 12 inches of annual precipitation. Hence, most agriculture in the Bitterroot Valley depends on irrigation.

Total subbasin precipitation is dominated by snow. At high elevations, such as Twin Lakes snow telemetry (SNOTEL) station in the Bitterroot Mountains, an estimated 65 to 75 percent of annual precipitation occurs as accumulated snowfall between late October and April.

Table 2.2. Precipitation at various elevations in the Bitterroot Subbasin.

Station Location and Years of Record	Elevation (feet)	Lat/Long (degree minutes N and W)	Annual Mean Precip (inches)	High Annual Precip (inches)	Low Annual Precip (inches)
Stevensville (1911-2007)	3,380	46.31/ 114.06	12.49	20.83	7.07
Hamilton (1895-2007)	3,530	46.15/ 114.09	12.22	20.11	4.9
Sula (1955-2007)	4,400	45.51/ 113.57	16.11	22.56	10.14
Lolo Hot Springs (1959-1984)	4,060	46.45/ 114.32	24.22	32.28	16.64
Skalkaho Summit SNOTEL (1981-2007) Skalkaho Hwy/ Sapphire Mtns	7,250	46.14/ 113.46	37.2	53.8	28.2
Saddle Mountain SNOTEL (1979-2007) near Lost Trail Pass, East Fork drainage	940	45.41/ 113.58	35.2	46.5	25.6
Twin Lakes SNOTEL (1979-2007) Bitterroot Mountains, southwest of Hamilton	6,400	46.09/ 114.30	62.8	88.3	42.1

From: Western Regional Climate Center and USDA NRCS SNOTEL Sites.

Annual mean maximum daily temperature at Stevensville is 58.6 degrees Fahrenheit (14.7 degrees Celsius) (Table 2.3), while at Sula it is 57.3 degrees Fahrenheit (14 degrees Celsius) (Table 2.4). Although their mean maximum daily temperatures are similar, minimum daily temperatures are far lower at Sula, often five to seven degrees (Fahrenheit). The difference in elevation between the towns is about 1,000 feet. This difference in minimum temperatures is roughly equivalent to the theoretical dry adiabatic lapse rate of 5.4 degrees Fahrenheit for each one thousand feet of elevation change (Moore 2005). This means minimum temperatures at ungauged locations can be expected to be approximately five degrees (Fahrenheit) lower for every 1,000 feet of elevation gain.

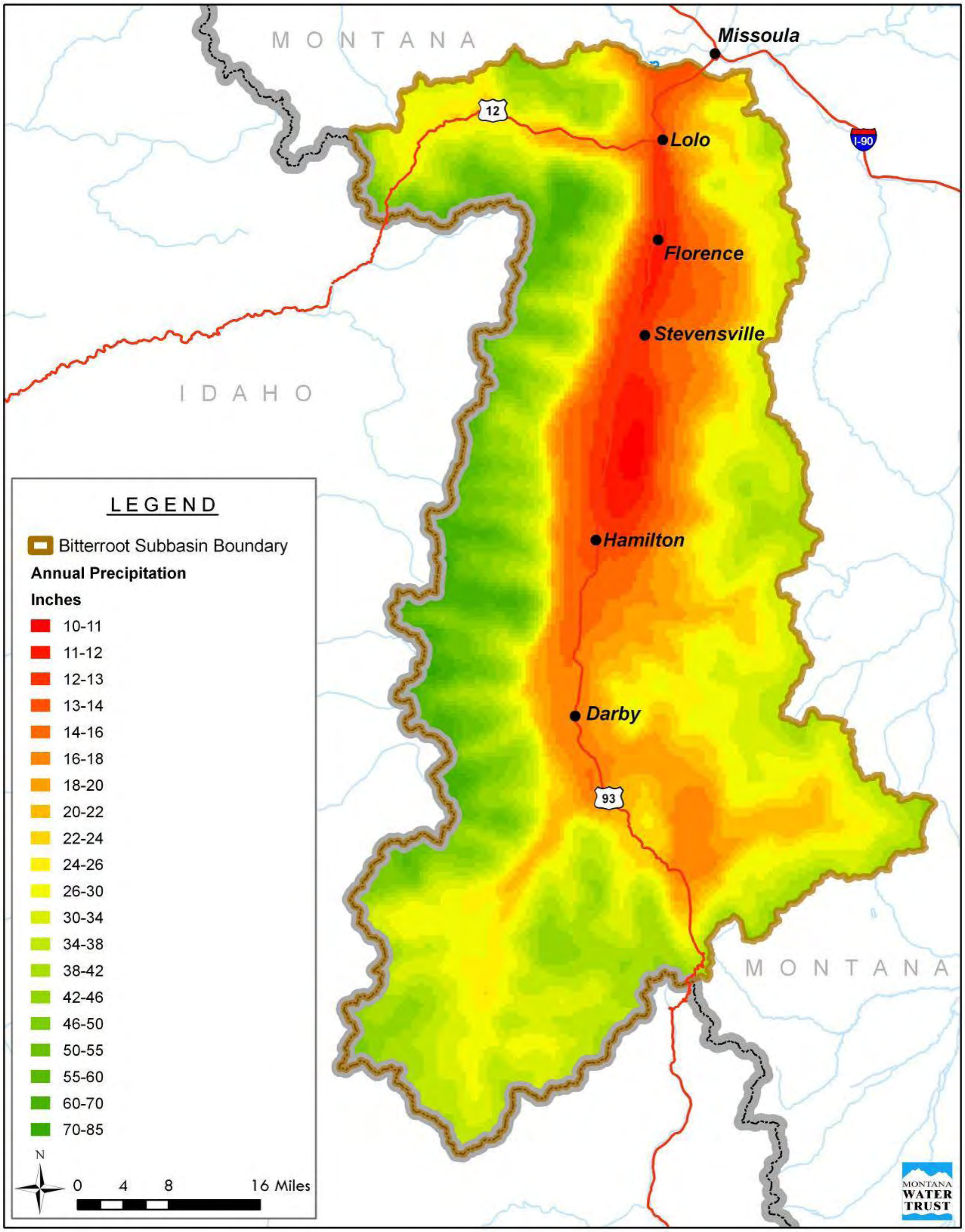


Figure 2.4. Isohyet map of annual precipitation in the Bitterroot Subbasin.
Data Sources: PRISM (2006).

Table 2.3. Monthly maximum and minimum temperatures in Stevensville, Montana, at 3,380 feet elevation.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean of Max/Min
Max (F˚)	33.2	39.8	49.0	59.6	68.2	75.3	85.1	83.5	72.2	59.2	43.3	34.6	58.6
Min (F˚)	15.1	19.0	24.6	30.6	37.4	44.0	47.3	45.3	38.2	30.6	23.2	17.1	31.0

From: Western Regional Climate Center.

Table 2.4. Monthly maximum and minimum temperatures in Sula, Montana, at 4,400 feet elevation.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean of Max/Min
Max (F˚)	33.2	40.1	47.6	56.1	64.9	72.8	82.7	81.7	71.8	59.6	43.0	33.6	57.3
Min (F˚)	10.1	14.0	20.0	26.4	32.5	38.5	40.5	38.8	31.9	25.0	18.8	11.8	25.7

From: Western Regional Climate Center.

High elevation sites, such as the SNOTEL site at Skalkaho Summit (7,250 feet) have much lower minimum temperatures than valley sites, with minimum temperatures of negative 10 degrees Fahrenheit (negative 23 degrees Celsius) to negative 15 degrees Fahrenheit (negative 26 degrees Celsius) recorded in winter nearly every year, and a minimum temperature of negative 36 degrees Fahrenheit (negative 38 degrees Celsius) recorded in three different years of an 18-year data set (USDA NRCS SNOTEL Sites).

2.4 Geology

The Bitterroot Subbasin is a north-south-trending structural basin filled with deep Tertiary sediments and surrounded by intrusive, metasedimentary, metamorphic, and volcanic bedrocks. The basin-fill Tertiary sediments in the valley have been estimated at up to 3,000 feet thick near Hamilton and Corvallis. The Bitterroot Mountains bordering on the west, and much of the West Fork and East Fork area in the southern end of the subbasin, are composed of Cretaceous granitic rocks associated with the Idaho Batholith. The Sapphire Mountains that form the eastern boundary of the basin are composed of metasedimentary rocks of the Middle Proterozoic Belt Supergroup. They include quartzites, quartizitic and calcareous argillite, and argillaceous limestone. Tertiary volcanic rocks, including tuffs, breccia, ash and some rhyolitic rocks, outcrop locally near the margins of the structural basin (Briar and Dutton 2000). Figure 2.5 shows a map of the geology of the Bitterroot Valley area.

Tertiary sediments overlie the bedrock throughout the area, make up most of the basin fill, and outcrop as unconsolidated tertiary sediments on the eastern benches and foothills of the Bitterroot Valley and to a much lesser extent on the west side (Figure 2.5). These unconsolidated sediments (gravels, sands, silts, and clays) include two major geologic units: ancestral Bitterroot River deposits and the Sixmile Creek Formation. The Sixmile Creek Formation is made up of a variety of alluvial fans, debris flows, and fluvial materials. Much of it silts, sands and gravels locally derived from adjacent Belt rocks. Some parts have extensive volcanic ash deposits (Lonn and Sears 2001). The ancestral Bitterroot River deposits are older and generally outcrop downslope of the Sixmile Formation, closer to the present valley bottom. They vary from clays and silts to cobbles and boulders. Their lithology includes rock from throughout the subbasin.

Quaternary alluvial sediments are prevalent within the valley bottom and river floodplain and nearby terraces and often occupy a continuous band up to two miles wide. They are relatively shallow, often only 40 feet thick, and overlay deep Tertiary valley-fill sediments (McMurtrey and Swenson 1972). There are two prominent Quaternary alluvial terraces within the valley, one called the Riverside Terrace, located about 10 to 15 feet above the current floodplain, and one called the Hamilton Terrace, about 20 to 25 feet above the floodplain. The valley bottom itself is interlaced with myriad ancestral river channels, especially on the east side, which form sloughs, oxbows, and alternate overflow channels for the Bitterroot River (Briar and Dutton 2000).

On the west side terraces, quaternary alluvial-fan deposits of coarse materials (gravel and cobbles) are a dominant feature. Quaternary alluvial fans also form prominent features where Skalkaho, Threemile, and particularly Burnt Fork Creeks enter the valley from the Sapphire Mountains to the east. Except for these Quaternary features, most of the east side foothills are made up of the previously mentioned Tertiary sediments. Quaternary glacial till is a minor feature found only in the west side foothills, with more significant deposits around Lake Como and west of Darby, where it forms distinctive glacial features (moraines, kettle holes, etc.) (Figure 2.5).

Late Quaternary (Pleistocene) glacial activity in the Bitterroot Mountains carved the steep U-shaped canyons seen today on west-side drainages like Kootenai Creek, Big Creek, Blodgett Creek, Roaring Lion Creek, and Rock Creek, and deposited glacial till at the mouth of some canyons. Glacial Lake Missoula backed up water into the northern Bitterroot Valley to an elevation of approximately 4,200 feet, briefly filling the Bitterroot Valley. A few, small glacial lake-bed deposits still remain (Figure 2.6). The Sapphire Mountains did not experience significant glacial activity because they were too low in elevation (USDA NRCS 2004) (Figure 2.7).

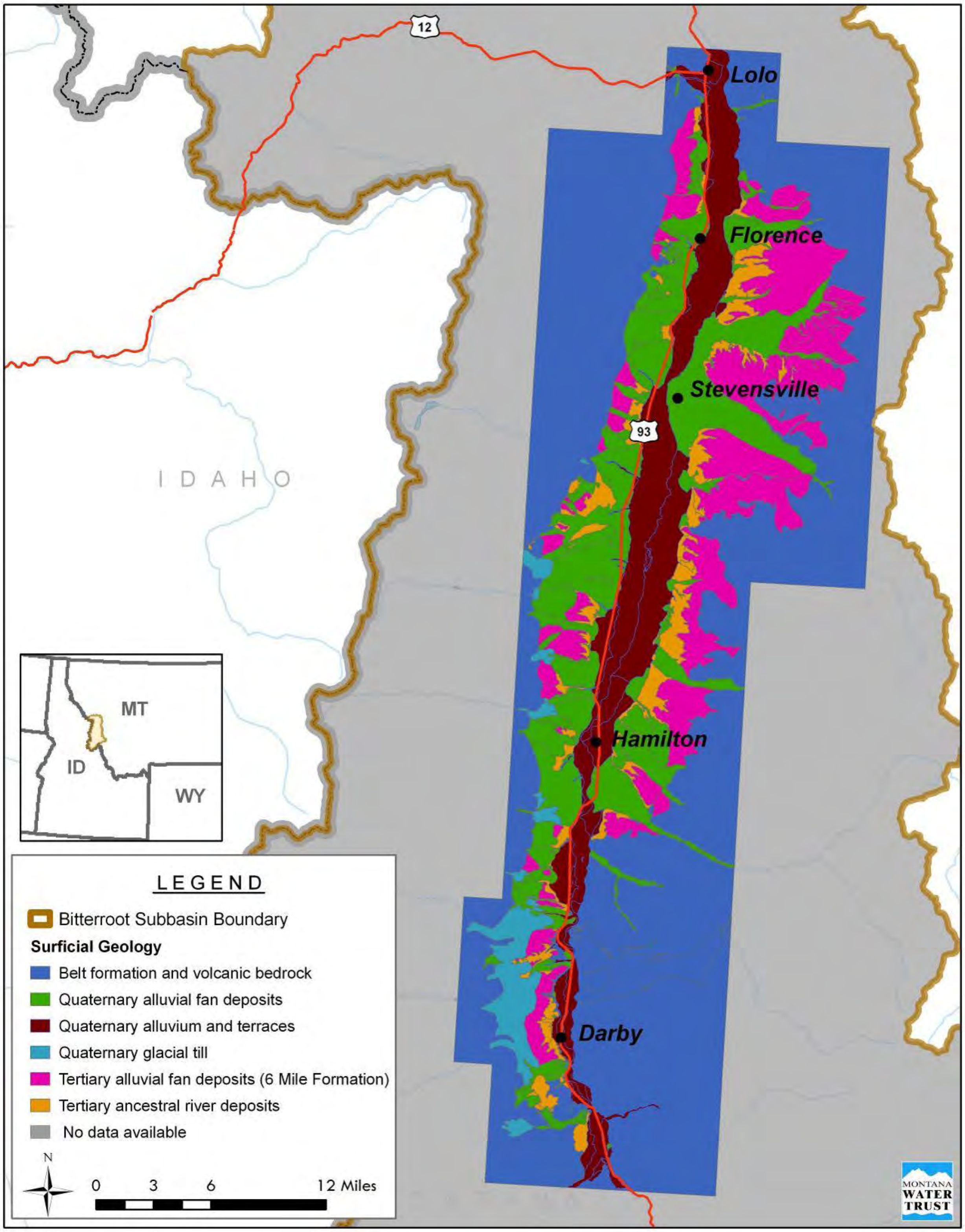


Figure 2.5. Geologic map of Bitterroot Valley within the Bitterroot Subbasin.
Data Sources: USGS (1998) and MT BMG Surficial Geologic Map.

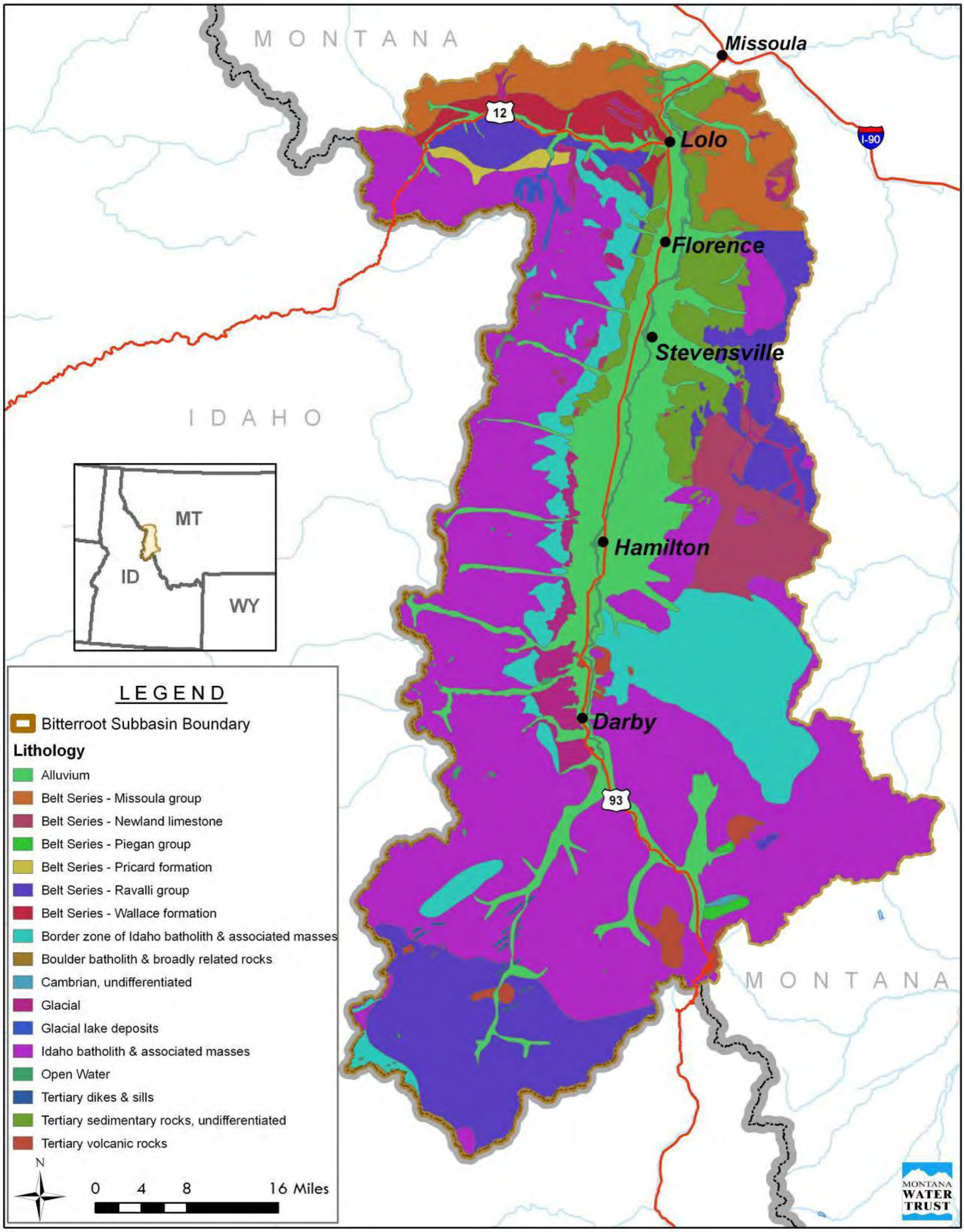


Figure 2.6. Lithology map of the Bitterroot Subbasin.
Data Sources: USGS (1998).

2.5 Topography and Channel Morphology

The Bitterroot Subbasin is a topographically complex and highly dissected mountain region (Figure 2.7). Elevations range from 10,157 feet at Trapper Peak in the southwest to approximately 3,100 feet at the confluence with the Clark Fork River. Over 3,000 miles of perennial streams drain the area. Three major types of topography are present: (1) the Bitterroot Valley, north of Skalkaho Creek, forms a broad valley averaging 7 to 10 miles wide, made up of flat floodplains, gently sloping terraces, and rolling foothills; (2) the Sapphire Mountains to the east and south are a moderately steep, moderately dissected range rising from 4,000 feet to 7,500 feet; and (3) the Bitterroot Mountains to the west rise abruptly from 4,000 to 4,500 feet at the western valley margin to elevations averaging over 9,000 feet. The Bitterroot Mountains are dissected by numerous parallel drainages, forming extremely steep canyons, cliffs, and rocky peaks.

2.5.1 Slopes

The Montana Natural Resource Information System (NRIS) has mapped slope patterns in the Bitterroot Subbasin into seven categories. Figure 2.8 displays the patterns described above, with the steepest slopes in the basin in the Bitterroot Mountains to the west, the gentlest slopes in the valley bottom, and moderate slopes in the Sapphire Mountains to the east.

2.5.2 Channel Morphology

Boyd and Thatcher (2008) characterize the Bitterroot River as “a dynamic alluvial river” with a high bedload of sediment, particularly cobbles. They describe the Bitterroot as “a predominantly braided channel embedded in a network of narrow, sinuous minor channels” and note that it is known for a high frequency of overbank flow, a high percentage of eroding banks, frequent meander cutoffs, and a natural potential in many areas for major lateral channel migrations. The minor channels are in the floodplain and are fed by groundwater discharge. The river is capable of shifting part of its flow into these minor channels during flood events, or even shifting its main thread to a new location in the floodplain. Boyd and Thatcher report that 36 percent of the river’s banks between Darby and Florence are eroding, which is considered a very high rate, but there is no evidence of long-term aggradation or degradation in the channel bed. Therefore, they do not believe the Bitterroot is geomorphically “unstable.” Rather they describe these characteristics as resulting from the expected behavior of this fluvial system.

The Bitterroot River can be generally split into four distinct reaches based on differences in channel morphology: (1) the upper river, from the headwaters of the East and West Forks downstream to the confluence near Conner; (2) the Conner to Skalkaho reach; (3) the middle river, from Skalkaho Creek north to Eightmile Creek; and (4) the lower river, from just below Eightmile Creek to the confluence with the Clark Fork River (Figure 2.9). Table 2.5 lists typical channel characteristics for two sites on the mainstem Bitterroot River—one in the Conner to Skalkaho reach (Darby Gage) and one in the lower end of the middle river reach (Florence Gage). Table 2.6 summarizes geomorphic characteristics of the four distinct reaches.

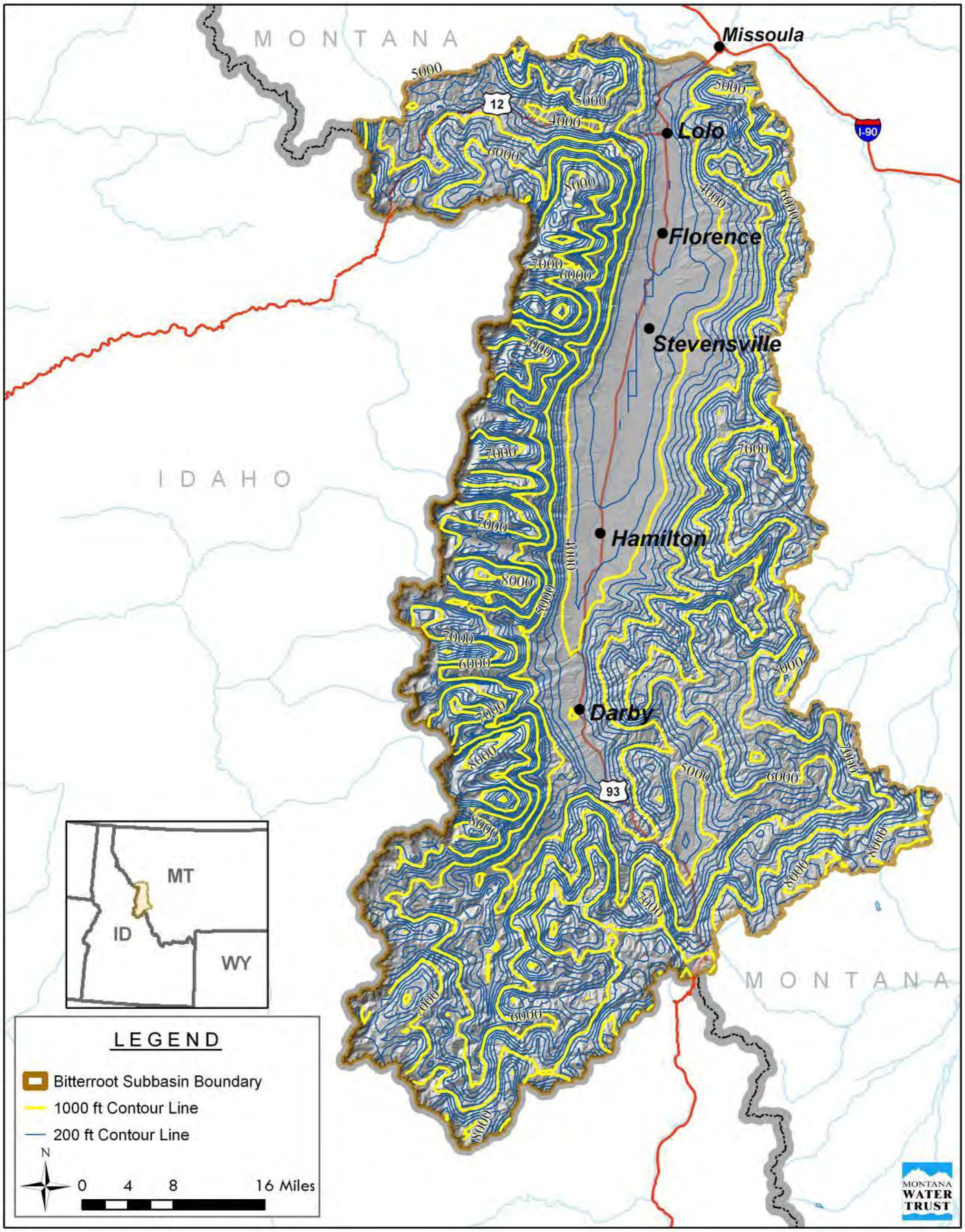


Figure 2.7. Topographic map of the Bitterroot Subbasin.
Data Sources: USGS (1995).

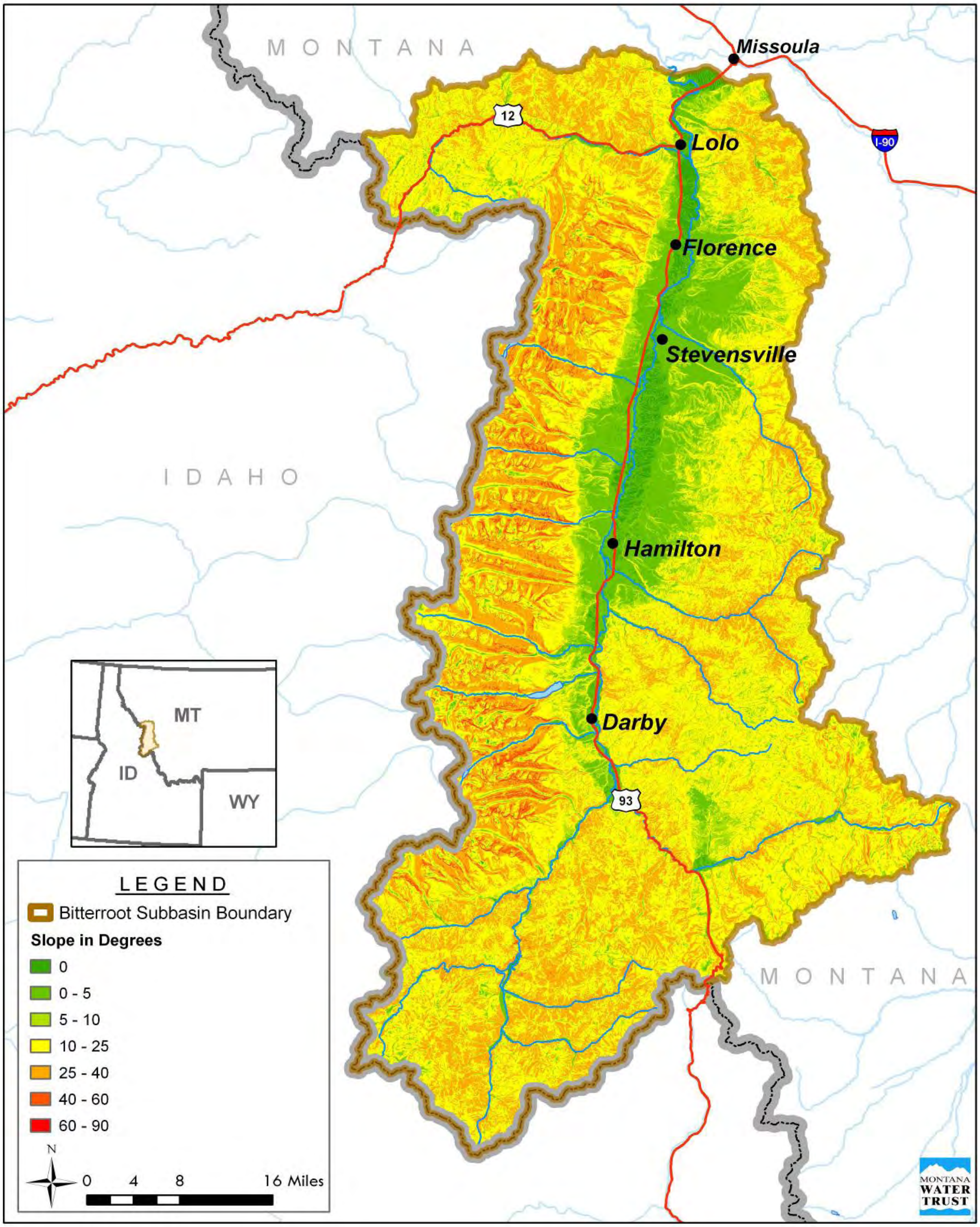


Figure 2.8. Slope patterns in the Bitterroot Subbasin.
Data Sources: Derived from National Elevation Dataset (2003).

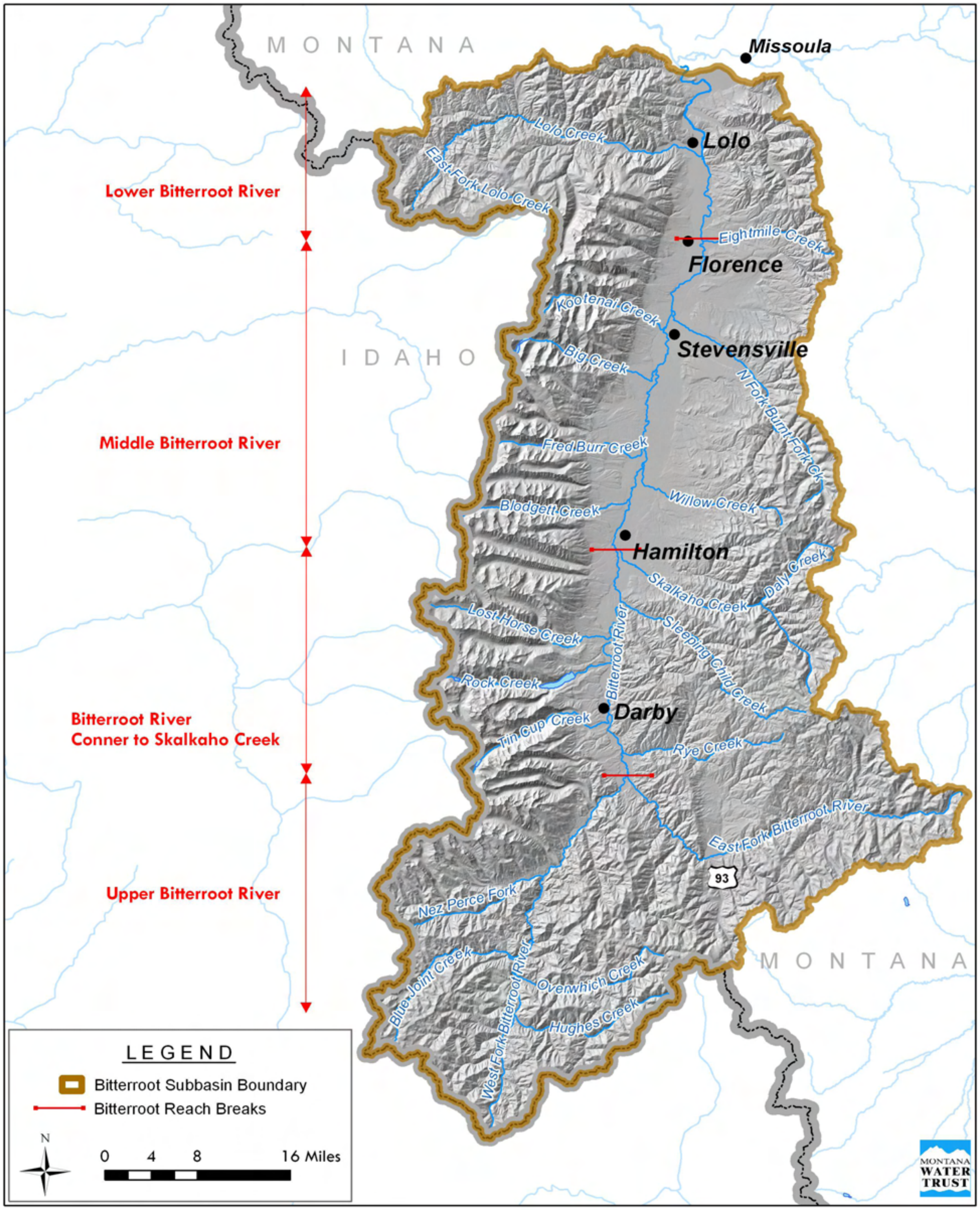


Figure 2.9. Overview of Bitterroot Subbasin showing major reach breaks of the mainstem Bitterroot River based on differences in channel morphology.
Data Sources: Derived from National Elevation Dataset (2002).

Table 2.5. Channel morphology data for two USGS gage locations in the Bitterroot Subbasin.

Characteristic	Darby Gage (12344000)	Florence Gage (12351200)
Location	Conner to Skalkaho reach	Middle River reach
Watershed area (square miles)	1,049	2,354
Mean basin elevation (feet)	6,490	5,920
Stream length upstream (miles)	47.2	90.8
Percent of basin > 6000 feet elevation	61	47
Main channel slope (feet/feet)	0.0067	0.0042
Width of active channel (feet)	148	260
Mean depth for active channel (feet)	2	3
Width of bankfull channel (feet)	184	300
Mean depth of bankfull channel (feet)	4	7 *(may be overestimate)*
Two-year return flood (calculation) (cfs)	5,890	15,200
Maximum measured flood (cfs)	11,500	28,400

From: Parrett (1998).

Table 2.6. Summary of geomorphic characteristics of four reaches of the Bitterroot River channel.

Reach	Dominant Channel Form	Sinuosity	Channel Slope (Percent)	Belt Width	Floodplain Width (feet)	Rosgen Channel Types (in order of prevalence)
Upper (East and West Forks)	Single thread	Low	>0.3	Low	Low	B
Conner to Skalkaho	Single thread	1.15	0.22	770	1,000 to 2,000	B, C, D
Skalkaho to Eightmile (Florence)	Braided	1.1 to 1.2	0.1 to 0.26	1,200 to 2,000	2,000 to 8,000	D, C, Da
Eightmile to Missoula	Single thread	1.2 to 1.5	0.1 or less	1,200 to 8,000	1,000 to 7,000	B, C

From: Boyd and Thatcher (2008).

The East Fork and West Fork of the upper Bitterroot River are mostly moderately entrenched Rosgen B2, B3, and B4 stream-channel types (Table 2.6) flowing through V-shaped Type-II valleys formed by moderately steep, forested colluvial slopes. Tributary streams in this area are steep and drain steep, forested granitic and glacial mountains with moderate sediment supplies. Most of the valleys are very narrow with little floodplain development and high sediment transport capacity. Some small, open valleys with floodplains are present where the East Fork and West Fork transition from steeper B-type channels to more moderately sloped C-channel types (valley and channel descriptions based on Rosgen 1996) (Tables 2.7 and 2.8).

Table 2.7. Rosgen major stream types including defining criteria.

Type	Entrenchment Ratio*	Bankfull Width/ Depth Ratio	Sinuosity	Water Surface Slope	Stream Substrate Types**
A	<1.4	<12	1-1.2	0.04 – 0.099	1,2,3,4,5,6
B	1.4 - 2.2	>12	>1.2	0.02 – 0.039	1,2,3,4,5,6
C	>2.2	>12	>1.2	<0.02	1,2,3,4,5,6
D	N/A	>40	N/A	<0.04	3,4,5,6
E	>2.2	<12	>1.5	<0.02	3,4,5,6
F	<1.4	>12	>1.2	<0.02	1,2,3,4,5,6
G	<1.4	<12	>1.2	0.02-0.039	1,2,3,4,5,6

**Higher entrenchment ratio means greater flood prone width relative to bankfull channel width*
***Substrates are D50 sizes: 1=bedrock, 2=boulder, 3=cobble, 4=gravel, 5=sand, 6=silt*
From: Rosgen (1996).

The middle Bitterroot River reach includes two valley sub-types. From near Conner, downstream past Darby to Skalkaho Creek, the valley is a narrow, Type IX valley type. From Skalkaho Creek to Eightmile Creek, the river valley is a wide, Type VIII valley type. Although the river valley is narrow in the Conner-to-Sleeping Child Creek reach, a number of glacial moraine and glacial outwash-affected streams on the west side (Tin Cup Creek, Rock Creek, and Lost Horse Creek), and large, steep tributaries on the east side (Rye Creek and Sleeping Child Creek), contribute considerable flow and sediment to the river system. Boyd and Thatcher (2008) note that the Darby-to-Hamilton reach of the river, which correlates to the Conner-to-Skalkaho reach, is mostly a single-thread channel with a sinuosity of 1.15, a 770-foot-wide belt-width within which the stream meanders, and a 1,000-to-2,000-foot-wide floodplain. It has characteristics of a B channel to a C3 or C4 channel type and also includes some braided reaches typical of high-sediment-load Rosgen D3 or D4 channel types. Tributaries on the west side of the middle reach are steep. They exit glacially formed canyons and cross short alluvial fans before reaching the river.

In the wider (Type VIII) valley extending from Skalkaho Creek to Eightmile Creek, the river also shows a tendency to form braids, with evidence of historical channel migration and braided paleo-channels abundant on the floodplain east of the river. Although in some places in this 30-mile-long reach the river meets criteria for Rosgen C3 and C4 channel types, it is mostly Rosgen D3 and D4 channel types due to high sediment loads and frequent braided sections (Boyd and Thatcher 2008 and Rosgen pers. comm. 2000). High sediment loads, extensive bank erosion, and significant lateral migration potential of the channel have posed a challenge for bridge and hydraulic-structure design. Boyd and Thatcher (2008), quoting Gaeuman (1997), subdivide it into three sub-reaches, with the steepest channel slope and greatest floodplain width in the Hamilton to Stevensville sub-reach. But for the purposes of this assessment, the Skalkaho to Eightmile reach can be regarded as one geomorphic section, with a channel slope of 0.1 to 0.2 percent, a sinuosity of 1.1 to 1.2, a broad belt width, and a very wide floodplain. The river varies from a single-thread to braided form many times in this reach.

Table 2.8. Rosgen valley morphology types and associated common stream types.

Valley Type	Valley Type Description	Valley Slope	Geomorphic Origins	Valley Materials and Sediment Supply	Common Stream Types
I	V-shaped, high-relief, canyons	>2%	Faults	Bedrock, colluvium, debris, glacial till	A, G
II	V-shaped, moderately steep, gently sloping sides	<4%	Colluvial	Colluvium, residual soils, alluvium	B, sometimes G
III	Alluvial fans or debris cones	>2%	Depositional	Alluvium or colluvium/ High sediment supply	A, B, G, D
IV	Gentle gradient canyons, gorges, confined valleys	<2%	Incised in uplifted valley	Alluvium	F, or C in confined valleys
V	U-shaped glacial trough valley	<4%	Glacial scour	Alluvium or glacial till, glacial fluvial or lacustrine	C, D, G
VI	Moderately steep, fault-line valley	<4%	Faults	Colluvium, some alluvium	B, sometimes C,F,G
VII	Steep, highly-dissected fluvial slopes (in badlands or loess)	>2%	Erosion of fine sediments	Colluvium, alluvium, residual soils, eolian deposits/ HIGH	A, G
VIII	Wide, gentle valley with floodplain and terraces	<2%	Alluvial deposition	Alluvium/ HIGH	C, E, sometimes D, F, G
IX	Wide, glacial outwash valley with moderate to gentle slopes	>2%	Glacial, alluvial or eolian deposition	Till, alluvium, eolian deposits/ High sediment supply	C, D
X	Very broad, gentle relief, plains	<2%	Alluvial or lacustrine	Alluvium or eolian	C, E, with G, F if altered
XI	Deltas	<2%	Depositional	Alluvium	D

From: Rosgen (1996).

The lower Bitterroot River from Eightmile Creek to Missoula is mostly confined in a narrow valley. Foothills reach the river in many places, especially on the eastern side of the valley, and with the exception of Lolo Creek, few major tributaries enter the river. The channel is a more confined Rosgen B3 or B4 type through much of this reach, although some portions have wider floodplains and so are classified as Rosgen C3 or C4 channel types.

In general within the subbasin, tributaries on the east side (e.g. Skalkaho Creek, Willow Creek, and Burnt Fork) exit the mountains with high sediment loads and transition to slightly entrenched C3 or C4 channels as they cross their own ancient alluvial fans. On the west side of the valley there is a much denser drainage network, and streams drain steep, glacially-formed canyons where Rosgen A- and B-type channels are common. The streams cross short alluvial fans before discharging into the Bitterroot River. In some cases, tributaries from both sides of the valley turn parallel to the river in its floodplain, and flow north as meandering Rosgen E-type channels before entering the river (examples include Willow Creek, Fred Burr Creek, and McCalla Creek).

The fluvial geomorphology of subbasin streams is related to a variety of factors, particularly soils and topography, but also forest management and fires. Granitic soils in the Idaho Batholith and parts of the Sapphire Range are susceptible to erosion when disturbed. Natural disturbances such as fire and anthropogenic disturbances such as road-building on steep slopes can trigger major debris flows and floods (Meyer et al. 2001).

In the aftermath of the 2000 fires in the southern part of the subbasin, summer rainstorms caused landslides and debris flows in several areas, including the heavily roaded Laird Creek watershed, and in a roadless area of the upper Sleeping Child watershed. This type of catastrophic-fire-induced, debris-flow event has had a large impact on fluvial morphology and sediment yields of Idaho Batholith watersheds for thousands of years. Forest management decisions in this geomorphic setting, especially those related to fire regimes, can have major impacts on local erosion rates, landforms, and the health of riparian ecosystems.

2.6 Soils

In general soils in the Bitterroot Subbasin are strongly related to geologic substrates and landforms. They are, however, extremely varied due to the diverse influences of climate, vegetation, and hydrology. The NRCS has described typical Bitterroot Subbasin soils by landscape position.Table 2.9 includes descriptions of typical soils from various parts of the subbasin.

Lolo Creek and Bitterroot Mountain soils are diverse, but include mostly inceptisols and entisols (young, poorly formed soils), most of which formed from granitic, gneiss, or schist substrates under forests. Some have volcanic ash surface components. Textures are generally coarse, depths are shallow to deep, and permeability is moderate to rapid, indicating potential for these to be groundwater recharge areas, especially at the mountain fronts.

East Fork-West Fork soils have a geologic derivation similar to that of the Bitterroot Mountain soils. Both are part of the Idaho batholith system, which includes abundant granitic rocks as well as other igneous rocks and metamorphic rocks like quartzite. A few mollisols (more developed soils that formed under grasslands) exist in the small valleys of the East Fork. The most common soil complex in the subbasin above the East Fork-West Fork confluence is the Ovando-Elkner-Rock Outcrop type which makes up 30 percent of the area.

The Sapphire Range has diverse geology, and the soils include those formed from Belt metasedimentary rock (quartzite, argillite, or limestone) as well as some granitics. Well-drained inceptisols are common, and small amounts of volcanic ash exist in some soils. Because of their metasedimentary origins, Sapphire Mountain range soils are expected to produce higher background sediment and nutrient loads than the granitics and glacially-derived soils of the Bitterroot Mountain range.

Table 2.9. Typical Bitterroot Subbasin soils by landscape position.

Soil Series	USDA Taxonomy	Physical Properties	Derivation (& Setting)
East Fork-West Fork Mountain Sites (Eastern Batholith Ecoregion)			
Ovando	Cryorthent (Entisol)	Very deep, excessively drained, rapid permeability, stony sandy loam.	Formed in colluvium from granite (mountain forests).
Winkler	Haplustept (Inceptisol)	Very deep, somewhat excessively drained, moderate-rapid permeability, gravelly loam.	Formed in colluvium from quartzite (mountain forests).
Victor	Haplustoll (Mollisol)	Very deep, somewhat excessively drained, moderate to mod. rapid permeability, gravelly sandy loam.	Formed from alluvium of igneous rock (small valley grasslands).
Bitterroot Mountain/ Foothill Soils (Glaciated Bitterroot Mountains/Canyons Ecoregion)			
Lolopeak	Andic Humicryepts (Inceptisols)	Very deep, excessively drained, bouldery loam. Large volcanic ash component at surface.	Colluvium and glacial till derived from granite & gneiss (steep mountain forests).
Petty	Andic Haplocryepts (Inceptisols)	Very deep, somewhat excessively drained, rapid permeability, gravelly ashy loam. Moderately acid (pH 5.6-6.5).	Formed in volcanic ash over granite and gneiss (mountain forests).
Woodside	Spodic Dystrocryepts (Inceptisol)	Fairly shallow, well-drained, coarse loam over boulders.	Formed in glacial till from granite, gneiss, schist (terminal moraine forests).
Sapphire Mountains/ Foothill Soils			
Beeskove	Typic Eutrudept (Inceptisol)	Very deep, well-drained loam to gravelly loam. A pH of 6.6 to 7.3.	Formed from colluvium of argillite, quartzite, limestone (forested mountains).
Wheelbarrow	Typic Haplustolls (mollisol)	Moderately deep, somewhat excessively drained, mod-rapid permeability, coarse sandy loam.	Formed in alluvium and residuum of weathered granite (foothills grassland).
Lone Rock	Haplustoll (mollisol)	Very deep, well-drained, very rapid permeability, sandy or cobbly loam.	Formed on alluvial fans (terraces with grassland).
Bitterroot Valley Soils			
Anaconda	Aridic Haplustoll (mollisol)	Very deep, well-drained, coarse loam over calcareous lower horizons. A pH of 6-7.3 at surface.	Formed in calcareous alluvium (grasslands on fans and stream terraces).
Dominic	Typic Haplustolls (mollisol)	Very deep, well-drained cobbly sandy loam.	Formed in alluvium (low terraces, alluvial fans with grassland).
Grantsdale	Calcic Haploxeroll (mollisol)	Very deep, well-drained, moderate permeability, coarse silt loam over sandy subsoil. PH 6-7.3.	Formed in alluvium (grassland on terraces and fans).

From: USDA NRCS Official Soil Series Descriptions.

Bitterroot Valley soils and many adjacent foothill soils are largely mollisols, soils that formed organic matter in their surface horizon due to long-term grassland cover. Due to the complex alluvial morphology of the valley, soil textures are diverse, ranging from very coarse to very fine. Some fertile loams and silt loams—also mollisols—occur along the eastern edge of the valley bottom and first terrace where there are more fertile Sapphire-range sediments. Located primarily between Hamilton and Stevensville along the eastern fringe of the river's historical floodplain, these are the best agricultural soils in the subbasin. They are often part of the Hamilton-Corvallis-Grantsdale soil association (Johnson pers. comm. 2008).

2.7 Vegetation and Land Cover

The Montana Gap Analysis Program (GAP) has classified vegetation types existing in the Bitterroot Subbasin (Table 2.10, Figure 2.10).

Table 2.10. GAP vegetation classification within the Bitterroot Subbasin.

GAP Vegetation Type	Middle/Lower Subbasin (square miles)	Upper Subbasin (square miles)	Total (square miles)	Percent
Lodgepole Pine	145.8	199.5	345.3	
Mixed Subalpine Forest	252.7	168.2	420.9	
Douglas-fir	178.5	161.0	339.5	
Douglas-fir/Lodgepole Pine	89	116.0	205.0	
Ponderosa Pine	96.4	32.4	128.8	
Mixed Mesic Forest	174.3	28.6	202.9	
Mixed Xeric Forest	84	21.0	105.0	
Mixed Whitebark Pine Forest	19.6	20.9	40.5	
Grand fir	3.1	0	3.1	
Western Larch	1.8	0	1.8	
Western Red Cedar	0.02	0	0.0	
Conifer Forests Subtotal			**1792.8**	**63.3**
Mixed Broadleaf and Conifer Forest	9.1	3.5	12.6	
Mixed Broadleaf Forest	6.1	11.7	17.8	
Standing Burnt Forest	1	1.5	2.5	
Other Forests Subtotal			**3618.5**	**1.1**
Mixed Mesic Shrubs	111.8	0	111.8	
Mixed Xeric Shrubs	0.3	7.6	7.9	
Sagebrush	37.2	31.5	68.7	
Moderate/High Cover Grasslands	3.4	4.4	7.8	

GAP Vegetation Type	Middle/Lower Subbasin (square miles)	Upper Subbasin (square miles)	Total (square miles)	Percent
Low/Moderate Cover Grasslands	190.3	55.6	245.9	
Very Low Cover Grasslands	0.5	1.6	2.1	
Altered Herbaceous	98.0	8.6	106.6	
Shrub/Grassland Subtotal			**7787.8**	**19.4**
Shrub Riparian	9.4	3.3	12.7	
Conifer Riparian	7.8	2.9	10.7	
Mixed Broadleaf and Conifer Riparian	1.2	1.8	3.0	
Broadleaf Riparian	4.2	0.2	4.4	
Graminoid and Forb Riparian	4.3	1.8	6.1	
Mixed Riparian	0.4	1.7	2.1	
Water (Lakes, rivers, ponds)	7.0	1.7	8.7	
Wetland/Riparian Subtotal			**15623.3**	**1.7**
Rock	169.6	30.2	199.8	
Mixed Barren Sites	34.2	6.0	40.2	
Alpine Meadows	0	1.2	1.2	
Snowfields or Ice	0	0.3	0.3	
Montane Parklands and Subalpine Meadows	36.8	20.0	56.8	
Alpine/Subalpine/Barren Subtotal			**31544.9**	**10.5**
Agricultural Lands – Dryland farmed	34	0.2	34.2	
Agricultural Lands-Irrigated	67	0	67	
Urban and developed	9.2	0	9.2	
Agricultural and Urban Subtotal			**63200.2**	**3.9**
Total	**110.2**	**0.2**	**2,833**	**100**

Data Sources: USGS GAP Analysis Program (2005).

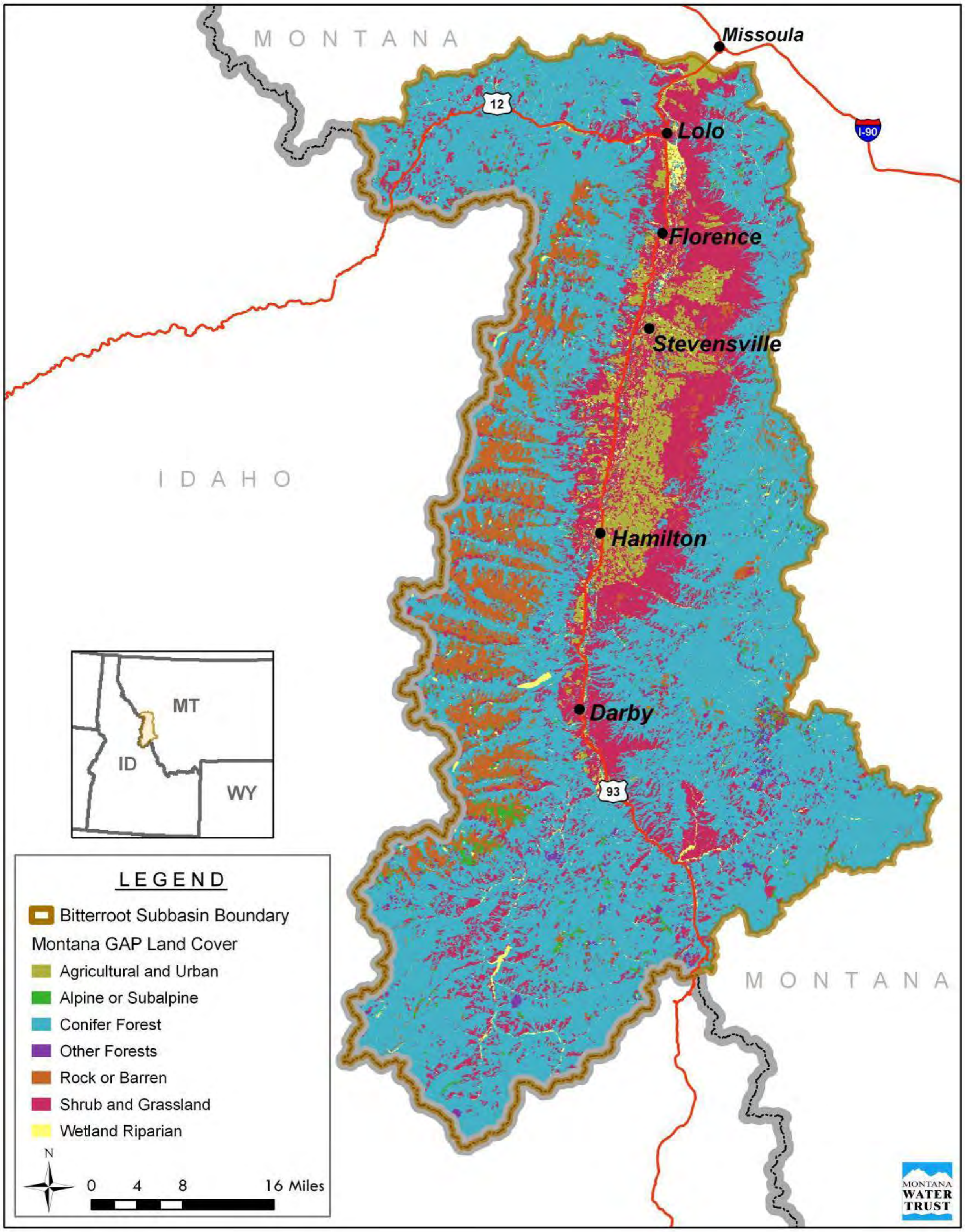


Figure 2.10. Montana GAP land cover types including all vegetation types consolidated into seven categories for the Bitterroot Subbasin.
Data Sources: USGS GAP Analysis Program (2005).

Because of the variety of moisture regimes, soils, and climates at different elevations, the natural vegetation of the Bitterroot Subbasin is diverse (Figure 2.10). Forest management, fire regimes, agriculture and other forms of economic development have also played a major role in the composition and distribution of vegetation. Major vegetation types are summarized below and described in greater detail in Chapter 3.

Conifer forests are the dominant natural vegetation type, occupying over 60 percent of the total subbasin area. Although lodgepole pine (*Pinus contorta*), a fire-adapted species, is not a climax species, it is one of the most abundant forest types. Lodgepole pine is found at middle to higher elevations along with Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and several other less common conifer species such as alpine larch (*Larix lyallii*). Whitebark pine (*Pinus albicaulis*) is the highest-elevation conifer species. Ponderosa pine (*Pinus ponderosa*) and Douglas-fir are the most common found at lower elevations, and western larch (*Larix occidentalis*) is a minor component within this same elevation zone. Both ponderosa pine and western larch are fire-resistant when mature. Ponderosa pine is often found in areas interspersed with dry grasslands, such as foothills, while western larch is found in more humid settings, such as north and east facing slopes. Western larch generally occurs in the northern part of the subbasin; only scattered individuals are found south of Hamilton.

Other types of forest are found in riparian areas and floodplains (and otherwise in very limited areas) and include broadleaf forests such as black cottonwood (*Populus balsamifera* subsp. *trichocarpa*) or quaking aspen (*Populus tremuloides*).

Shrublands include sagebrush lands located primarily on east side benches and several distinctive shrub types found in the southeastern part of the subbasin in warm, dry locations. Mesic shrublands may include areas regenerating from clear-cut logging or fires.

Native grasslands were once abundant in the central Bitterroot Valley, but have been heavily altered by grazing, agriculture, and invasive weeds. Most of these vegetation types are now used for livestock grazing.

Riparian lands, including riparian shrublands and forests, and wetlands, lakes, ponds, and rivers are critical cover types for many fish and wildlife species. These lands cover less than two percent of the entire subbasin.

Alpine, subalpine, rock, and barren lands are relatively abundant in the Bitterroot Subbasin due to the steep, high-elevation terrain of the Bitterroot Mountains and to a lesser degree of the Sapphire Mountain range. They include scree, talus, rock outcrops, and barren mountaintops as well as some subalpine or alpine meadows and parklands. These harsh-climate areas are important to many specialized plants and animal species.

Agriculture, meaning intensively farmed land, currently occupies a little over three percent of the subbasin. However, much larger areas are actively used as pasture for livestock production. Many of these pastures are in the shrub/grassland cover category. Formerly many more drylands were cultivated, but areas with more marginal soils have reverted to altered herbaceous and other grassland cover types. Timber production, sometimes considered to be a component of agriculture, is discussed in Section 2.10.6.

2.8 Hydrology

The Bitterroot River is the most important surface-water feature in the subbasin (Figure 2.11). The river's hydrology is dominated by snowpack accumulation in winter and spring snowmelt runoff. Approximately 55 percent of the annual flow is discharged during peak snowmelt runoff in May and June (McMurtrey et al. 1972). Flows are much lower and more stable through the late summer, fall, and winter. The size of the accumulated snowpack at high elevations (5,000 to 10,000 feet) in late winter is the major determinant of water yield and the magnitude of river flows for the remainder of the year.

Tributary streams reflect the same seasonal runoff pattern as the river, with high flows in spring and early summer and often very low flows in late summer and early fall. Tributary streams freeze nearly every year above 4,000 to 5,000 feet, while the Bitterroot River mainstem rarely freezes.

Irrigation withdrawals are substantial in the subbasin and have important influences on hydrology. Irrigation withdrawals significantly reduce the flow in the river and many tributary streams, but much of this water eventually returns to the river, often through groundwater. Groundwater inflow is an important component of Bitterroot River flows during the fall-to-winter low-flow seasons.

Irrigation water that soaks into the ground, becoming shallow groundwater that eventually flows into the river is extremely important to the Bitterroot River system under current land and water-use patterns. Hydraulic gradients of groundwater indicate that nearly all major aquifers in the subbasin discharge into the Bitterroot River, directly or indirectly. Recent research has shown that groundwater levels increase rapidly on both the east and west sides of the valley when irrigation season begins, then gradually decline after the season ends. In many Montana valleys, this gradual decline in groundwater level after irrigation season is associated with increased discharge of shallow groundwater to springs or streams. Briars and Dutton (2000) concluded that abandonment of irrigation could cause permanent declines in local groundwater elevations in the Bitterroot Subbasin.

The basin fill aquifers in the Bitterroot Valley are an important source of irrigation water and the most important source of drinking water in the subbasin. Recharge to these aquifers originates from precipitation, and the "two-fold difference in the quantity of precipitation falling on the western side of the valley….(versus the eastern side) is probably the most significant factor affecting the quantity and quality of groundwater …" (Briars and Dutton 2000). This precipitation infiltrates into bedrock and mountain streambeds. The streams in turn infiltrate into basin-fill aquifers as they leave the mountains. Infiltration from irrigation ditches is another important source of recharge. The largest component of discharge from the basin-fill aquifers takes place as seepage to streams and springs, much of it occurring in the floodplain of the Bitterroot River.

A water budget completed using data from the late 1950s showed that 1,772,000 acre-feet of water flowed into the Bitterroot River in Ravalli County, while 1,540,000 flowed out of the system downstream, reflecting a 232,000 acre-feet net loss (13 percent of total inflow) to irrigation, natural evapotranspiration, deep storage, and other consumptive uses (McMurtrey et al. 1972).

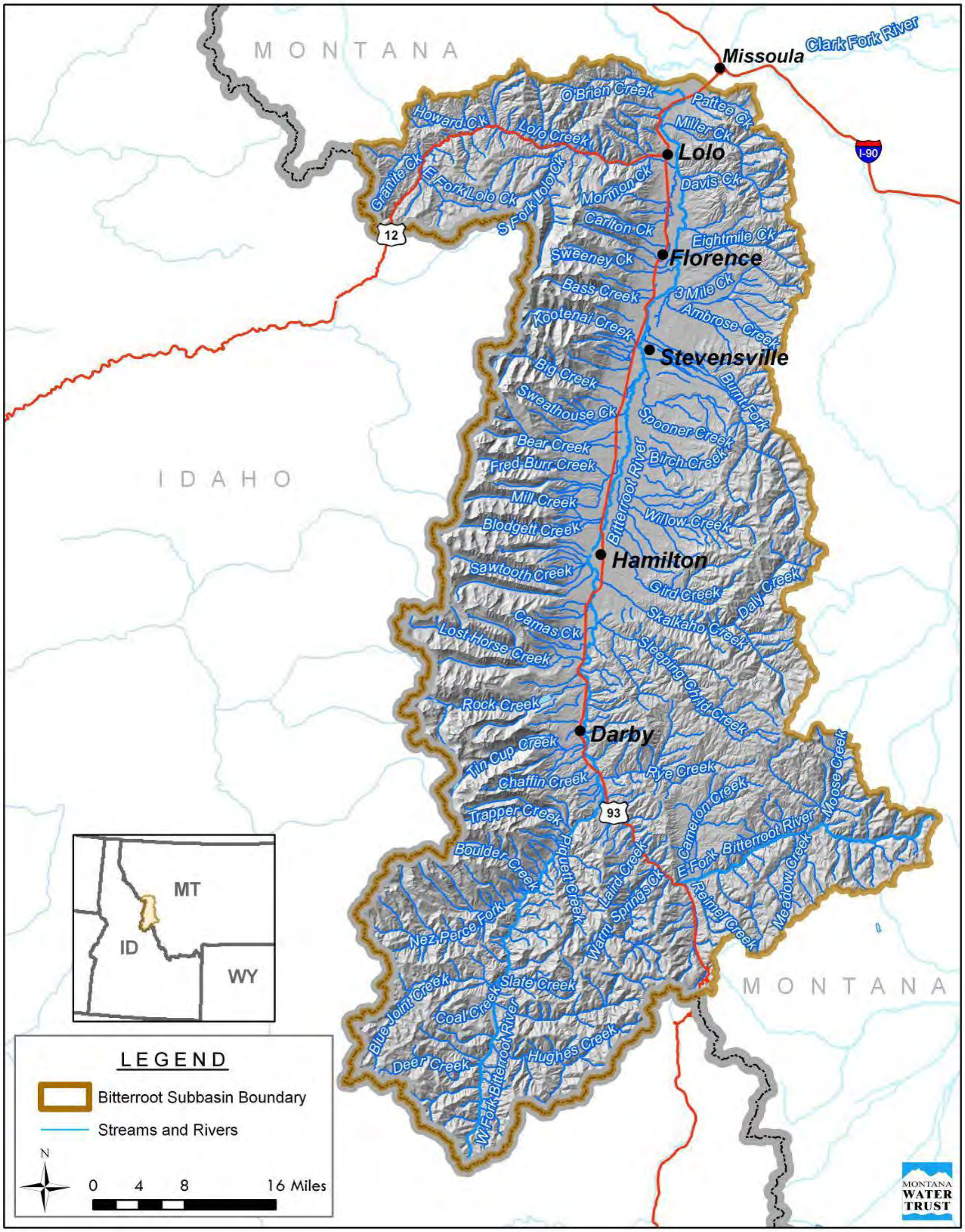


Figure 2.11. Hydrography data of the Bitterroot Subbasin.
Data Sources: USGS (2000) National Hydrography Dataset.

2.8.1 Hydrologic Unit Codes

Hydrologic Unit Codes (HUCs) are a numeric system used by various agencies (NRCS, USGS, EPA, USFS, and State agencies) to identify watershed units. Sixth-code HUCs have 12 digits (six two-digit codes representing increasingly smaller nested watershed units) and represent a subwatershed at the scale of the one drained by, for example, Kootenai Creek (Figure 2.12). From the point of view of aquatic species management, these modified units correspond most closely to the management areas used by fisheries biologists.

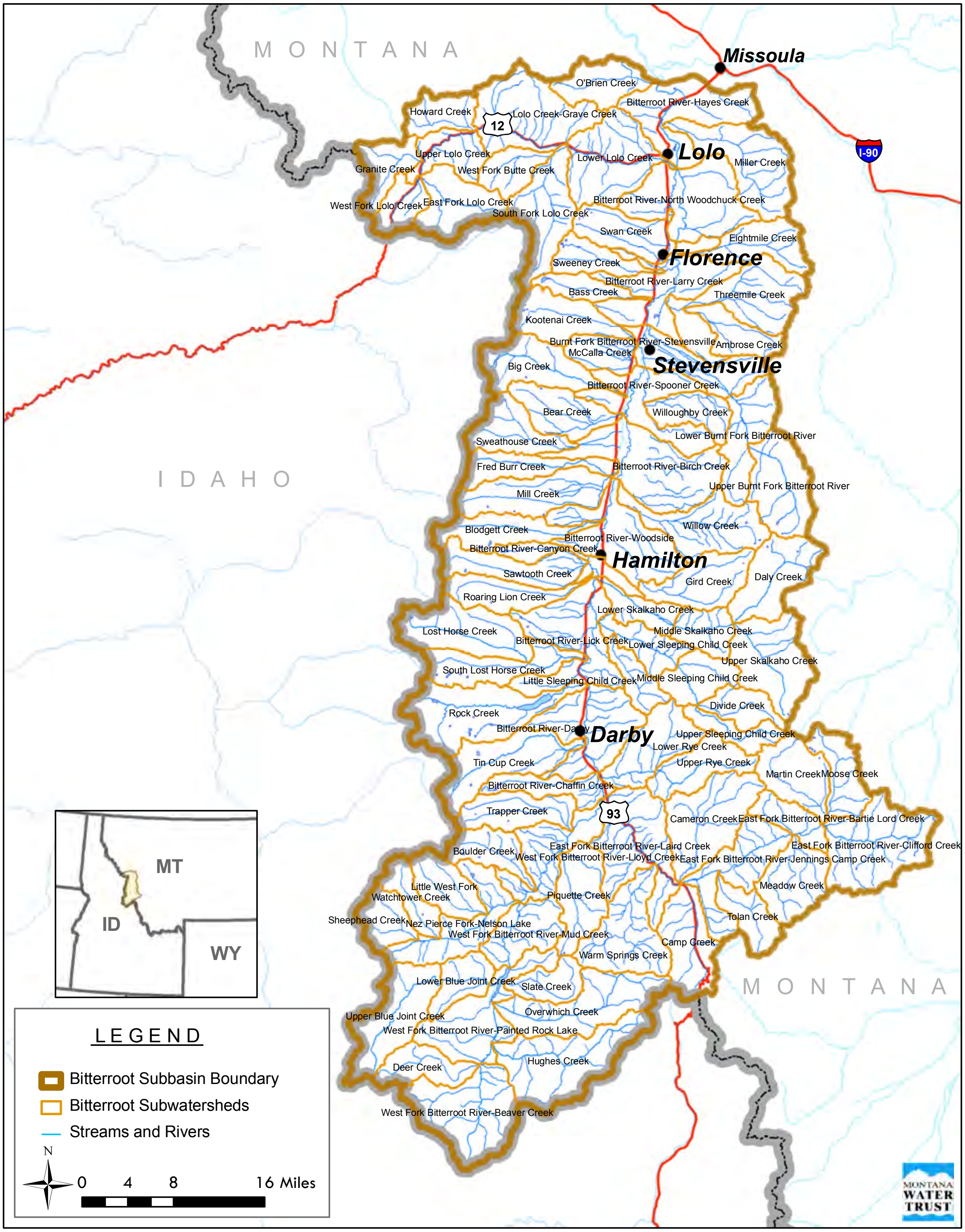


Figure 2.12. Sixth code hydrologic unit subwatersheds of the Bitterroot Subbasin.
Data Sources: Montana Natural Resources Conservation Service (2006).

2.8.2 Stream Flows and Gaging

Gaging stations with long-term records continue to be operated at several sites on the mainstem of the Bitterroot River by the USGS (Figure 2.13). Five gages are still actively used in the subbasin, four on the mainstem Bitterroot River (Figure 2.13).The Darby gage (1234000) is just downstream of the confluence of the East Fork and West Fork.The Florence bridge gage (12351200) measures flow near the transition between the middle river and the lower river, and the Buckhouse Bridge gage (12352500) measures essentially the entire flow of the subbasin. Some tributaries were gauged in the past (Figure 2.13). The hydrologic characteristics of selected stations are described for the mainstem in Table 2.12 and for tributary streams in Table 2.11.

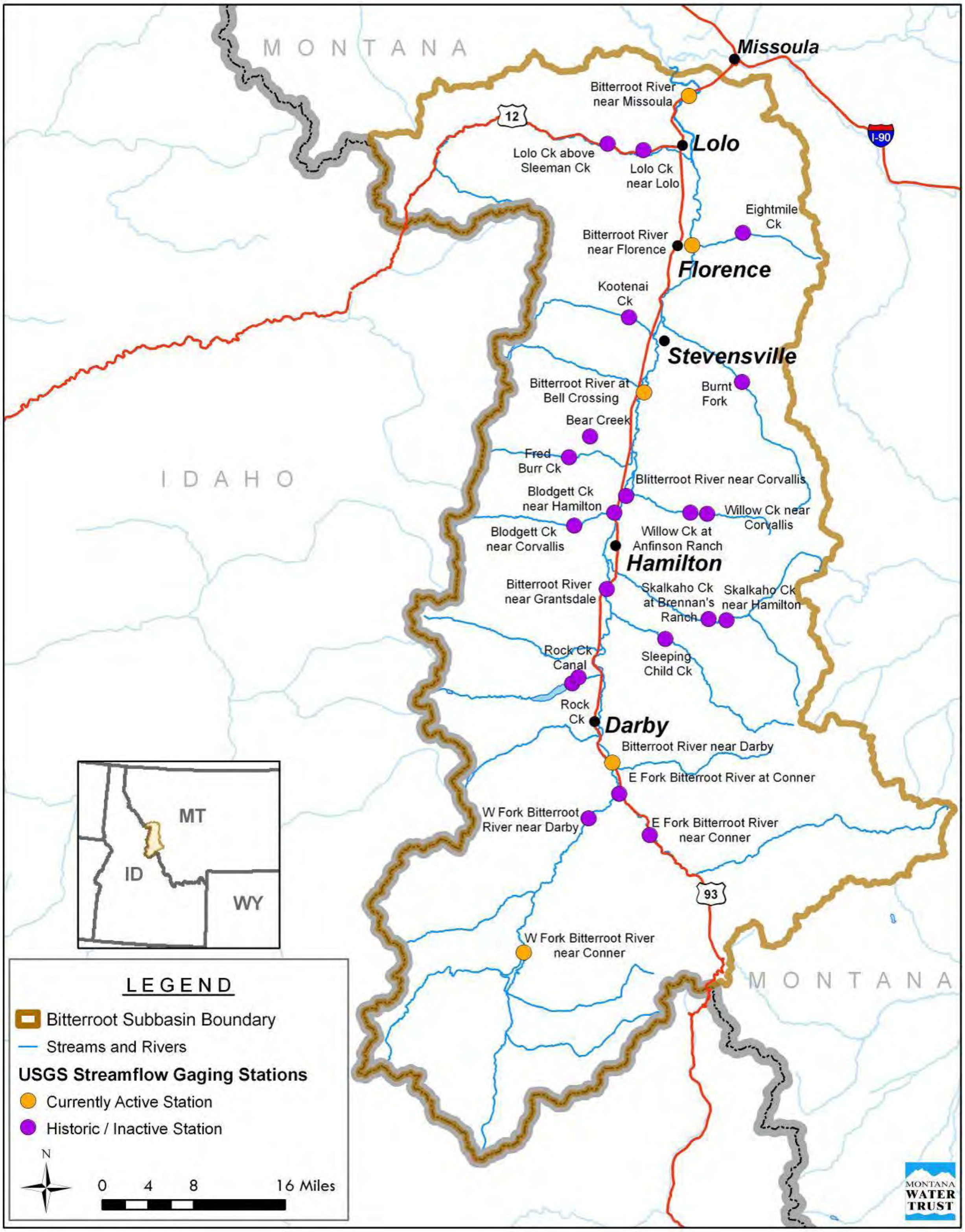


Figure 2.13. U.S. Geological Survey (USGS) gaging stations on the Bitterroot River and tributaries.

Table 2.11. Hydrology of selected tributary gaging stations in the Bitterroot Subbasin (USGS).

Stream and USGS Station	Years Operated	Drainage area (square mile)	Mean annual flow (cfs[1])	Mean Annual Water yield (cfs[1]/square mile)	Maximum recorded flow (cfs[1])	Minimum recorded flow (cfs[1])
East Fork Bitterroot near Conner (12343400)	1956-1972	381	293	0.77	4,000	23
Skalkaho Cr. near Hamilton (12345850)	1949-1953 1957-1979	87.8	93.5	1.06	1210	10
Blodgett Cr. near Corvallis (12347500)	1947-1969	25.9	70.5	2.72	836	1.2
Burnt Fork near Stevensville (12351000)	1920 1922-1924 1938-1962	74.0	48.3	0.65	641	2.0
Lolo Creek above Sleeman Cr. (12352000)	1951-1960	250	215	0.86	2430	6.3

[1] *cfs = cubic feet per second*

From: Kendy and Trensch (1996). Data Sources: Montana State Library, MT USGS stream flow stations.

Table 2.12. Hydrologic characteristics of Bitterroot River at three gaging stations.

Stream and USGS Station	Years operated	Drainage area (square miles)	Mean annual flow (cfs[1])	Mean Annual Water yield (cfs1/square mile)	Maximum recorded flow (cfs[1])	Minimum recorded flow (cfs[1])
Bitterroot River near Darby (12344000)	1937-1995	1,049	869	0.83	11,500	71
Bitterroot River at Florence (12351200)	1957-1967 2003-2007	2,354	1,898	0.81	28,400	365
Bitterroot River at Missoula (12352500)	1898-1905 1989-2007	2,814	2,267	0.81	38,000	300

[1] *cfs = cubic feet per second*

From: USGS (1996) and Kendy and Trensch (1996).

Water yield calculations from gaging station flow data indicate that the Bitterroot River continues to gain water from tributaries and groundwater inflow at a steady rate throughout its downstream course (0.81 to 0.83 cubic feet per second per square mile). Although the East Fork and West Fork are critical components of the hydrologic system, other areas, especially the west-side canyon streams and Lolo Creek, contribute proportionally nearly the same amount, or more, water to the river system.

The largest floods on record for the Bitterroot River occurred in 1899 at Missoula (38,000 cubic feet per second) and in 1974 at Florence (28,400 cubic feet per second). Both occurred in late June (Table 2.13), and both were in excess of the calculated 100-year flood events for those locations.

Table 2.13. Flood frequency for the Bitterroot River at three gaging stations (calculations by USGS).

USGS Station	Years of Record	Drainage Area (square miles)	Calculated 2-year Flood (cfs[1])	Calculated 10-year Flood (cfs[1])	Calculated 100-year Flood (cfs[1])
Bitterroot River at Darby (12344000)	1937-1998	1,049	5,890	9,790	13,900
Bitterroot River at Florence (12351200)	1958-1965 1972 1974 1982	2,354	15,200	20,800	27,700
Bitterroot River at Missoula (12352500)	1899-1904 1990-1998	2,814	14,500	23,400	32,500

[1] *cfs = cubic feet per second*
From: USGS Montana Flood Frequency and Basin Characteristic Data.

Although Painted Rocks Reservoir is on the upper West Fork of the Bitterroot and a number of small reservoirs exist near the headwaters of tributary streams on the west side of the valley, the subbasin's overall flood hydrology is not markedly affected by these small storage facilities. During flood events larger than the approximate two-year flow, the river's banks are over-topped, floodplain forests are inundated, large quantities of debris (large trees) are transported downstream, and the riverbed's form is reworked. Large areas, mostly lightly populated, are vulnerable to flooding in larger events. Figure 2.14 shows the 100-year-flood-elevation boundary along the mainstem of the Bitterroot River. Frequent flooding and a functioning floodplain are important aspects of the ecological integrity of the Bitterroot River aquatic and riparian ecosystems.

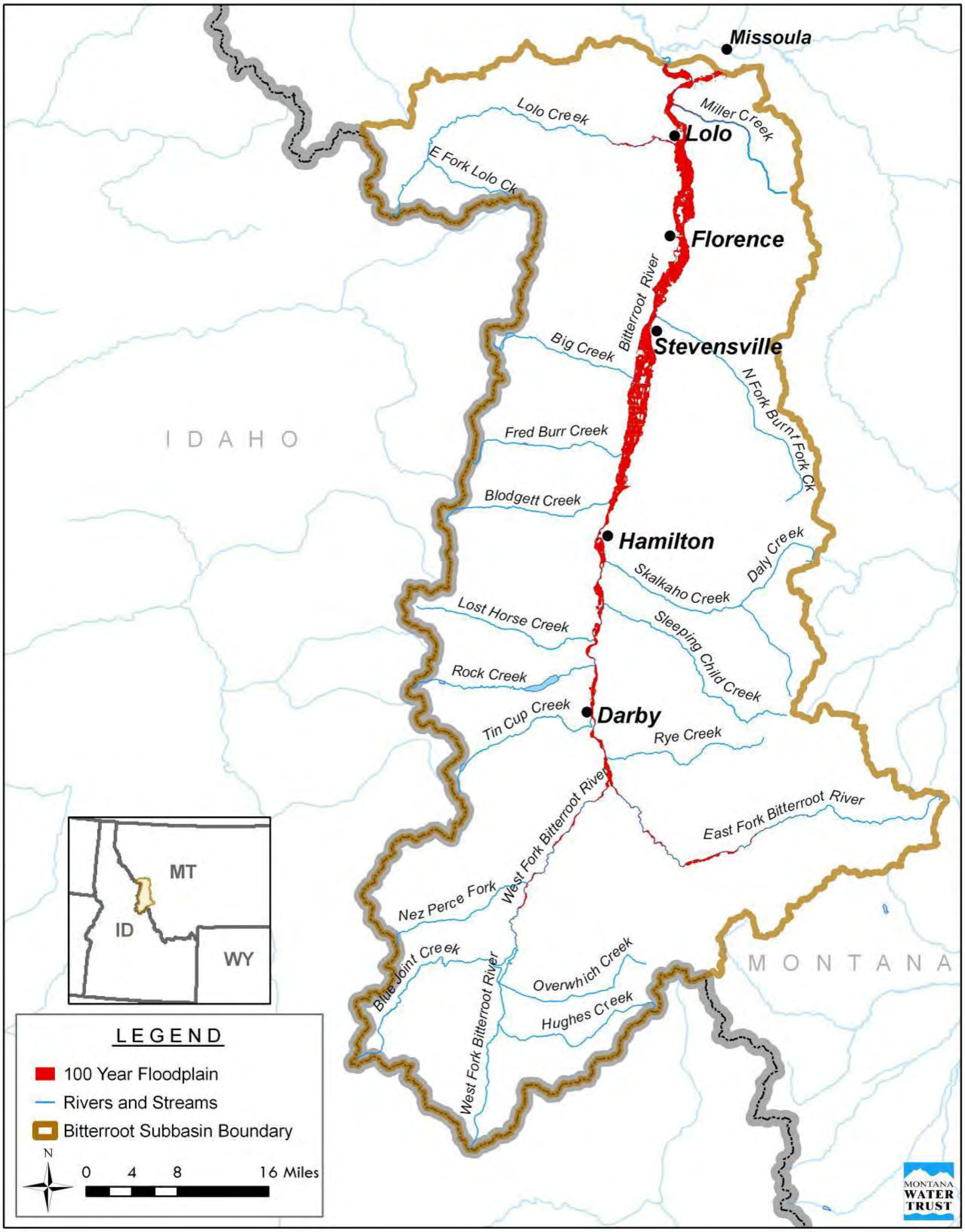


Figure 2.14. Federal Emergency Management Agency (FEMA) 100-year floodplain map of the Bitterroot Subbasin.
Data Sources: Federal Emergency Management Agency (1988 and 1996).

Tributary streams on the east side of the subbasin (i.e. East Fork Bitterroot River, Skalkaho Creek, or Burnt Fork) have significantly lower water yields per square mile than Blodgett Creek on the west side of the subbasin (Table 2.11). This is related to the significantly higher elevations and higher precipitation amounts (primarily winter snowfall) in the Bitterroot Mountains relative to that of the Sapphire Mountains. Lolo Creek does not manifest this same tendency only because much of the Lolo Creek watershed is significantly lower in elevation compared with other west-side streams. So in general, west-side streams have higher water yields than east-side streams, and because there are so many more significant tributaries on the west side, that area is relatively more important in supplying water to the Bitterroot River.

2.9 Water Quality

The Bitterroot Subbasin has a number of water quality issues, mostly related to non-point sources of pollutants, alteration of channels, and water withdrawals. Sediment, nutrients, and temperature are three of the most commonly cited water quality issues for the mainstem of the Bitterroot River and some tributary streams. In many cases, these water quality problems can be related to land-use issues in tributary watersheds or along the river itself.

The Montana Department of Environmental Quality (MT DEQ) has collected data and completed extensive reviews of water quality status for the Bitterroot Subbasin through its Total Maximum Daily Load (TMDL) development process. This process was completed in 2003 for Upper Lolo Creek, in 2006 for the area upstream of the confluence of the East Fork and West Fork (Bitterroot Headwaters), and is currently in progress for the middle and lower subbasin (MT DEQ 2005; MT DEQ 2008a). The TMDLs developed for the Bitterroot Subbasin are based on the current DEQ regulations, the Clean Water Act, and Section 303d list (2006) of impaired water bodies (Table 2.14, Figure 2.15).

Table 2.14. Impaired stream segments in the middle and lower Bitterroot Subbasin based on the Montana Department of Environmental Quality 2006 303d list of impaired water bodies.

Water Body	Miles Affected	Causes of Impairment	Probable Sources of Impairment
Ambrose Creek	11.4	Nitrogen (Total) Phosphorus (Total) Physical substrate habitat alterations	Agriculture Grazing in riparian or shoreline zones
Bass Creek	5.3	Low flow alterations Total Kjehldahl Nitrogen (TKN)	Dam or impoundment Flow alterations from water diversions Irrigated crop production Natural sources Source unknown
Bear Creek	8.7	Low flow alterations	Agriculture
Bitterroot River East-West Fork confluence to Skalkaho	24.3	Alteration in stream-side or littoral vegetative covers Copper	Grazing in riparian or shoreline zones Rangeland grazing Streambank modifications/ destabilization Source unknown
Bitterroot River Skalkaho to Eightmile	36.5	Low flow alterations Nitrate/Nitrite (as N) Phosphorus (Total) Sedimentation/siltation	Agriculture Irrigated crop production Habitat modification - other than hydromodification Wet weather discharges (point source and combination of stormwater, SSO or CSO)
Bitterroot River Eightmile to mouth	23.4	Alteration in stream-side or littoral vegetative covers Copper Lead Nitrogen, Nitrate Sedimentation/siltation	Rangeland grazing Sediment resuspension (contaminated sediment) On-site treatment systems (septic systems and similar decencentralized systems) Wet weather discharges (point source and combination of stormwater, SSO or CSO) Streambank modifications/ destabilization
Blodgett Creek	12.6	Low flow alterations	Agriculture
Kootenai Creek	5.8	Alteration in stream-side or littoral vegetative covers Low flow alterations	Grazing in riparian or shoreline zones Livestock (grazing or feeding operations) Silviculture Natural sources Source unknown

Water Body	Miles Affected	Causes of Impairment	Probable Sources of Impairment
Lick Creek	6.2	Alteration in stream-side or littoral vegetative covers Chlorophyll-a Phosphorus (Total) Sedimentation/Siltation Total Kjehldahl Nitrogen (TKN)	Agriculture Habitat modification - other than hydromodification Site clearance (land development or redevelopment)
Lolo Creek (Mormon Creek to the mouth)	2.8	Low flow alterations Physical substrate habitat alterations Sedimentation/siltation	Agriculture Silviculture activities Streambank modifications/ destabilization
Lolo Creek (Sheldon Creek to Mormon Creek)	14.3	Physical substrate habitat alterations Sedimentation/siltation	Habitat modification - other than Hydromodification Highways, roads, bridges infrastructure (new construction) Silviculture activities
Lolo Creek (Headwaters to Sheldon Creek)	13.0	Physical substrate habitat alterations Sedimentation/siltation	Hydromodification Highways, roads, bridges Silviculture
Lolo Creek, South Fork	6.2	Low flow alterations Physical substrate habitat alterations	Impacts from hydrostructure flow regulation/modification Forest roads Silviculture
Lolo Creek, West Fork	6.8	Alteration in stream-side or littoral vegetation cover Sedimentation/siltation	Forest roads Streambank modifications/ destabilization Highway & bridge runoff
Lost Horse Creek	20.1	Low flow alterations	Agriculture
McClain Creek	5.3	Sedimentation/Siltation	Forest roads (road construction and use)
Mill Creek	8.0	Alteration in stream-side or littoral vegetative covers Low flow alterations Temperature (water)	Grazing in riparian or shoreline zones Highways, roads, bridges infrastructure (new construction) Loss of riparian habitat, site clearance (land development or redevelopment) Impacts from hydrostructure flow regulation/modification
Miller Creek	16.8	Alteration in stream-side or littoral vegetative covers Chlorophyll-a Nitrate/nitrite (Nitrite + Nitrate as N) Phosphorus (total), Sedimentation/siltation Temperature (water)	Crop production (crop land or dry land) Grazing in riparian or shoreline zones Loss of riparian habitat Silviculture activities Silviculture harvesting Source unknown

Water Body	Miles Affected	Causes of Impairment	Probable Sources of Impairment
Muddy Spring Creek	2.0	Nitrate/nitrite (Nitrite + Nitrate as N) Sedimentation/siltation	Rangeland grazing Source unknown
North Burnt Fork Creek	10.4	Bottom Deposits Phosphorus (Total) Total Kjehldahl Nitrogen (TKN)	Grazing in riparian or shoreline zones Irrigated crop production
North Fork Rye Creek	7.0	Alteration in stream-side or littoral vegetative covers Nitrogen (total) Phosphorus (total)	Forest roads (road construction and use) Grazing in riparian or shoreline zones Streambank modifications/ destabilization
Rye Creek	5.6	Alteration in stream-side or littoral vegetative covers Nitrogen (total) Phosphorus (total) Sedimentation/siltation	Animal feeding operations (NPS) Grazing in riparian or shoreline zones Forest roads (road construction and use) Silviculture activities
Skalkaho Creek	25.1	Low flow alterations Mercury	Agriculture Irrigated crop production Source unknown
Sleeping Child Creek	23.9	Nitrogen (total) Phosphorus (total) Sedimentation/siltation Temperature (water)	Agriculture Highways, roads, bridges, infrastructure (new construction) Silviculture activities
Sweathouse Creek	11.3	Alteration in stream-side or littoral vegetative covers Low flow alterations Phosphorus (total)	Loss of riparian habitat Site clearance (land development or redevelopment)
Threemile Creek	17.3	Low flow alterations Nitrate/nitrite Phosphorus (total) Sedimentation/siltation	Agriculture Irrigated crop production Rangeland grazing
Tin Cup Creek	7.0	Alteration in stream-side or littoral vegetative covers Total Kjehldahl Nitrogen (TKN)	Irrigated crop production Loss of riparian habitat Natural sources Silviculture activities
Willow Creek	16.3	Alteration in stream-side or littoral vegetative covers Chlorophyll-A Sedimentation/siltation, Temperature Total Kjehldahl Nitrogen (TKN)	Irrigated crop production Loss of riparian habitat Silviculture activities Source unknown Natural sources Flow alterations from water diversions
Buck Creek	2.0	Formerly sedimentation/ siltation—now fully supporting	None

Water Body	Miles Affected	Causes of Impairment	Probable Sources of Impairment
Ditch Creek	2.7	Sedimentation/siltation	Forest roads (construction and use) Silviculture activities
Hughes Creek	17.6	Alteration in streamside or littoral habitats Physical substrate habitat alteration Sedimentation/siltation Temperature	Channelization Impacts from abandoned mine lands (inactive) Placer mining
Overwhich Creek		Sedimentation/siltation Temperature	Highway/road/bridge runoff (non-construction related) Natural sources Site clearance (land development or redevelopment)
Nez Perce Fork	14.7	Temperature Modifications	Forest roads (construction and use), loss of riparian habitat
West Fork Bitterroot River	39.4	Other habitat alterations Siltation Temperature	Highway/road/bridge runoff (non-construction related) Highways, roads, bridges infrastructure (new construction) Streambank modifications/ destabilization
Reimel Creek	7.4	Other habitat alterations Siltation Suspended Solids	Agriculture Natural sources
Gilbert/Laird Creeks	8.0	Other habitat alterations Siltation Suspended solids	Forest roads (road construction and use) Silviculture activities
East Fork Bitterroot River	29.9	Other habitat alterations Siltation Temperature Copper/lead	Channelization Grazing in riparian or shoreline zones Highways, roads, bridges infrastructure (new construction) Streambank modifications/ destabilization Watershed runoff after forest fire Source unknown (metals)

From: MT DEQ (2008a).

Figure 2.15. 2006 303d-listed stream segments in the Bitterroot Subbasin.
Data Sources: Montana Department of Environmental Quality (2006).

Sediment and nitrogen are the leading causes of water quality impairment in the Bitterroot Subbasin, followed by flow alterations, phosphorous, and temperature (Table 2.15).

Table 2.15. Leading causes of water quality impairment in the Bitterroot Subbasin.

Cause of Impairment	Stream Miles Affected
Sedimentation/siltation	320.4
Nitrogen	183.5
Temperature	166.6
Low-flow	159.7
Phosphorus	140.8
Other (various)	318.4

From: Montana Water Trust (2008).

Unless a detailed source assessment study has been performed, the sources of water quality impairment are not often clear. Even with a detailed assessment there is a level of uncertainty. The MT DEQ's 2006 303d list is the best available information on this topic. Their data indicate that the leading sources of water quality impairment in the Bitterroot Subbasin are: agriculture, crops, grazing/feeding operations, silviculture, dewatering for irrigation, and streambank modification (often as part of a construction activity). Roads are also an important source, particularly unpaved roads along stream channels. Even paved roads that are graveled in winter (such as Highway 12 along Lolo Creek) can impair water quality.

Currently the MT DEQ is performing a TMDL study of the middle and lower Bitterroot Subbasin, which should clarify the sources of many identified water quality impairments. An Upper Lolo Creek TMDL study was completed in 2003. The Bitterroot Headwaters Planning Area TMDLs and Water Quality Improvement Plan (Bitterroot Headwaters TMDL) was finished in 2005 for the area above the confluence of the East Fork and West Fork. The fieldwork and analysis completed during that study clarified the 303d list status of the 14 streams initially thought to be impaired in that area.

The result of the Bitterroot Headwaters TMDL was that four of the 14 streams originally thought to be impaired were removed from the 303d list. The streams removed included Deer Creek, Moose Creek, Martin Creek, and Meadow Creek, all of which flow through heavily forested areas with relatively few roads. Buck Creek was removed from the list after the TMDL was completed. Other streams—the East Fork of the Bitterroot for example—were discovered to have additional impairments (such as water temperature) during the TMDL development process. This same process is expected to change the status of some middle and lower Bitterroot River tributaries as more data are accumulated and analyzed.

Data collected during the TMDL development process for both the headwaters and middle and lower Bitterroot River maintained mean total nitrogen and total phosphorous levels below the nutrient standards that exist for the Clark Fork River (0.3 milligrams per liter total nitrogen and 0.04 milligrams per liter total phosphorous). It is probable that Montana will eventually adopt standards similar to those for the Clark Fork throughout the western part of the State. Total nitrogen and total phosphorous do increase in a downstream direction as non-point and some small point source loads accumulate in the river (Table 2.16).

Table 2.16. Summary of Montana Department of Environmental Quality water quality data for Bitterroot River sampling sites (n=62 samples) collected in January or December between 2001 and 2006.

Site	Mean Concentration of Total N (mg/L[1])	Mean Concentration of Total P (mg/L[1])	Mean Concentration of Total Suspended Solids (TSS) (mg/L[1])	Mean Flow (cfs[2])
Darby (near USGS gage)	0.167	0.017	5.9	802
Main Street Bridge in Hamilton	0.171	0.018	7.2	---
Below Hamilton (Silver Bridge)	0.189	0.023	6.6	---
Poker Joe Rail Road Bridge	0.220	0.021	6.9	---
Florence Bridge	0.223	0.025	7.5	---
Buckhouse Bridge (Missoula)	0.218	0.021	8.1	2,225

[1] *mg/L = milligrams per liter*
[2] *cfs = cubic feet per second*
From: MT DEQ (2008b).

2.9.1 Nutrients and Algae

Analysis of seasonal nitrate concentrations in the Bitterroot River suggests that a major source of nitrate to the lower river is groundwater inflow and that this source is particularly important from late fall to late winter. This pattern is not seen in the upper river due to the different hydrogeology and because the influence from irrigation recharge is less (McDowell 2006).

Algae samples collected from the Bitterroot River between 2004 and 2007 show that chlorophyll-a (Chl a), an algae indicator, is usually quite low in the river. However, in 2004 some measurements below Hamilton and below Stevensville exceeded Montana water quality standards for noxious algae (100 milligrams Chl a per square meter) established on the Clark Fork River (McDowell 2006). Montana does not yet have statewide algae standards; however, the Bitterroot Headwaters TMDL set a benthic chlorophyll-a target of 33 milligrams per square meter for the East Fork and West Fork area (MT DEQ 2005).

Total suspended sediment concentrations tend to be very low in the Bitterroot River. Suspended sediment levels over the five-year monthly sampling period between 2001 and 2006 reached a maximum during high flow events of 27.5 milligrams per liter at Darby and 62.5 milligrams per liter at Florence (both during late May 2003).

Table 2.17 summarizes water quality data for selected tributary streams in the Bitterroot Subbasin. The nutrient and suspended sediment data for sampled tributary streams indicate that measured values are only occasionally greater than proposed water quality standards. Montana is developing nutrient criteria for streams, and it is likely that 0.3 milligrams per liter total N and 0.04 milligrams per liter total P will be used as standards in many western Montana streams, as they already are in the Clark Fork.

Table 2.17. Summary of Montana Department of Environmental Quality water quality data for selected tributaries to the Bitterroot River (n=8 samples) collected in 2005 and 2006.

Tributary	Mean Concentration of Total N (mg/L[1])	Mean Concentration of Total P (mg/L[1])	Mean Concentration of Total Suspended Sediment (TSS) (mg/L[1])	Mean Flow (cfs[2])
Threemile Creek	0.416	0.063	18.9	23.7
Burnt Fork Creek	0.252	0.042	09.6	19.3
Sleeping Child Creek	0.229	0.027	07.6	76.8
Rye Creek	0.214	0.059	19.0	45.1
Sweathouse Creek	0.203	0.024	04.9	28.7
Bear Creek	0.264	0.003	01.3	42.9

[1] *mg/L = milligrams per liter*
[2] *cfs = cubic feet per second*
From: MT DEQ (2008b).

Of the tributary streams summarized in Table 2.17, only Threemile Creek clearly exceeds the probable total nitrogen standard (proposed to be 0.3 milligrams per liter), while the mean values for Threemile Creek, Burnt Fork, and Rye Creek exceed the probable total phosphorus standard (proposed to be 0.04 milligrams per liter). No streams in the Bitterroot headwaters (East Fork and West Fork areas) exceeded these levels during limited sampling done for the Headwaters TMDL (MT DEQ 2005).

Threemile Creek had the highest concentrations of both total nitrogen and total phosphorous of any measured Bitterroot Subbasin tributary stream. Total phosphorous concentrations at the mouth of this creek were often three times higher than the Bitterroot River. Rye Creek also had high total phosphorus concentrations at the mouth, and apparently it is a major contributor to the nutrient load of the upper Bitterroot River above Darby.

Although no numeric standard exists for total suspended solids (TSS), only the Threemile and Rye Creek levels appear elevated. Phosphorus levels appear positively correlated to suspended sediment concentration (r^2=0.95) in the six measured tributaries (Figure 2.16). This may indicate that phosphorus sources and sediment sources are similar in the subbasin.

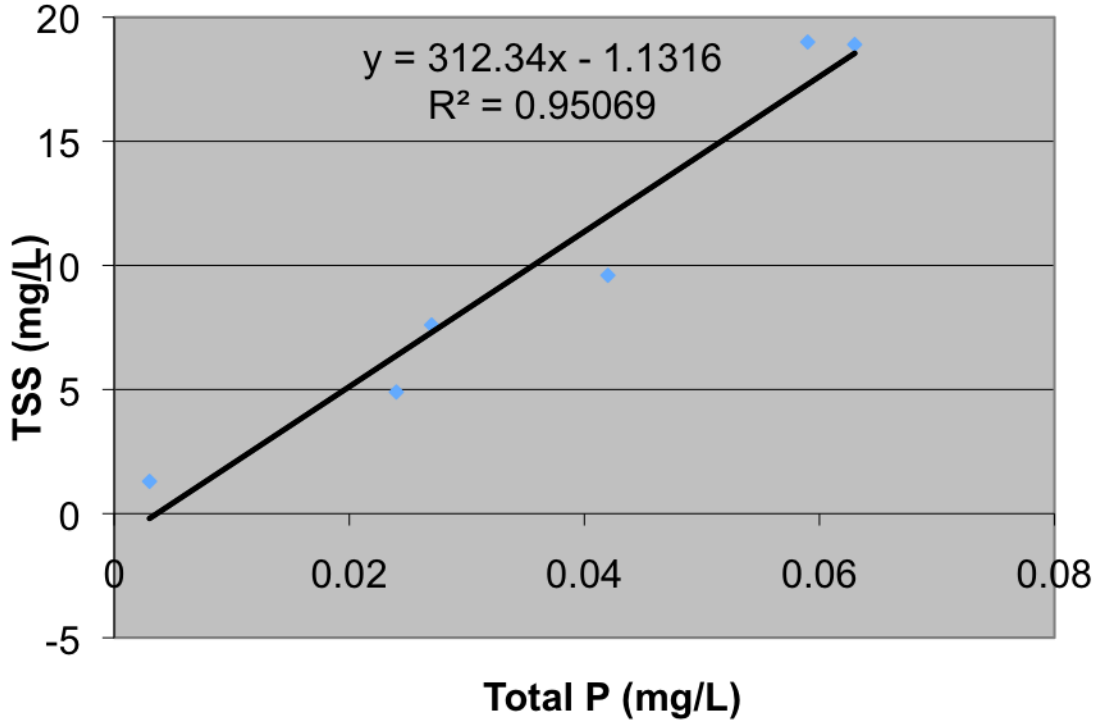


Figure 2.16. Regression of mean total Phosphorus (P) against total suspended solids (TSS) in six Bitterroot River tributary streams.

2.9.2 Groundwater Quality

Aquifers in many parts of the Bitterroot valley are "relatively susceptible to potential contamination from surface or near-surface sources because the coarse-grained character of the…sediments could allow contaminants to readily infiltrate" (Briar and Dutton 2000). Potential contamination sources include septic systems, fuels, leachate from landfills and sewage lagoons, agricultural chemicals, urban storm-water, and dry sumps. Nitrate is a common contaminant often used as an indicator of the level of human land use impact on aquifers. Nitrate concentrations in shallow wells in the subbasin tend to be much lower than U.S. EPA maximum contaminant levels (10 milligrams per liter) but are somewhat elevated over background rates. Sources of nitrate loading may be inorganic fertilizers, animal manures, and septic system effluent.

The sensitivity of the aquifers to contamination is also related to the total recharge from precipitation, which provides dilution water for nitrate or other groundwater contaminant loads. Because of this dilution effect, aquifers on the west side of the Bitterroot valley often have lower nitrate concentrations than aquifers on the east side, regardless of land use. The Bitterroot River receives much of the discharge from the valley's aquifers. Due to this dynamic, the river probably receives a significant portion of its soluble contaminant loads (like nitrate nitrogen) from these aquifers. This close relationship of land use, contaminant sources, aquifer water quality, and river water quality highlights the importance of integrated protection of water resources in the Bitterroot Subbasin.

2.9.3 Water Temperature

Water temperature is a major factor affecting the quality of native fish habitat in western Montana. Native species of fish thrive in cold water; water temperatures over 60 degrees Fahrenheit (20 degrees Celsius) are unhealthy for all life stages of native salmonids, especially westslope cutthroat (*Oncorhynchus clarki lewisi*) and bull trout (*Salvelinus confluentus*). Water temperature targets measured as mid-summer maximum seven-day moving averages were set in the Bitterroot Headwaters TMDL for various stages of bull trout propagation and growth. They range from 53.6 degrees Fahrenheit (12 degrees Celsius) in headwater areas to 59 degrees Fahrenheit (15 degrees Celsius) in lower parts of the East Fork and West Fork drainages (MT DEQ 2005).

As part of the TMDL planning process, Montana DEQ contracted a Forward-Looking infrared digital camera system (FLIR) to estimate water temperatures along the entire length of the Bitterroot River in summer 2004 (Watershed Consulting 2005). The digital infrared images were complemented by a number of thermal data-loggers placed in the river for calibration purposes (Figures 2.17 and 2.18).

The results of this work and other water temperature data collected by Montana Fish, Wildlife & Parks (MFWP) indicate that much of the lower Bitterroot River and several tributaries have mid-summer temperatures stressful to native fish. Tributaries generally have lower maximum daily temperatures, especially in their upstream reaches, and sometimes contribute to cooling of the mainstem Bitterroot River. Conditions in the Bitterroot River are particularly problematic downstream of Hamilton, where irrigation return flows, diversion of water for irrigation purposes, and the exposed, wide valley setting, which increases sunlight hours, all contribute to elevated water temperatures and thermal stress on aquatic species.

The water temperatures in the East Fork of the Bitterroot River are substantially lower than the middle and lower mainstem Bitterroot River (Figures 2.17 and 2.18). However, the mid-summer temperatures in the East Fork still do not meet the TMDL criteria for bull trout mentioned above.

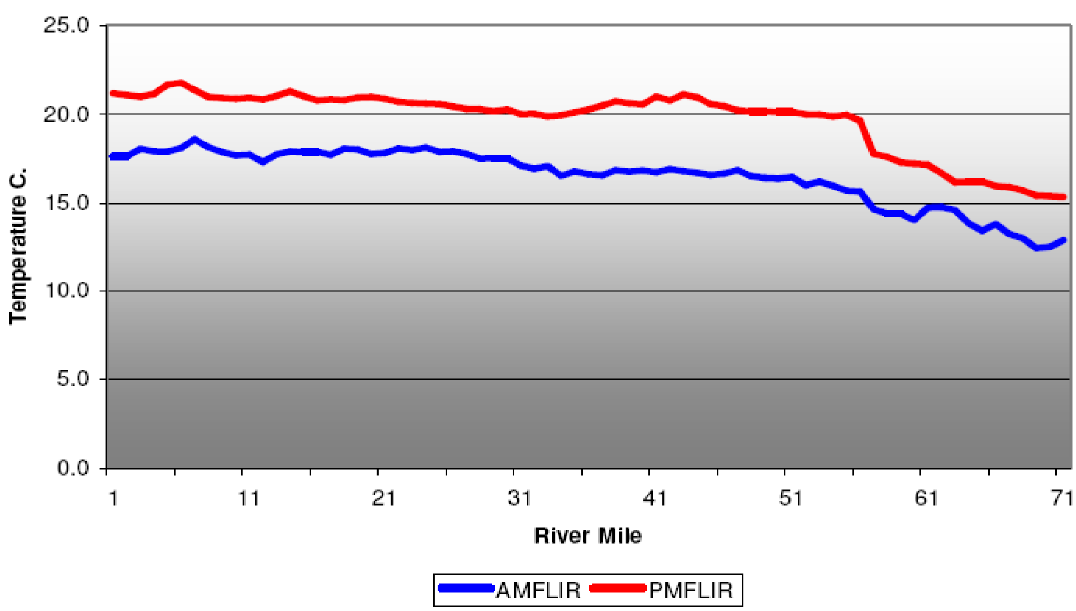


Figure 2.17. Morning (AM) and afternoon (PM) water temperature data from calibrated infrared photos (FLIR) taken in August 2004 on the mainstem Bitterroot River for Montana Department of Environmental Quality. *Data Source: Watershed Consulting (2005).*

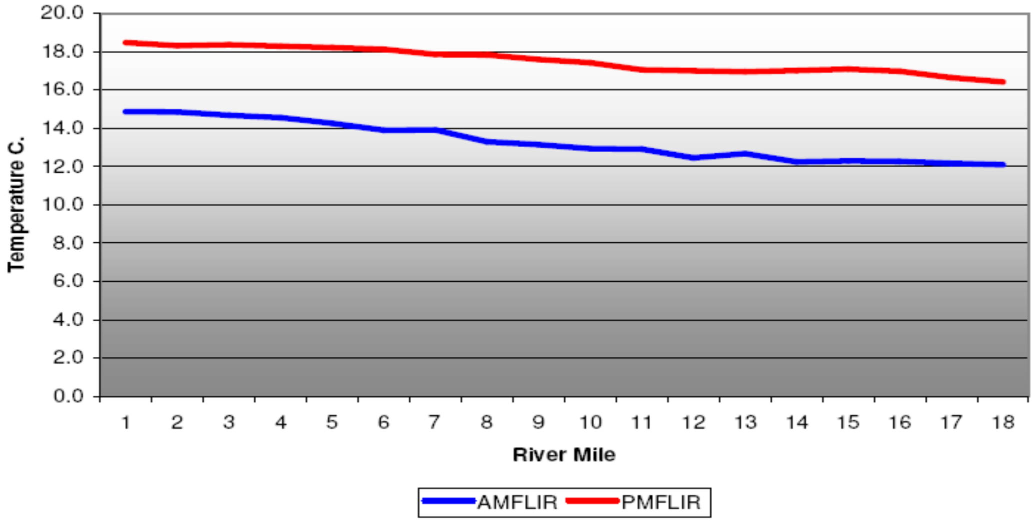


Figure 2.18. Morning (AM) and afternoon (PM) temperature data for calibrated infrared photos (FLIR) taken in August 2004 on East Fork of Bitterroot River for Montana DEQ.
From: Watershed Consulting (2005).

2.10 Population and Land Uses

2.10.1 Demography of Bitterroot Subbasin

The total population of the Bitterroot Subbasin was approximately 51,000 persons at the time of the 2000 census. This estimate includes the following areas:

- Ravalli County (all): 36,070 persons
- Missoula County (Lolo area): 3,388 persons
- City of Missoula (south area): approximately 11,900 persons

The estimate is constructed from U.S. Census data for Ravalli County, Lolo, and the 59803 zip code census blocks of Missoula (South Hills, Linda Vista, Miller Creek, and Pattee Canyon, but not including East Missoula) (U.S. Census Bureau Factfinder).

Ravalli County, the south side of the City of Missoula, and Lolo are very fast-growing areas of Montana. Ravalli County's population growth is considered peri-urban and non-farm rural, with the largest town being Hamilton (population of 3,705 in 2000) (Figure 2.19). The Bitterroot Subbasin portion of the City of Missoula includes the rapidly expanding suburban area of the South Hills and Miller Creek. The year 2010 populations of Missoula County and Ravalli County are projected to reach over 109,000 and 46,000, respectively (Table 2.18)

Table 2.18. Recent historical and projected growth of Bitterroot Subbasin counties.

County	1980 Census	1990 Census	2000 Census	2010 (projection)
Missoula	73,326	78,687	95,802	109,916
Ravalli	20,600	25,010	36,070	46,120

From: Ravalli County Growth Policy (2004) and USDA, Forest Planning, Socio-Economic Assessment.

The U.S. Forest Service calculates that growth in Ravalli County could increase by 65 percent from 2000 to 2025, while Missoula County could grow 39 percent in population during the same period. These growth rates could result in significant overall population density increases in the non-federal lands portions of each county (USDA, Forest Planning, Socio-Economic Assessment).

2.10.2 Actual Land Use

According to the State Department of Revenue, in 2004 Ravalli County included 45,000 acres of irrigated agricultural tracts, 5,300 acres of dryland agriculture, and 29,000 acres of small-tract agricultural land not in production (20 to 160 acre parcel size). An additional 129,000 acres of private lands are used for grazing, for a total of approximately 210,000 acres of agricultural land in Ravalli County in 2004 (Swanson 2006). This represents a decline of 18 percent since the early 1980s, when the total was closer to 260,000 acres. The majority of those lost agricultural acres have become residential.

Private forestland accounts for 103,160 acres in the subbasin, and federal and state forestland accounts for 1,095,000 acres, the latter primarily within the Bitterroot National Forest.The amount of commercial land (1,684 acres) and industrial land (244 acres) is minor in the subbasin.

Land use in the Missoula County portion of the subbasin is also dominated by federal forestlands (Lolo National Forest). However, Plum Creek Timber Company also has a significant amount of private corporate timberland in the northern part of the subbasin, especially in the Lolo Creek, Miller Creek, and Eightmile Creek drainages. Agricultural lands are much more restricted in Missoula County's portion of the subbasin.

One of the major changes in land use in recent years has been the subdivision of lands formerly used for agriculture, and their conversion to low or medium-density residential uses. Ravalli County approved 88 major subdivisions between 1991 and 2001, affecting 17,000 acres of land, much of it of agricultural value. Recent concern for the conservation of "open lands," including agricultural or grazing lands and lands with high wildlife or other public-benefit values, has increased in both Ravalli and Missoula Counties. Voters passed an Open Lands Initiative in Ravalli County in 2006, authorizing a ten million dollar bond measure to acquire conservation easements and prevent the subdivision of valuable resource lands. A similar ten-million dollar measure was passed by Missoula County voters in 2006 as a follow-up to a 1995 program run by Missoula City-County governments.

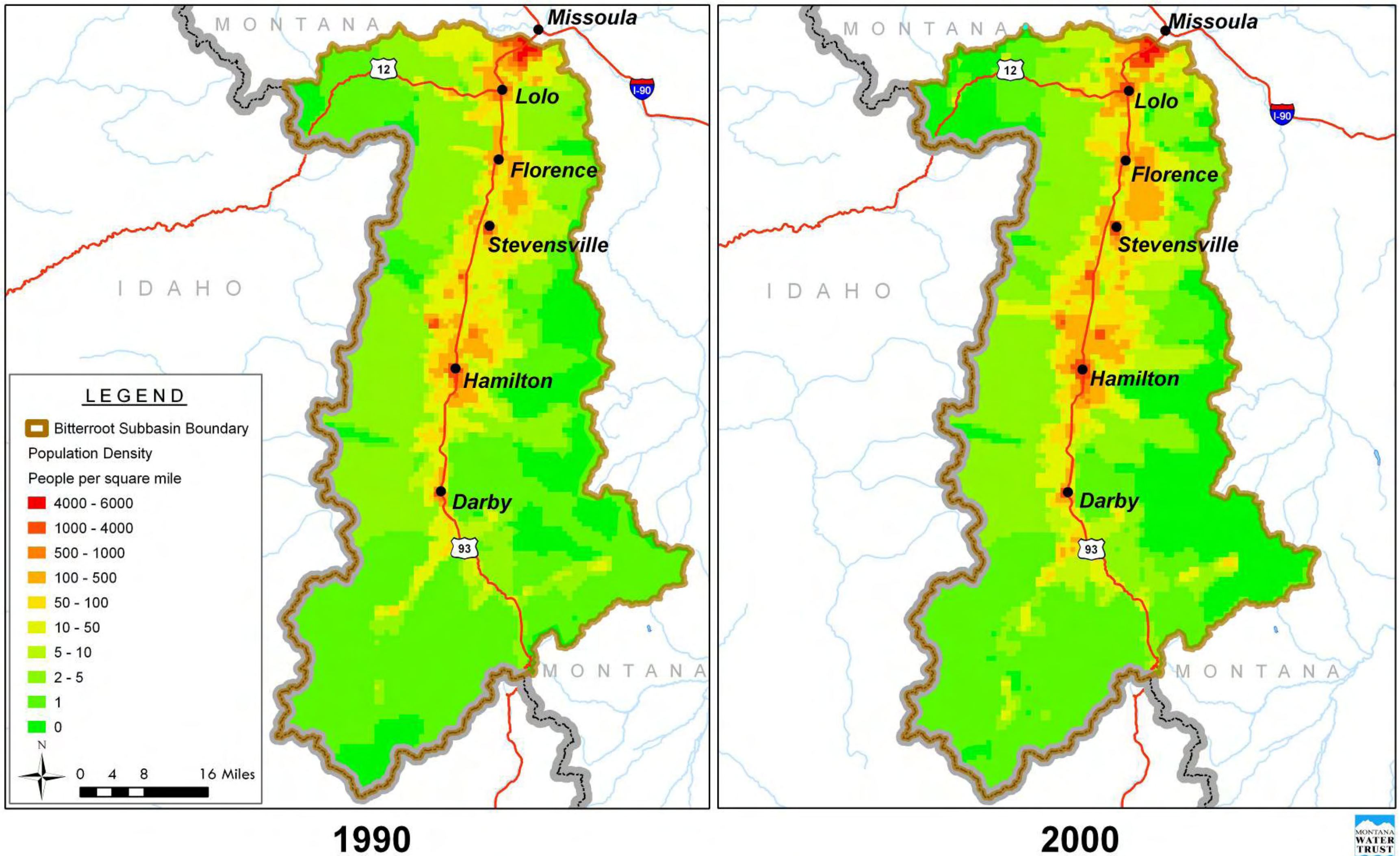


Figure 2.19. Population density of the Bitterroot Subbasin in 1990 and 2000.
Data Sources: Montana State Library (1990 and 2000).

2.10.3 Agriculture: Prime Farmland, State or Locally Important Soils

High-quality agricultural lands in the Bitterroot Subbasin are defined in three categories, with definitions as follows (Skovlin pers. comm. 2007).

1. "**Prime farmland** is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods."

2. "**Additional farmland of statewide importance** is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oil seed crops. Criteria for defining and delineating this land are to be determined by the appropriate state agency. The Montana Farmland of Statewide Importance Criteria includes:

1. Product of C (climatic factor) x I (soils erodibility) is less than 80.
2. Product of Kw (erodibility factor) x maximum slope is less than or equal to 3.
3. Frost free season is greater than 70 days.
4. Not frequently flooded during the growing season.
5. Depth to water table is greater than or equal to 24 inches.
6. Surface layer is not cobbly or stony (<15% by volume rock fragments greater than 3 inches).
7. Available water holding capacity in the upper 40 inches is $\geq$ 3.75 inches.
8. pH is $\leq$ 9.0 in upper 40 inches.
9. EC (electrical conductivity) is $\leq$ 4 in upper 24 inches and $\leq$ 8 from 24 to 40 inches.
10. SAR (sodium adsorption ratio) is < 13 in upper 24 inches.
11. Permeability of the upper 20 inches is not slow or very slow."

3. "**Farmland of local importance.** In some local areas, there is concern for certain additional farmlands for the production of food, feed, fiber, forage, and oilseed crops, even though these lands are not identified as having national or statewide importance. The Bitterroot Conservation District defined the criteria for farmland of local importance within Ravalli County in January 2007. Criteria include:

"The soil map unit is not already designated as Prime Farmland, Prime Farmland if irrigated, or Farmland of Statewide Importance and has one or more of the following:

1. Soil map units that have 50% or more named components meeting prime or statewide criteria.
2. Soil map units that have slopes less than 15%, are not frequently flooded, are poorly drained or better, and where at least 50% of the named components meet <u>at least one</u> of the following yields:
    a. Irrigated alfalfa hay yields $\geq$ 4.0 tons per acre.
    b. Irrigated grass hay yields $\geq$ 3.0 tons per acre.
    c. Non-irrigated grass hay yields $\geq$ 1.0 tons per acre.
    d. Irrigated alfalfa-grass hay yields $\geq$ 3.5 tons per acre.
    e. Irrigated pasture $\geq$ 5.0 AUM.
    f. Non-irrigated pasture $\geq$ 1.0 AUM."

The most important agricultural soils in the Bitterroot Subbasin are generally found in the valley bottom (Figure 2.20).

2.10.4 Irrigation: Diversions, Impoundments and Irrigation Projects

The Bitterroot Subbasin is highly developed for surface water irrigation. Development of surface waters for irrigation purposes began in the 1860s, and some of the largest irrigation systems were completed in the first decade of the 1900s.

Two large reservoirs and at least 28 small reservoirs are located on tributary streams in the subbasin. The two large reservoirs are Painted Rocks Reservoir on the West Fork, and Lake Como on Rock Creek. The mainstem of the Bitterroot River and the East Fork have no reservoirs.

Painted Rocks Reservoir, built in the 1930s, is managed by the Montana Department of Natural Resources and Conservation (DNRC). It is used primarily as an irrigation-storage structure with some limited seasonal recreational uses. The 143-foot high earthen dam impounds 31,706 acre-feet of water, with the reservoir pool covering approximately 655 acres (MT DEQ 2005). There are no fish passage facilities at the reservoir. The DNRC has contracts to deliver 15,000 acre-feet for in-stream fisheries flows and 10,000 acre-feet for irrigation each year. The contracts require delivery of the water between May 1 and September 30. The irrigation water is delivered as far north as Florence (approximately 65 miles downstream). Under an agreement with MFWP, in-stream fisheries flows are protected as far as Bell Crossing, which is located south of Stevensville and approximately 48 miles downstream.

The summer release of stored water from Painted Rocks Reservoir alters the summertime flow and temperature regime throughout the entire 23 miles of the lower West Fork. Generally, river flows are higher than normal until late summer or early fall, and then drop rapidly as the pool in the reservoir becomes depleted (PBSJ 2008a).

Lake Como is an irrigation storage structure built in 1910 on Rock Creek, northwest of Darby, by local irrigators and investors. It is managed by the Bitter Root Irrigation District (BRID). Lake Como is on USFS-administered land, and recreation facilities exist at the reservoir. The reservoir is formed by a 70-foot high earthen dam that impounds 38,500 acre-feet of water. Major safety-related modifications were made to the dam and spillway in 1954, 1976, and 1994. The U.S. Bureau of Reclamation has been involved in some of the major repairs and improvements (Bureau of Reclamation 2008). The last modifications added 3,000 acre-feet of storage, which is used for enhancing summer low flows in the Bitterroot River.

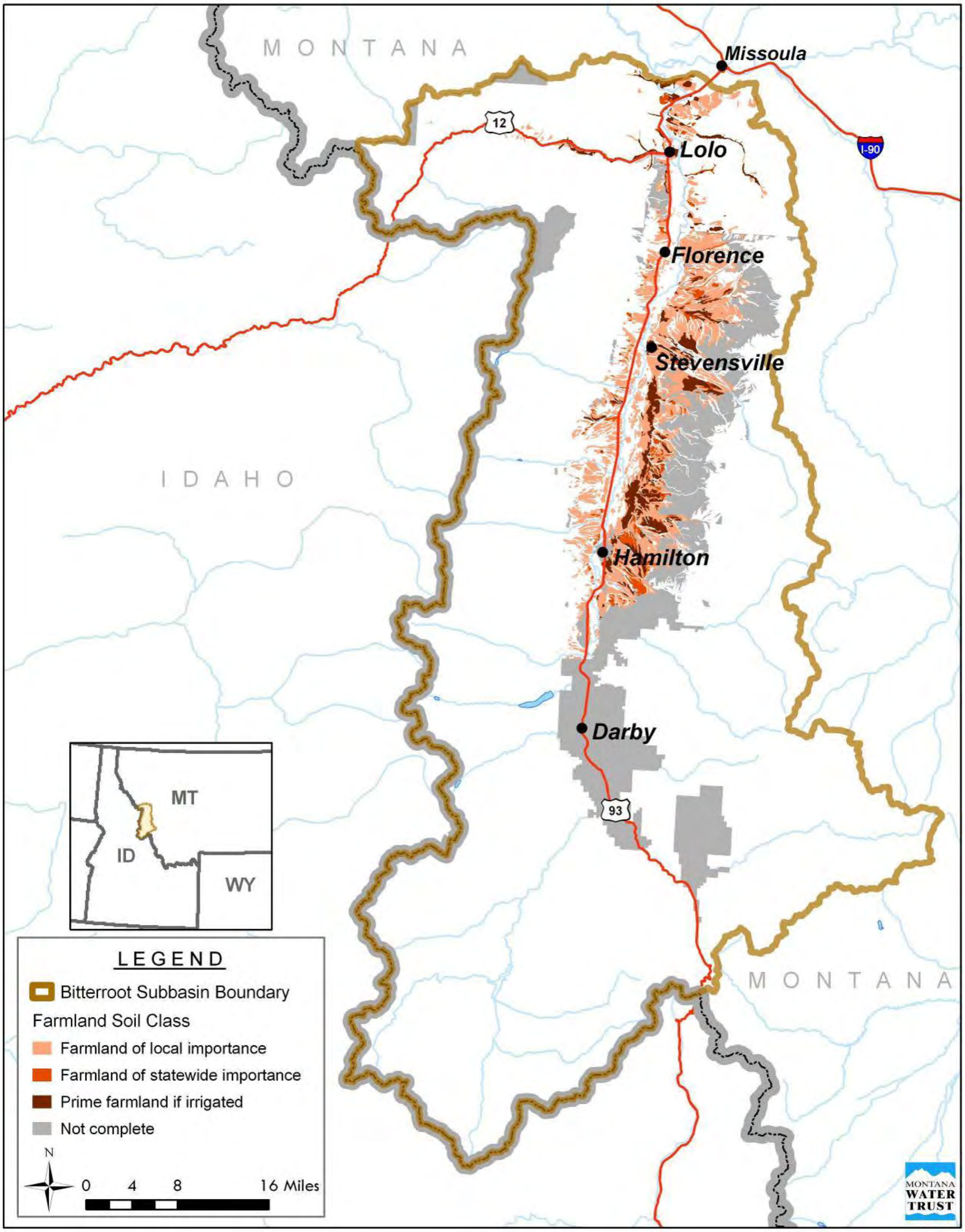


Figure 2.20. Important agricultural soils in the Bitterroot Subbasin.
Data Sources: Natural Resources Conservation Service (2007).

Water released from Lake Como runs down Rock Creek for about one mile. It is then diverted into a large canal (known as the Big Ditch or the BRID canal) with capacity for approximately 325 cubic feet per second. This canal then joins a canal diverting water from Lost Horse Creek and crosses the Bitterroot River, where it becomes the largest single source of irrigation water on the east side of the Bitterroot Valley.

Approximately 28 small irrigation reservoirs are located high in tributary drainages, mostly in the Bitterroot Range on the west side of the valley. The dams are often modifications to the outlets of existing natural lakes. These small storage systems provide supplemental, late-season irrigation water to small irrigator organizations near the outlet of the drainage where they are located (Table 2.19).

Irrigation diversions on the mainstem Bitterroot River exist at several locations, with a concentration of diversions just downstream of Hamilton. Some of these river diversions, such as the Republican Ditch diversion near Sleeping Child Creek, involve low diversion structures spanning the entire river. Most, however, do not involve river-spanning structures. Tributary diversions structures are diverse and numerous, and are found on nearly every tributary in the subbasin.

Water rights in the Bitterroot Subbasin have been awarded to approximately 109,000 acres of land (PBSJ 2008a) from Montana DNRC. Surface water rights are currently under adjudication, and allocation of new surface water rights was suspended in 1999 by the State of Montana legislature through the temporary Bitterroot Basin Closure act 85-2-344, MCA (Montana DNRC 2004). Some new water uses, for example groundwater use and small-scale domestic use, are still allowed.

2.10.5 Livestock and Crop Production: Census and Distribution

Livestock production is the most important agricultural activity in the Bitterroot Subbasin, and most irrigated land is devoted to hay and pasture production. The National Agricultural Census of 2002 prepared a livestock inventory and crop production summary in 2002.Tables 2.20 and 2.21 summarize this information.

The total amount of intensively farmed land, approximately 49,000 acres, corresponds well to the Montana Department of Revenue and Ravalli County estimate of 45,000 acres of irrigated agricultural tracts and 5,000 acres of dryland cropland. Since Ravalli County is entirely within the Bitterroot Subbasin, and most agricultural land in the subbasin is in Ravalli County, this is an acceptable estimate of irrigated cropland in the subbasin. A small amount of additional irrigated land (several thousand acres) is in southern Missoula County. That land is mostly irrigated hayland around Lolo.

Table 2.19. Large irrigation districts and companies in the Bitterroot Subbasin including number of acres serviced by each district and primary water source.

Irrigation Companies/Districts	Source Streams	Irrigated Acres
Blodgett Creek Irrigation District	Blodgett Creek	239
C&C Ditch Users Association	Bitterroot River (swamp seepage)	249
Ward Irrigation District	Bitterroot River, Lost Horse Creek	567
Webfoot Ditch Company	Bitterroot River	613
Sweeney Creek Water Users Assoc.	Sweeney Creek/Holloway Lake	652
Lomo Irrigation District	Blodgett Creek	674
Woodside Irrigation Company	Bitterroot River	680
Rock Creek Water Company	Rock Creek	732
Fred Burr Water Users Association	Fred Burr Creek	860
Carlton Creek Irrigation Company	Carlton Creek/Carlton Creek Lakes	874
Charlos Irrigation District	Lost Horse Creek, Twin Lakes	969
Big Flat Irrigation District	Bitterroot River	998
Tin Cup Water Company	Tin Cup Creek/Tin Cup Lake	1,029
Canyon Creek Irrigation District	Canyon Creek/Canyon Creek Lake	1,033
Etna Ditch Company	Bitterroot River	1,060
Union Ditch Company	Bitterroot River	1,147
Mill Creek Irrigation District	Mill Creek/Mill Creek Lake	1,677
Bass Lake Reservoir Company	Bass Creek/Bass Lake	2,383
Big Creek Lakes Reservoir Association	Big Creek/Big Creek Lake	2,413
Sunset Irrigation Project	Burnt Fork Creek/ Burnt Fork Lake	2,634
Corvallis Canal and Water Company	Bitterroot River	3,850
Supply Ditch Association	Bitterroot River: Burnt Fork Creek	4,361
Ravalli Water Users Association (Daly Ditches)	Bitterroot River: Skalkaho Creek, Gird Creek	12,258
Bitterroot Irrigation District (BRID)	Rock Creek, Lake Como, Lost Horse Creek Skalkaho Creek, Willow Creek, Burnt Fork Creek, Three Mile Creek, Ambrose Creek	17,432
Total		59,384

From: PBSJ (2008a).

Table 2.20. Livestock (and bee hive) inventory in Ravalli County for 2002.

Livestock (and bee hives) Type	Inventory (2002)
Total Cattle and Calves	33,846
Cattle: Dairy	1,560
Sheep and Lambs	4,473
Horses	4,927
Hogs	854
Bee Hives	2,940

From: NASS (2008).

Table 2.21. Crop production in Ravalli County for 2002.

Crop	Acreage (2002)
Wheat	1,789
Barley	1,262
Oats	742
Hay	44,256
Orchards	273
Nursery, Greenhouse, Sod	294

From: NASS (2008).

2.10.6 Timber Production: History and Status

The Bitterroot Subbasin, which includes USFS-administered lands, State DNRC forest lands, Plum Creek Timber Company lands, and other private forestlands, has a long history as an important timber production area.

The BNF dominates the timber land base in the basin. Table 2.22 summarizes the forest's timber production by decade.

Table 2.22. Bitterroot National Forest timber production by decade from 1961 through 2007.

Decade	Total Timber Cut (MMBF[1])	Annual Average (MMBF)
1961-1970	583	58.3
1971-1980	306	30.6
1981-1990	318	31.8
1991-2000	80	8.0
2001-2007	48	6.9
Total	1335	28.4

[1] *Million board feet.*

Source: USFS (2007); USFS (2006).

The major timber species for many decades have been Douglas-fir and ponderosa pine, with much smaller harvests of Engleman spruce, western larch, and other species.

Forest Service Region 1 data for the BNF indicate that clearcuts were prevalent in the 1964-to-1973 time frame, with between 1,200 and 3,400 acres of clearcuts occurring per year during that time. From 1973 to 1978, selective cuts were more prevalent. Between 1979 and 1986 salvage cuts became prominent with 1,000 to 2,000 acres occurring per year. Clearcuts made a brief resurgence (900 to 1,200 acres per year) from 1985 to 1988. After 1990, timber cutting decreased drastically on the BNF.

Plum Creek Timber owns 120 square miles of timberland in the north end of the subbasin, primarily in the Eightmile Creek, Miller Creek, and Lolo Creek drainages. Dating back to the early 1900s, management of timber on these lands has emphasized removal of high-value species through selective cutting. Beginning in the 1960s, higher-elevation north aspect slopes were commonly logged by seed tree and clearcut harvests. Lower elevation and drier aspects were harvested with selection cuts.

2.10.7 Forest Fire History

The BNF has fire-history records based on silvicultural calculations of timber acres lost to fire (Table 2.23). A small portion of the forest is in the Selway drainage of Idaho. Therefore, these data are used simply to illustrate the changes in incidence and magnitude of forest fires in and near the subbasin over the last 45 years.

Table 2.23. Historical losses of timber acres to fire in the Bitterroot National Forest 1961-2006.

Decade	Timber Acres Lost to Fire	Major Fire Years
1961-1970	27,441	1962 – 23,259 acres
1971-1980	4,322	1979 – 1,333 acres 1980 – 1,928 acres
1981-1990	839	None
1991-2000	190,336	2000 – 189,940 acres
2001-2006	44,956	2003 – 9,285 acres 2005 – 20,910 acres 2006 – 14,761 acres

Source: USFS (2007).

Obviously, the fires in the period 2000 to 2006 have dominated the fire history of the last 45 years. It is noteworthy that before the 2000 fires, there had been no really large fires in the BNF for 38 years—since the Sleeping Child fire of 1962. Prior to 2000, the last decade in which more than 100,000 acres burned, was 1910 to 1920 (USFS 2000).

In 2000, several large fires in the south end of the subbasin coalesced and burned large portions of the East Fork, Rye Creek, Sleeping Child Creek, and Skalkaho Creek drainages. A total of 292,000 acres in the subbasin were affected by forest fires that year, including nearly 50,000 acres of state and private land. About 46 percent of the 2000 fires that burned within the subbasin were of low-intensity (USFS 2000).

The 2000 fires, particularly the medium and high-intensity blazes, had major social and economic effects, with numerous structures and other infrastructure lost, especially in the areas near Sula and Conner south and east of Darby. Over fifty million dollars was spent fighting fires in the Bitterroot Subbasin in 2000.

Forest fires, especially high-intensity burns, have major hydrologic and ecological impacts on conifer forests and nearby aquatic ecosystems. The 2000 fires in the Bitterroot were documented to cause localized fish kills, change vegetation types, change ungulate grazing patterns, increase or decrease populations of various species of birds, and cause a variety of other ecological effects (USFS 2000). They also contributed to landslides, debris flows, and major sediment pulses in some Bitterroot tributaries in 2001 (i.e. Laird Creek and Sleeping Child Creek).

2.10.8 Forest Roads: Road Density and Roadless Areas

Roads and road density can be key factors affecting both terrestrial and aquatic habitat in the Bitterroot Subbasin. Increasing road density is correlated with declining aquatic habitat and declines in native salmonids, primarily due to negative effects of increased sedimentation associated with roads (USFS 1996). Roads that are improved to meet “best management practices” (BMPs) can reduce these negative effects. Montana DNRC monitors forest-road BMPs and has noted some improvements in rate of road BMP application on private forest lands, for example on Plum Creek Timber lands (Sugden 2008).

Roads are also a key factor in conservation of game animals and large carnivores due to habitat fragmentation and increased hunter access (Lyon 1983; Mattson et al. 1996).

The Bitterroot Subbasin includes some extensive roadless areas, including parts of two designated wilderness areas and a number of wilderness study areas within the two National Forests (Figure 2.23). However, some areas of the subbasin’s uplands have been extensively roaded for timber production, and the valley areas have a large and growing road network (Figure 2.21). Data for road densities and roadless areas distributed through some of the major tributary areas of the subbasin were collected for the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (Table 2.24).

Table 2.24. Road density and roadless area within selected tributaries to the Bitterroot River.

Bitterroot River Tributary	Total Tributary Watershed Area (square miles)	Road Miles	Road Density (mile/square mile)	Percent Roadless
East Fork (includes a-e)	407.3	1,481.8	3.6	22.5
a. Laird Creek	9.4	47.4	5.0	22.2
b. Reimel Creek	9.2	6.4	0.7	62.1
c. Martin Creek	31.9	89.8	2.8	31.4
d. Meadow Creek	32.1	81.9	2.5	20.9
e. Moose	24.9	37.7	1.5	72.9
West Fork (includes f-j)	559.4	1,272.3	2.3	46.3
f. Buck Creek	2.4	15.0	6.2	0.0
g. Hughes Creek	59.8	87.1	1.5	62.5
h. Deer Creek	22.7	7.4	0.3	93.1
i. Overwhich Creek	50.2	77.6	1.5	58.8
j. Nez Perce Fork	37.3	89.7	2.4	46.9
Rye Creek	62.9	295.2	4.7	N/A
Tin Cup Creek	42.2	24.4	0.6	N/A
Lost Horse Creek	74.6	54.7	0.7	N/A
Sleeping Child	76.3	186.7	2.4	N/A
Skalkaho Creek	79.9	169.8	2.1	N/A

Bitterroot River Tributary	Total Tributary Watershed Area (square miles)	Road Miles	Road Density (mile/square mile)	Percent Roadless
Willow Creek	42.4	135.0	3.2	N/A
Blodgett Creek	28.3	7.5	0.3	N/A
Mill Creek	63.8	81.6	1.3	N/A
Bear Creek	32.3	33.9	1.0	N/A
Sweathouse Creek	27.8	75.7	2.7	N/A
Threemile Creek	72.5	281.3	3.9	N/A
Kootenai Creek	31.5	8.9	0.3	N/A
McClain Creek	3.8	19.4	5.1	N/A
Lolo Creek	273.2	1,153.0	4.2	N/A
Miller Creek	47.9	158.5	3.3	N/A
Entire Bitterroot Subbasin	2,850			

N/A – Not Available
From: MT DEQ (2005) and PBSJ (2008b).

The ICBEMP found that over the entire Columbia River basin, road densities between 1.7 and two miles per square mile of watershed appear to be a threshold above which watershed and fisheries condition may be negatively impacted (USFS 1996). At the local level, the LNF found that in streams sampled, the percentage of surface fines increased with watershed road density, which reflected the Interior Columbia River Basin Ecosystem findings (Riggers et al. 1998). Tributary watersheds where agencies recognize some of the most severe sediment or siltation problems in the Bitterroot Subbasin include: Laird Creek, Rye Creek, Threemile Creek, McClain Creek, and Lolo Creek. All have road densities among the highest of any tributaries in the subbasin.

2.10.9 Mining: History and Status

The Bitterroot Subbasin, like many areas of Montana, was subject to intense prospecting and metal-mine development during the later nineteenth century and early twentieth century. Mines were developed mostly for gold, silver, zinc, and copper. Large-scale commercial metal mining is not currently an important economic activity in the subbasin.

Only a few Ravalli County and southern Missoula County mines are part of MT DEQ's priority abandoned mine lands program, which identifies and prioritizes abandoned mines in need of reclamation. The Curlew mine west of Victor was identified as a high-priority abandoned mine, and 28 acres were reclaimed by the state of Montana in 1996. Currently only two abandoned mines in the subbasin are on the state priority list: the Bluebird Mine (#121) in the Pleasant View District, and the Montana Prince in the Frog Pond District (#133). Both are in the Bear Creek drainage (MT DEQ 2008c). A number of other low priority abandoned mines are scattered throughout the subbasin.

Placer mining of stream beds was an important technique for gold mining in the late nineteenth century, and a number of Bitterroot streams were affected. Hughes Creek, an area in the upper West Fork where placer mining was extensively practiced, has many mining claims, some of which are still active.

Gravel mining for various aggregates is widely practiced in the Bitterroot Subbasin. Gravel mines exist in the river floodplain (such as Donaldson pit north of Hamilton) and in alluvial fan areas. A few minor stone quarries and pumice mines also exist.

2.10.10 Residential Uses: History and Status

As noted in Section 2.10.1, the Bitterroot Subbasin has experienced accelerated population growth since the early 1990s. Housing units in Ravalli County have increased from approximately 9,000 in 1980 to 16,300 in 2005 (Swanson 2006). Growth in the Lolo/Miller Creek/South Hills area of Missoula, which lies in the north end of the subbasin, has also been rapid. This residential growth is fragmenting habitats, and resulting in the loss of agricultural land, native grasslands and shrublands, riparian areas, and low-elevation coniferous forests (primarily ponderosa pine-Douglas fir forests).

One way to visualize the location of the highest growth areas and the highest residential densities is by comparing septic system densities (Figure 2.22). Except in the immediate town areas of Missoula, Lolo, Stevensville, Victor, Corvallis, Hamilton, and Darby, all residences use septic systems for on-site waste disposal.

2.10.11 Land Ownership

The land ownership in the Bitterroot Subbasin is dominated by the U.S. Forest Service, with the majority of land administered by the BNF. The LNF administers a large part of the lower basin, especially in Lolo Creek and the northern Sapphire Mountains (Table 2.25) (Figure 2.23). Plum Creek Timber Company has large holdings in the upper Eightmile drainage, Miller Creek, and the Lolo Creek drainage. Most of this public and private forestland is in the foothills and mountains.

Montana DNRC has timber and grazing lands throughout the subbasin, usually one or more sections per township, but it also holds the Sula State Forest in the Cameron Creek drainage of the East Fork. MFWP owns fishing access sites and several large game ranges in foothills areas used by big game as winter range. The largest state-owned game range is the Threemile Game Range in the Threemile Creek drainage.

Almost all the private lands, other than Plum Creek lands, are in the valleys and foothills of the subbasin. There are only about 50 private landowners who own more than 1,000 acres. Several of the largest private landholdings have conservation easements on all or part of their properties (Figure 2.22). A pending sale of a large quantity of Plum Creek Timber lands in the upper Lolo Creek and Miller Creek drainages to The Nature Conservancy and The Trust for Public Lands may go through as early as 2008-2009 (Montana Legacy Project 2008).

Remaining opportunities to conserve significant native grasslands, sagebrush, and riparian areas are almost entirely on private lands.

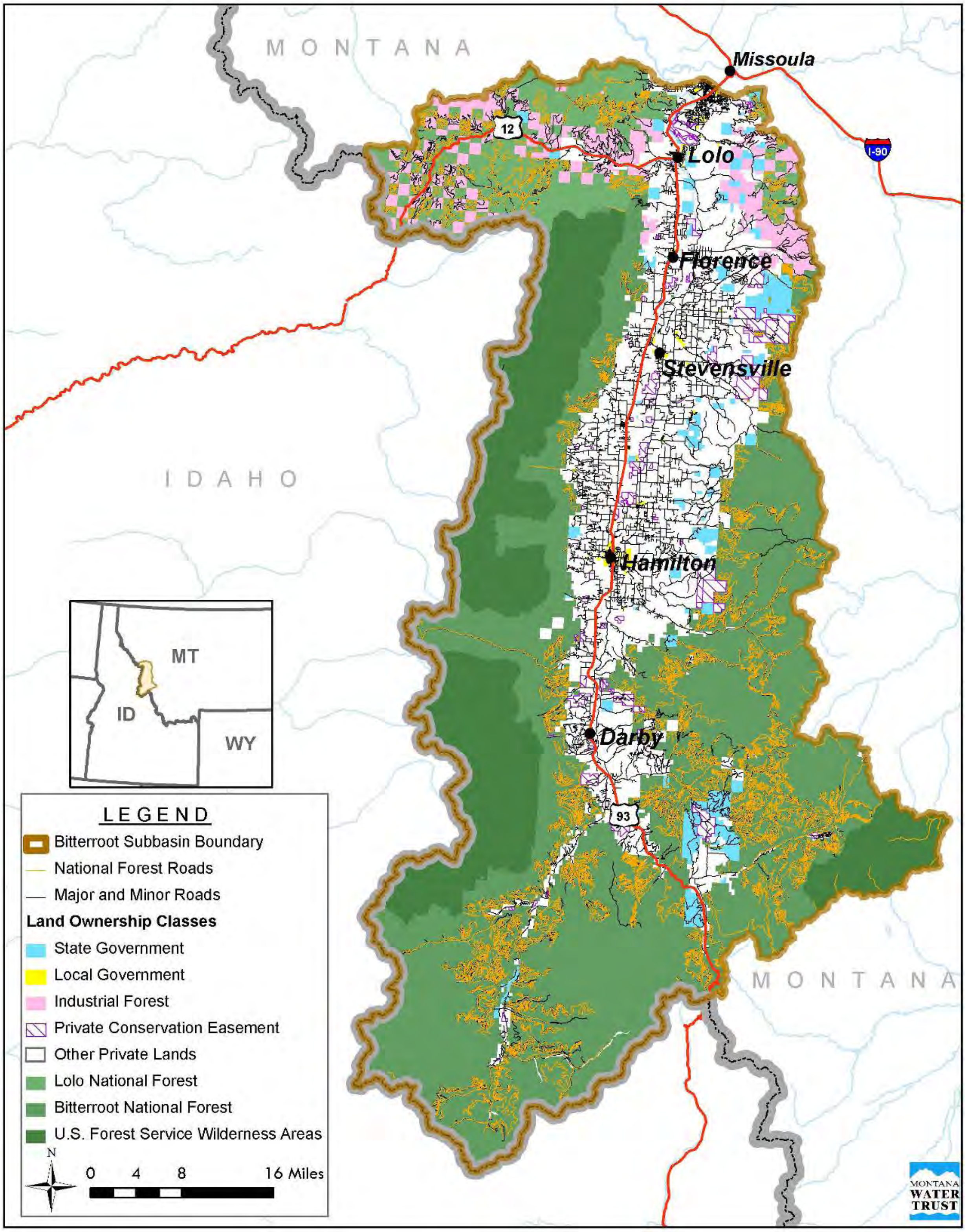


Figure 2.21. Road locations in the Bitterroot Subbasin.
Data Sources: U.S. Census Bureau TIGER Roads (2000) and U.S. Forest Service (2000).

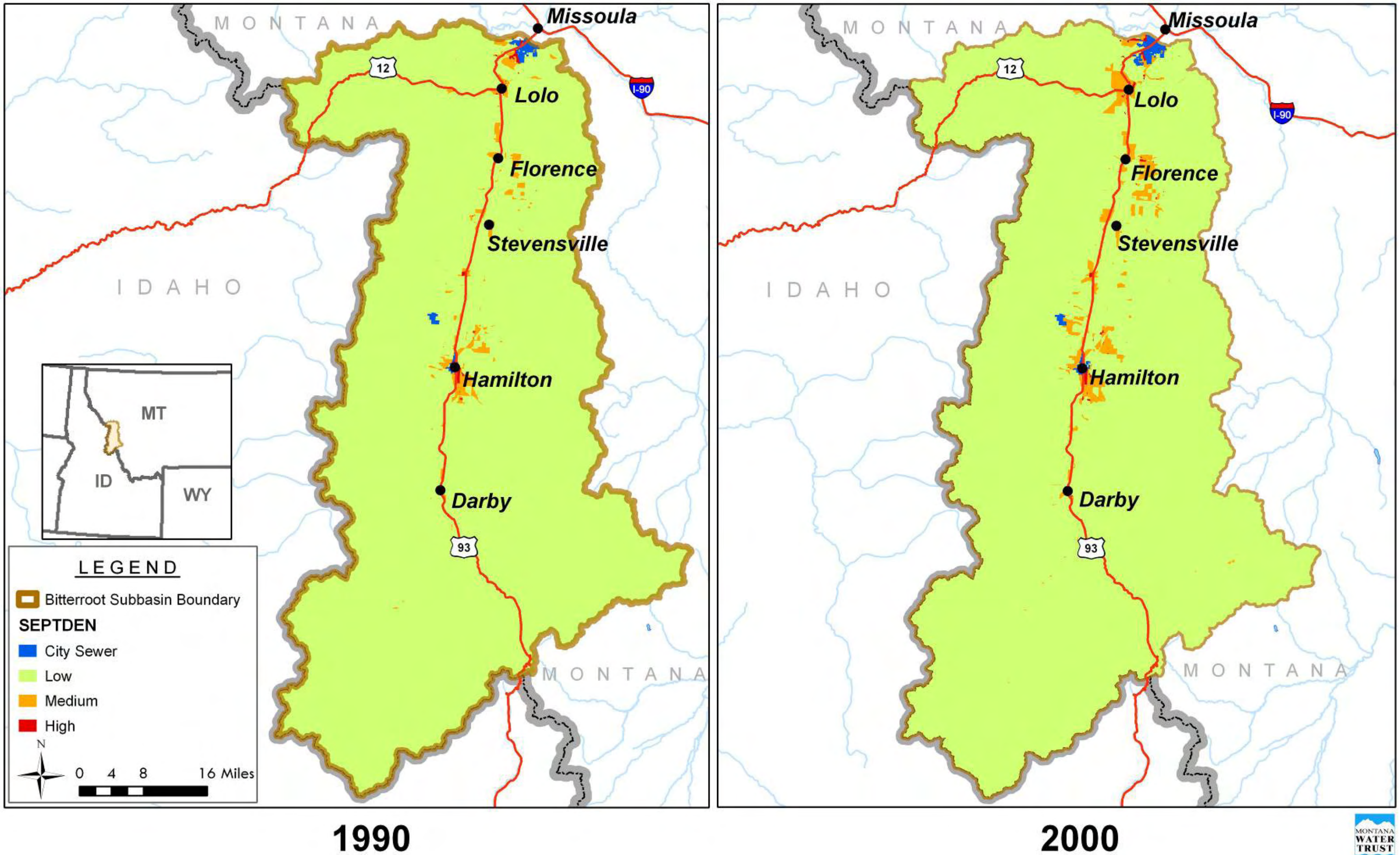


Figure 2.22. Comparison of septic densities between 1990 and 2000 in the Bitterroot Subbasin.
Data Sources: U.S. Census Bureau TIGER / Montana State Library (1990 and 2000).

Table 2.25. Land ownership in the Bitterroot Subbasin.

Owner/Administrator	Upper Subbasin (acres)	Middle and Lower Subbasin (acres)	Total (acres)	Percent
U.S. Department of Agriculture-Forest Service	569,079	686,580	1,255,659	68.6
Plum Creek Timber (private)	0	81,288	81,288	4.4
Other private	33,063	406,469	439,532	24.0
Montana Department of Natural Resources and Conservation	16,351	24,527	40,878	2.2
Montana Fish, Wildlife, & Parks	0	8,956	8,956	0.5
U.S. Fish & Wildlife Service	0	2,677	2,677	0.1
Other	0	1,781	1,781	0.1
Total	618,493	1,212,278	1,830,771	100

From: MT DEQ (2005) and PBSJ (2008b).

2.11 Economic Overview

The Bitterroot Subbasin has a diverse economy; professional/management, service, retail, and construction are the leading employment categories. Many people living in the subbasin in northern Ravalli County, and southern Missoula County work in Missoula, making it difficult to develop definitive statistics on subbasin-level employment. Ravalli County employment figures from the U.S. Census for 2000 are illustrative (Table 2.26). Major professional employers include the school districts, local government, U.S. Forest Service, health care facilities, private bio-technology research, and the National Institutes of Health, which has a large research laboratory in Hamilton.

Farming and timber employment is less than 3 percent of the employment total. Farming generates about $25 million in cash receipts annually (mostly in livestock sales), down from a high of near $50 million in the 1970s (Swanson 2006). Many people managing small farms are retired, and/or have other sources of employment. Timber industry jobs are few, especially since the Darby Lumber mill closed in 1999.

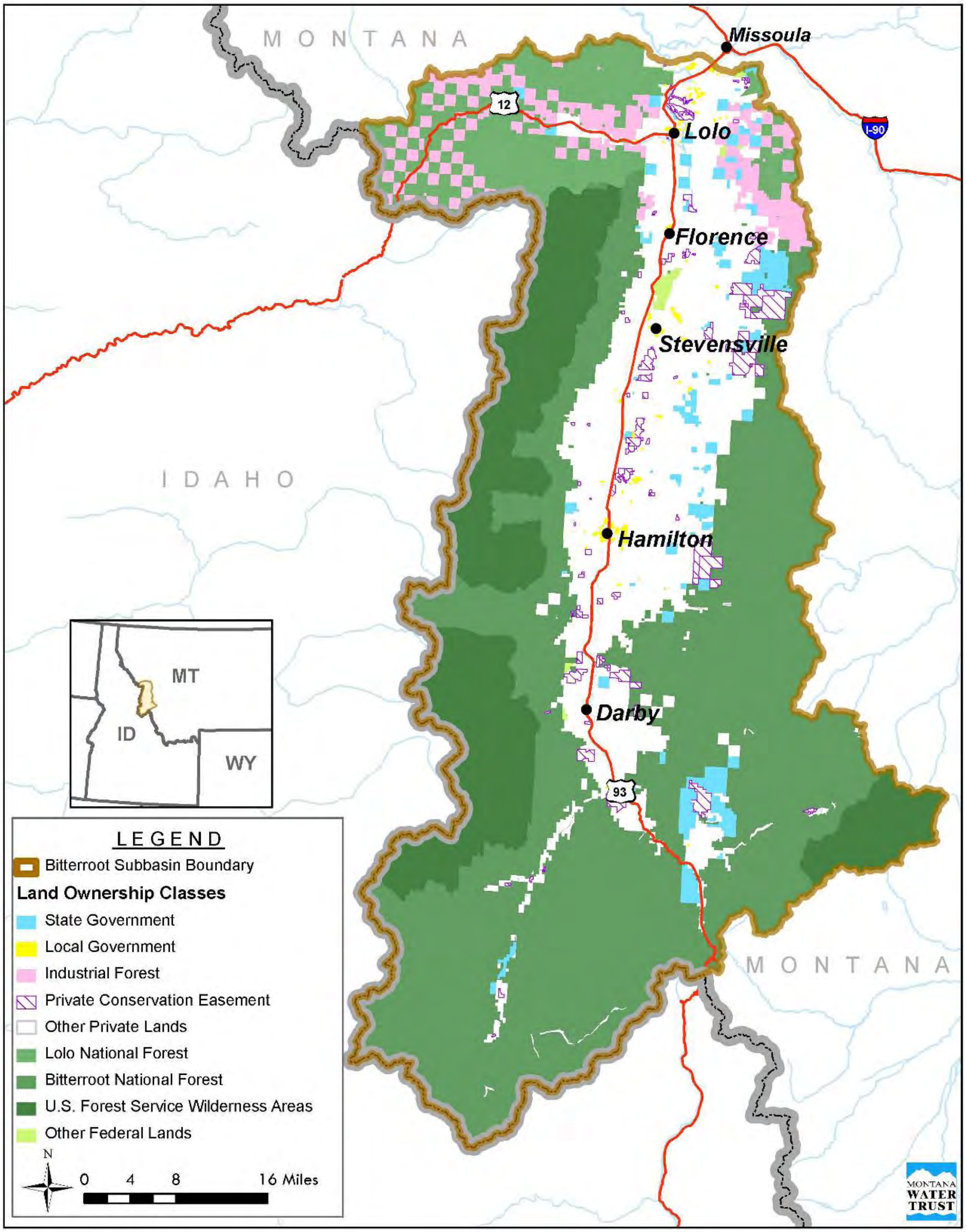


Figure 2.23. Overview of primary land ownership categories including private conservation easements in the Bitterroot Subbasin.
Data Sources: Montana Department of Administration (2008).

Table 2.26. Summary of employment in Ravalli County for the year 2000.

Employed Civilian Population 16 Years and Older	Number of People	Percent of Total
Occupation		
Management, professional, and related occupations	5,068	32.2
Service occupations	2,433	15.5
Sales and office occupations	3,772	24.0
Farming, fishing, and forestry occupations	375	2.4
Construction, extraction, and maintenance occupations	2,217	14.1
Production, transportation, and material moving occupations	1,865	11.9
Total by Occupation	15,730	100
Class of Worker		
Private wage and salary workers	10,563	67.2
Government workers	2,243	14.3
Self-employed workers in own not incorporated business	2,793	17.8
Unpaid family workers	131	0.8
Total by Class of Worker	15,730	100

From: PBSJ (2008b).

2.12 Bitterroot Subbasin in the Regional Context

The Bitterroot Subbasin is part of the greater Columbia River basin and is within the Mountain Columbia province (Figure 2.24). Due to the geological and biological history of the area, the Bitterroot was not accessible to anadromous fish. But it is immediately adjacent to three anadromous fish-bearing watersheds in Idaho: the North Fork of the Salmon River, the Selway River, and the Lochsa/Clearwater River. A portion of the subbasin falls within the approximately 1.3-million-acre Selway-Bitterroot Wilderness Area.

The subbasin includes a variety of terrain. High, glaciated mountains with alpine ridges, cirques, and steep glacial valleys make up the area along the Idaho border to the west. Extensive conifer forests are found at middle elevations. The lowest elevations are part of a relatively fertile, irrigated valley with grasslands and extensive riparian cottonwood forests. To the east, the subbasin is bounded by the rolling, forested Sapphire Mountain range. The Bitterroot valley was originally the home of Salish people. It became the first valley in Montana settled by Europeans.

Abundant surface water and a mild climate are the two primary factors that drove early settlement patterns. The relatively dense network of natural streams made it possible to develop the irrigation network that is now present in the valley bottom. The subbasin still holds a unique resident westslope cutthroat trout population with a high degree of genetic purity (see Chapter 4), which is also the result of abundant surface water combined with the fact that the upper portion of tributaries are on public land.

Figure 2.24. Location of the Bitterroot Subbasin within the Columbia River basin and Mountain Columbia Province.

2.12.1 Relationship of the Subbasin to Endangered Species Act

The Bitterroot Subbasin is part of the Clark Fork River Recovery Unit as described in the Draft Bull Trout Recovery Plan (USFWS 2002). The Clark Fork River Recovery Unit is the largest of the 22 recovery units designated for bull trout in the Columbia River basin. The following list describes the regions within the Clark Fork River Recovery Unit.

Clark Fork Basin

Clark Fork River drainage

- Lower Clark Fork River Recovery Unit (Lake Pend Oreille to Flathead River Confluence)
- Upper Clark Fork River Recovery Unit (upstream from Flathead River Confluence)
    - Rock Creek (tributary to upper Clark Fork River)
    - Bitterroot River
    - Blackfoot River
- Flathead River drainage upstream from Kerr Dam
    - Flathead River (North and Middle Fork Flathead River, Flathead Lake)
    - South Fork Flathead River (upstream from Hungry Horse Dam)

- Swan River drainage
- Swan River (upstream from Big Fork Dam)

- Priest River sub-unit

2.12.2 External Environmental Conditions Impacting the Subbasin

The Bitterroot Subbasin is part of the Clark Fork River Recovery Unit as described in the Draft Bull Trout Plan. The Clark Fork Recovery Unit includes the entire Clark Fork River basin, including Lake Pend Oreille (Figure 2.25). Although this recovery unit remains one of the relative strongholds of bull trout, most migratory populations of fluvial and adfluvial bull trout have been seriously depleted. Declining abundance has been due in large measure to disruption of historical connectivity, particularly within mainstem river corridors. Current trends in population abundance are variable in the 38 bull trout core areas, although for many populations the history or intensity of monitoring is not sufficient to accurately determine population status.

Large hydroelectric dams, erected on the mainstem Clark Fork River fifty to one hundred years ago, were the catalyst for much of the historical disruption of the migratory corridor. Presently three hydroelectric dams (Cabinet Gorge, Noxon Rapids and Thompson Falls) prevent upstream movement of bull trout in the Clark Fork River basin (Milltown dam, a few miles upstream of the confluence of the Bitterroot and Clark Fork Rivers, was removed in 2008 after blocking all upstream fish migration for 100 years) (Figure 2.25).

The legacy of metal mining in the late 1800s and early 1900s in the upper Clark Fork eradicated all fish from substantial portions of the upper drainage. Seasonal water temperature increases and dewatering, primarily associated with agricultural diversions, remain problematic in many drainages within the recovery unit. Continuing widespread habitat impacts from historical forestry and road-building practices as well as highway and railroad construction and agricultural conversion of riparian areas continue to affect bull trout. More localized problems result from livestock grazing and urban sprawl along some streams (USFWS 2002). All of these factors have contributed to the decline of bull trout populations in the Clark Fork River basin.

The Clark Fork River was historically a large migratory corridor connecting numerous bull trout subpopulations. It is assumed that the tributary populations in the Clark Fork Recovery unit, including the Bitterroot, were historically connected to other populations and to the Lake Pend Oreille population, although the extent to which they were connected is not completely understood.

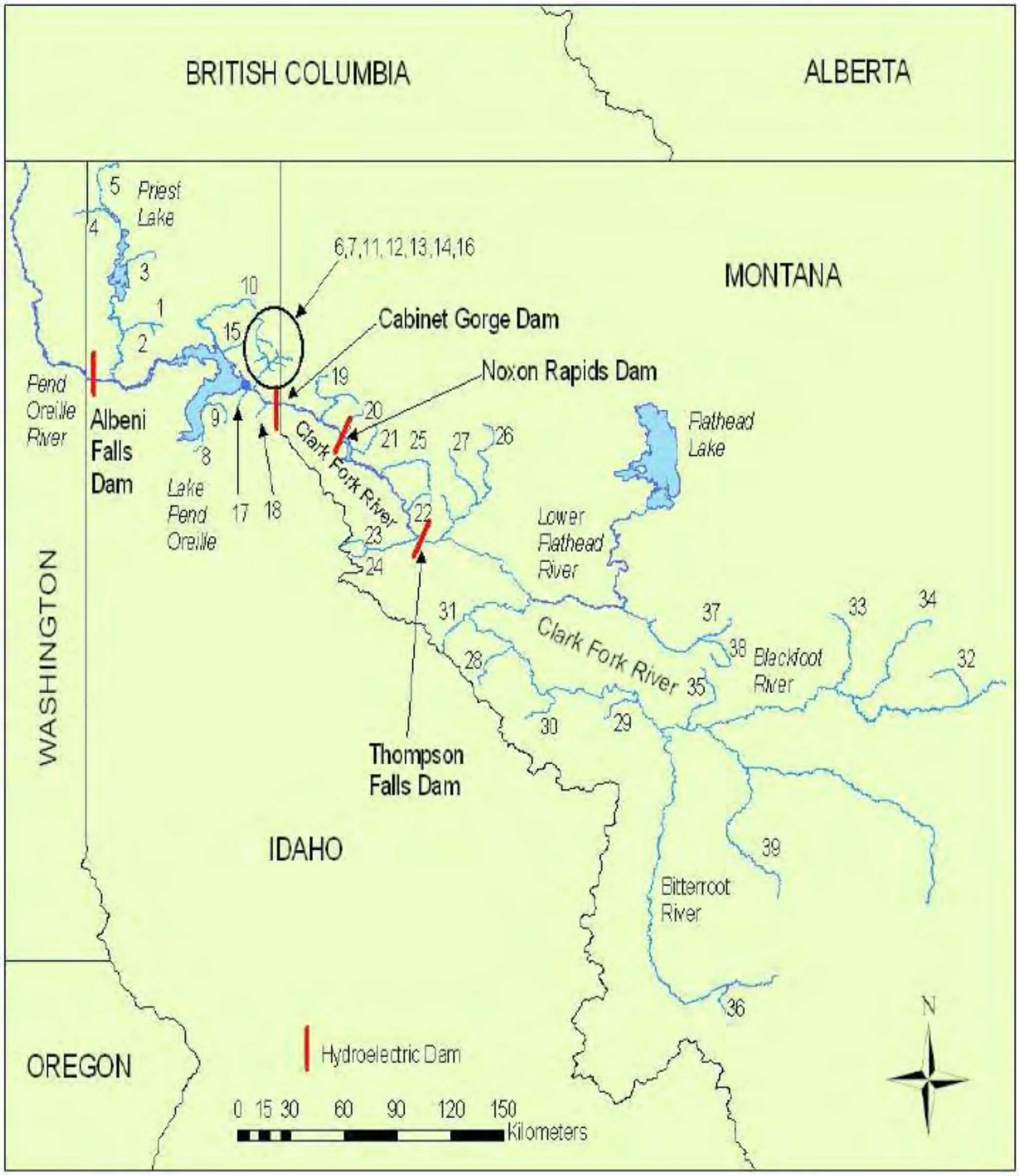


Figure 2.25. Lake Pend Oreille and Clark Fork River system in northern Idaho and northwestern Montana. Numbers on the figure correspond to bull trout population numbers for populations with a mapped genetic baseline.
Figure from: DeHaan and Hawkins 2008.

Research is currently in progress to identify the genetic origin of bull trout captured in the Clark Fork River downstream of Cabinet Gorge Dam (DeHaan and Hawkins 2008). This work has established a genetic baseline for 39 populations from the Lake Pend Oreille and Clark Fork River system. Each year the researchers trap bull trout below Cabinet Gorge Dam and move them upstream according to their genetic assignment, which includes four regions: (1) Lake Pend Oreille, (2) Clark Fork River between Cabinet Gorge and Noxon Rapids; (3) Clark Fork River between Noxon Rapids and Thompson Falls; and (4) Clark Fork River upstream of Thompson Falls). In 2008 they captured fish from all four regions and genetically assigned twenty-three percent of them to Region 4, where the Bitterroot, Blackfoot, and Rock Creek drainages are located.

2.12.3 Macroclimate

The general economic, demographic, and land use trends in the Bitterroot Subbasin are part of a larger pattern of in-migration and growth in the interior Rocky Mountain region. There are many counties experiencing rapid growth and associated transformation of open land and agricultural land to low-density residential and suburban uses, but they do not include all the counties surrounding the Bitterroot Subbasin. For example, some other Montana counties in the Clark Fork basin, such as Sanders and Mineral counties, experienced little growth during the 1980s and 1990s; however, since 2000 they have started to grow at a faster pace.

Meanwhile, counties like Powell and Beaverhead (in the adjacent Missouri River basin) have seen little population growth. Missoula, Lake (Flathead and Kootenai Subbasins) and Flathead (Flathead Subbasin) counties have experienced the same trends of rapid growth and land use transformation seen in Ravalli County (Swanson 2006). Proximity of population centers, amenities, and county planning regulations all appear to play a role in influencing the larger demographic trends.

Declines in agricultural income and agricultural and timber employment in the Bitterroot Subbasin are similar to what is occurring elsewhere in the interior Rocky Mountain region (Swanson 2006).

In addition to human occupation trends predicted in the subbasin, climate change will influence management over the long-term. As air temperature and degree warming days have increased, so too have water temperatures (BNF 2007). Both of the aquatic focal species included in this plan—bull trout and westslope cutthroat trout—require relatively cold water temperatures, making the predicted trends of particular concern to the development of short and long-term management plans.

As low elevation habitat becomes unsuitable for bull trout and westslope cutthroat trout, other limiting factors become more pronounced. Key among these is habitat fragmentation, which will be greatly exacerbated as low-elevation streams become too warm to support focal species' lifecycles. It is beyond the scope of this plan to address large-scale climate change, but a regional response to increasing air temperatures must be considered in the development of a management plan. Rieman et al. (2007) explore the effects of continued warming on bull trout habitat using Intergovernmental Panel on Climate Change model predictions for the next 100 years. Their conclusion that, "biologists working to understand local distributions or fish-habitat associations must consider both regional and local variation in climate," speaks to the important role that this variable must play in determinations of focal species' management and conservation.

2.13 Chapter 2 References

Boyd, Karin and Tony Thatcher. 2008. Bitterroot River geomorphic summary: mainstem channel and bridge crossings: Ravalli County, MT. For Montana Dept. of Transportation, Helena, MT

Briar, D. and D. M. Dutton. 2000. Hydrogeology and aquifer sensitivity of the Bitterroot Valley, Ravalli Co., MT, USGS Water Resources Investigations Report No 99-4219. Helena, MT

Federal Emergency Management Agency. 1996. Flood insurance rate map, Ravalli County. Digital data created by Ravalli County GIS Department based on hard copy FIRM maps.

Federal Emergency Management Agency. 1988. Flood insurance rate map, Missoula County. Digital data created by Missoula County Surveyors Office based on hard copy FIRM maps.

Gaeuman, David. 1997. Historical channel changes and processes of the central Bitterroot River. M.A. Thesis, University of Montana, Missoula, Montana, 78 p.

Johnson, Rob. 2008. Former MSU Ravalli County extension agent, personal communication.

Kendy, E. and R. Trensch. 1996. Geographic, geologic, and hydrologic summaries of intermontane basins of the Northern Rocky Mountains, Montana, USGS Water Resources Investigations Report 96-4025. Accessed July 2008 at: http://pubs.er.usgs.gov/djvu/WRI/wrir_96_4025.djvu.

Lonn, J. and J. W. Sears. 2001. Surficial geologic map of the Bitterroot Valley, Montana Bureau of Mines and Geology, Open File Report 441a, 441b, and 441c.

Lyon, L. J. 1983. Road density models describing habitat effectiveness for elk. Journal of Forestry 81: 592-595.

Mattson, D. J., S. Herrero, G. Wright, and C. M. Craig. 1996. Science and management of Rocky Mountain grizzly bears. Conservation Biology. 10(4): 1013-1025

McDowell. 2006. Draft final report, 2005 water quality sampling, Bitterroot River and tributaries, for MT DEQ 319 Program, by Tri-State Water Quality Council. Sandpoint, ID.

McMurtrey, R. G. and H. A. Swenson. 1972. Geology and water resources of the Bitterroot Valley, southwestern Montana, with a section on chemical quality of water. USGS Water Supply Paper, Report No. 1889. 80 p. Accessed July 2008 at:
http://pubs.er.usgs.gov/usgspubs/wsp/wsp1889

McMurtrey, R. G., et al. 1972. Geology and water resources of the Bitterroot Valley, southwestern Montana, USGS Water-Supply Paper 1889, in Briar, D. and D. Dutton, 2000.

Meyer, G. A., J. L. Pierce, S. H. Wood, and A. J. T. Jull. 2001, Fires, storms, and sediment yield in the Idaho Batholith. Hydrological Processes. 15:3025.

Montana Bureau of Mines and Geology. 2001. Surficial geologic map of the Bitterroot Valley. Open File Report 441a, 441b, and 441c.

Montana Department of Administration. 2008. Montana Cadastral Database, Missoula and Ravalli Counties. Accessed at: http://www.nris.mt.gov/nsdi/cadastral/

Montana Department of Environmental Quality. 2005. Water quality restoration plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area. Accessed July 2008 at: http://www.deq.state.mt.us/wqinfo/TMDL/BitterrootHeadwaters/FinalBitterrootSection02.pdf

Montana Department of Environmental Quality. 2008a. Clean Water Act Information Center. Accessed July 2008 at: http://cwaic.mt.gov/

Montana Department of Environmental Quality. 2008b. Unpublished data, from Tri-State Water Quality Council project database. Sandpoint, ID.

Montana Department of Environmental Quality. 2008c. DEQ-MWCB Priority Site List. Accessed at: http://www.deq.mt.gov/AbandonedMines/minepdfs/MinePriorityList.PDF

Montana Department of Natural Resources. 2004. Clark Fork Basin water management plan. Accessed July 2008 at: http://dnrc.mt.gov/wrd/water_mgmt/clarkforkbasin_taskforce/pdfs/chapter_4.pdf

Montana Legacy Project, 2008, accessed on internet at: http://www.themontanalegacyproject.org. The Trust for Public Land and The Nature Conservancy.

Montana Natural Resource Conservation Service. 2006. Montana subwatershed (6th-code) hydrologic units. Montana Natural Resources Conservation Service, Bozeman, Montana. Accessed 2008 at: http://nris.mt.gov/nsdi/nris/shape/subwatershed.zip.

Montana State Library. 2000. Montana 2000 population density 1-km grid.
Accessed November 2008 at: http://nris.mt.gov/nsdi/nris/shape/dens2000.zip

Montana State Library. 1990. Montana 1990 population density 1-km grid.
Accessed November 2008 at: http://nris.mt.gov/nsdi/nris/shape/oc39.zip

Montana State Library, Montana USGS stream flow stations. Accessed November 2008 at: http://nris.mt.gov/nsdi/nris/shape/hd42.zip.

Montana Water Trust. 2008. Unpublished analysis. Missoula, MT

Moore, M. 2005. Prepared for Northwest Weather and Avalanche Center. Accessed July 2008 at: http://www.nwac.us/education_resources/Weather_Glossary.htm

National Agricultural Statistical Service. 2008. Accessed July 2008 at: http://www.nass.usda.gov/census/census02/volume1/mt/index2.htm

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Map (scale 1:7,500,000). Annals of the Association of American Geographers. 77(1):118-125.

PBS&J. 2008a. From water resources survey, Ravalli County. 1958. State Engineers Office, Helena, MT

PBS&J. 2008b. Watershed characterization of Bitterroot mainstem planning area, report for Montana DEQ, Helena, MT; and http://www.epa.gov/wed/pages/ecoregions/mt_eco.htm.

Parrett, Charles. 1998. Montana flood-frequency and basin characteristic data. USGS Montana. Accessed July 2008 at:
http://mt.water.usgs.gov/freq?page_type=table

Ravalli County Growth Policy. 2004. Board of County Commissioners. Hamilton, MT

Riggers, B. W., A. R. Rosquist, R. Kramer, and M. Bills. 1998. An analysis of fish habitat and population conditions in developed and undeveloped watersheds on the Lolo National Forest. Lolo National Forest. Missoula, MT. Unpublished report. 34 pages plus appendices.

Rosgen, Dave. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, CO.

Rosgen, Dave. 2000. Wildland Hydrology, Pagosa Springs, CO. Personal communication.

Sugden, B. 2008. Plum Creek Timber Company, Columbia Falls, MT. Personal communication.

Swanson, Larry. 2006. Growth and change in the Bitterroot Valley and implications for area agriculture and ag lands. University of Montana, Missoula. For Bitterroot Land Trust.

Skovlin, Jay. 2007. Natural Resource Conservation Service, Hamilton, MT. Personal communication.

U.S. Bureau of Reclamation. 2008. Bitter Root Project. Accessed July 2008 at: http://www.usbr.gov/dataweb/html/bitter.html

U.S. Census Bureau. Factfinder. Accessed July 2008 at: http://factfinder.census.gov/home/saff/main.html?_lang=en

U.S. Department of Agriculture, Forest Service. 1996. Status of the Interior Columbia Basin: summary of scientific findings. PNW-GTR-385: 144 p. Accessed July 2008 at: http://www.fs.fed.us/pnw/pubs/summary/gtr_385e.pdf

U.S. Department of Agriculture, Forest Service. 2006. Northern Region, forest management reports. Accessed July 2008 at: http://www.fs.fed.us/r1/forest_range/timber_reports/silviculture_reports/2006_nharv_rpt.pdf

U.S. Department of Agriculture, Forest Service. 2007. Northern Region, forest management reports. Accessed July 2008 at: http://www.fs.fed.us/r1/forest_range/timber_reports/forest_r1/r1_statistics/2007_statistics_rpt.rtf.

U.S. Department of Agriculture, Forest Service, Bitterroot National Forest. 2000. Bitterroot fires 2000: an overview of events, effects on people and resources and post-fire recovery priorities. Hamilton, MT

U.S. Department of Agriculture, Forest Planning, Socio-Economic Assessment. Accessed July 2008 at: http://fs.fed.us/rl/wmpz/documents/.../zone/docs/soc-econ-assess2.pdf.

U.S. Department of Agriculture, Natural Resources Information System. 2003. PRISM precipitation. Accessed July 2008 at:
http://nris.state.mt.us/gis/gisdatalib/downloads/precip_17010205.pdf.

U.S. Department of Agriculture, Natural Resources Information System. 2003. Slope classes from National Elevation Dataset (NED). Accessed July 2008 at:
http://nris.state.mt.us/gis/gisdatalib/downloads/slope_17010205.pdf.

U.S. Department of Agriculture, Natural Resource Conservation Service. 2004. MT621-Soil survey of Granite County Area, Montana, Part 1. Accessed July 2008 at: http://soildatamart.nrcs.usda.gov/Manuscripts/MT621/0/PartI.pdf.

U.S. Department of Agriculture, Natural Resource Conservation Service. Official soil series descriptions. Accessed July 2008 at: http://soils.usda.gov/technical/classification/osd/index.html.

U.S. Department of Agriculture, Natural Resource Conservation Service, SNOTEL website data for 1989-2007. Accessed July 2008 at: http://www.wcc.nrcs.usda.gov/snotel/Montana/montana.html.

U.S. Environmental Protection Agency. 2002. Level III and IV Ecoregions of Montana - draft second edition. Accessed November 2008 at:
http://www.epa.gov/wed/pages/ecoregions/mt_eco.htm.

U.S. Fish and Wildlife Service. 2002 Bull trout (*Salvelinus confluentus*) draft recovery plan. Region 1, US Fish and Wildlife Service. Portland.

U.S. Geological Survey. 2005. Gap Analysis Program.

U.S. Geological Survey. 1995. Major lithology. Accessed July 2008 at: http://www.icbemp.gov/spatial/expnm/bvblith.html.

U.S. Geological Survey. 1996. Montana real-time water data for Montana. Accessed July 2008 at: http://waterdata.usgs.gov/mt/nwis/rt.

U.S. Geological Survey. 2000. National Hydrography Dataset. U.S. Geological Survey in cooperation with U.S. Environmental Protection Agency and other state and local partners. Accessed 2008 at: http://nhd.usgs.gov/index.html.

U.S. Geological Survey. Montana Flood frequency and basin characteristic data through 1998. Accessed July 2008 at: http://mt.water.usgs.gov/freq?page_type=table.

Watershed Consulting. 2005. Bitterroot River FLIR temperature analysis interpretative report, for MT DEQ. Whitefish, MT

Western Regional Climate Center. Data for 1911-2007. Accessed July 2008 at: http://www.wrcc.dri.edu/summary/Climsmnidwmt.html.

Woods, Alan J., Omernik, James, M., Nesser, John A., Shelden, J., Comstock, J.A., Azevedo, Sandra H. 2002. Ecoregions of Montana, 2nd edition (color poster with map, descriptive text, summary tables, and photographs). Map scale 1:1,500,000. Available at: http://www.epa.gov/wed/pages/ecoregions/mt_eco.htm. Accessed January 2008 at: ftp://ftp.epa.gov/wed/ecoregions/mt/mt_eco_pg.pdf2.

Chapter 3 Characterization of Habitats

This chapter describes critical functions and processes of each of the following broad habitat units, with particular emphasis on how humans have altered them:

- Aquatic habitats
- Riparian and wetland habitats
- Grassland and shrub habitats
- Conifer forest (subalpine and alpine) habitats
- Agricultural and farmland

It also discusses the historical and current status of each to determine how well the subbasin is functioning with respect to fish and wildlife populations. Limiting factors and disturbances are described to assess how changes within the habitat units and their quantities and distributions have affected fish and wildlife populations. The chapter provides supporting information for Chapter 4, which describes the focal aquatic and target wildlife species in the subbasin and specific impacts and limiting factors for species conservation.

Figure 3.1 shows the existing conditions of the habitat unit groupings, based on Gap Analysis Program (GAP) data (USGS GAP Analysis Program 2005). Figure 3.2 shows similar habitat unit groupings based on vegetation mapping completed during the Forest Survey of 1932 to 1940, the earliest data set available for making historical comparisons (Losensky 1993). These data are limited to Ravalli County, so any numeric comparisons with GAP data in this section were made using only the GAP data for the Ravalli County portion of the subbasin. Comparisons of the two data sets are included in the discussion of each habitat unit.

Individual fish and wildlife species have evolved with and adapted to landscapes that remained relatively stable for thousands of years. But the subbasin has changed dramatically over the last 100 years, and these changes have impacted fish and wildlife species. Changes include, but are not limited to agricultural and residential development, fire suppression, and logging. Assessments of how habitat units have been altered, combined with the effects these alterations have had on individual species (discussed in Chapter 4) is the basis for determining future conservation needs (discussed in Chapter 5).

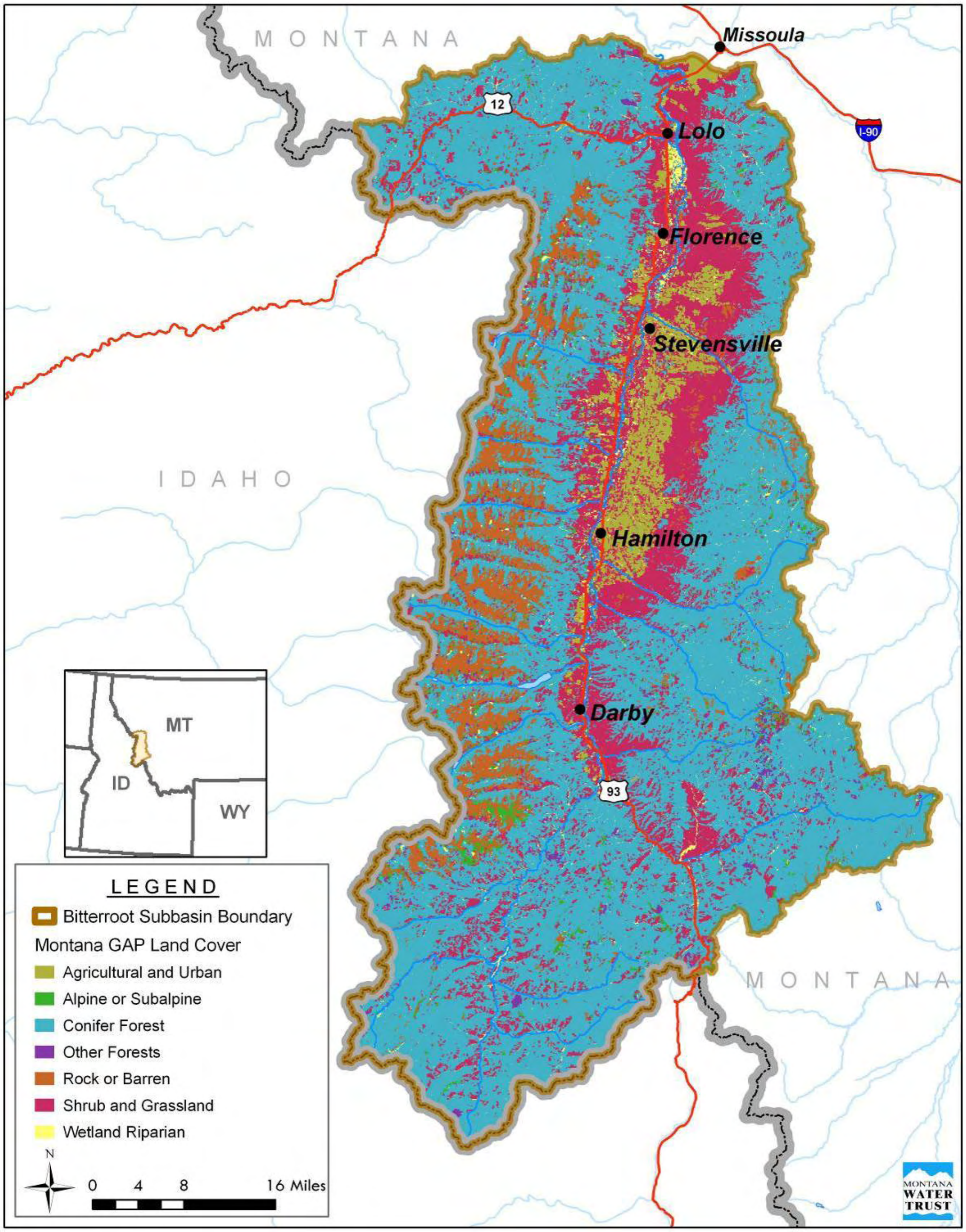


Figure 3.1. Current habitat unit distribution in the Bitterroot Subbasin based on GAP data.
Data Sources: USGS GAP Analysis Program (2005).

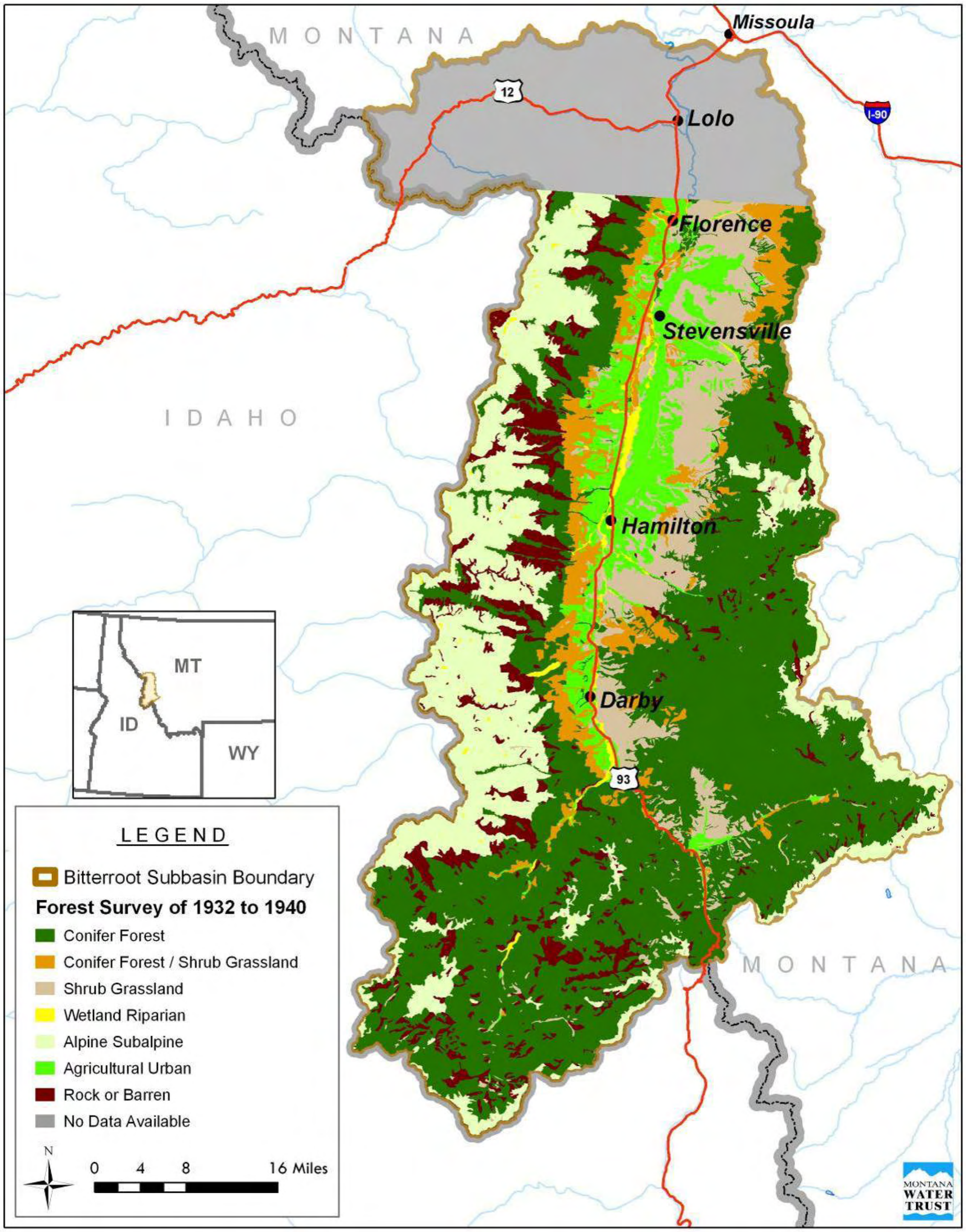


Figure 3.2. Historical habitat unit distribution in the Bitterroot Subbasin based on Forest Service data collected between 1932 and 1940.
Data Sources: Losensky (1993).

3.1 Aquatic Habitats

The aquatic habitats described in this section include the range of habitats described in Chapter 4 for aquatic species. In Chapter 4, aquatic habitats are described by 6th-field HUC and are related to the distribution of focal species. Sections 2.6, 2.9, and 2.10 in Chapter 2 describe existing conditions of rivers and streams in the Bitterroot Subbasin.

3.1.1 Critical Functions and Processes

Rivers and streams in their natural state are dynamic ecosystems that perform many beneficial functions and support an array of biological, physical, and chemical processes. Components of aquatic systems are interdependent and fundamentally linked to a diversity of habitats, plants, and animals in and around the stream.

Natural streams and their floodplains convey water and sediment, temporarily store excess flood water, filter and trap sediment and pollutants in overbank areas, recharge and discharge groundwater, naturally purify instream flows, and provide supportive habitat for diverse plant and animal species. Every stream is a dynamic hydrologic system that is continually altered by the changing character of the watershed. Streams naturally change course, overflow, erode their beds and banks, and deposit sediment. Some land uses, such as clearing riparian and wetland vegetation, can alter these processes and result in accelerated channel migration and unstable channel patterns or excessive erosion or sediment deposition.

Primary aquatic system functions and processes include:

- Channel hydraulics/flow regimes
- Sediment transport/dynamics
- Heat energy transfer
- Food web interactions
- Nutrient processing/uptake (nutrient spiraling)
- Production (primary or secondary)
- Large woody debris dynamics
- Organic matter exchange
- Habitat connectivity
- Water quality
- Hyporheic exchange

The functions and processes that form and maintain aquatic systems influence the structural (habitat) and biological (species) components of the system. They include:

- Stream habitat components (pools, riffles, runs, and glides) support different fish behaviors (e.g. resting, feeding, and spawning). The distribution of habitats vary based on longitudinal gradients and are tied to a variety of factors such as stream width, slope, and geology. Streams must have a variety of habitat types distributed along the length of the stream to provide good habitat for aquatic species.
- Channel configuration (straight, meandering), which influences the fish and other aquatic species and different life stages use of the stream.
- Riparian vegetation type and structure that provides shade, cover, food chain support, and instream structure in the form of large and coarse woody debris.

- Species composition (native trout, insects, and insect functional groups) is often determined by various combinations of the above habitat components.

3.1.2 Historical and Current Conditions

During presettlement times, aquatic and hydrologic processes and functions were likely intact in the Bitterroot Subbasin, and while headwater areas across portions of the subbasin remain relatively pristine (Selway-Bitterroot Wilderness), aquatic habitats in roaded areas have been impacted to varying degrees by the cumulative effects of agriculture, timber management, grazing, road building, dams, irrigation, and urban and suburban development. The magnitude and persistence of these impacts varies widely.

Prior to settlement, the Bitterroot River and its tributaries had relatively unaltered hydrologic regimes and supported a wide diversity of aquatic habitats. The natural hydrologic cycle in the subbasin includes a high-flow event during the spring melt and relatively constant, low flows throughout the remainder of the year. The presence of water throughout most or all of the summer season is the most important factor for aquatic and terrestrial species dependent on aquatic ecosystems.

Historically, waters of streams and rivers were cold and clean, and stream substrates consisted of clean, permeable gravels, cobbles, boulders, and sand. Aquatic habitats were distributed according to natural variability within watersheds created by geology, aspect, slope, and size, as well as disturbance regimes such as landslides, forest fires, floods, etc. Non-native species were absent.

Aquatic habitats and the species of wildlife, fish, and invertebrates dependent on them would have varied based on the type of channel and dominant formation processes. For example, habitat complexity in headwater streams would have been strongly associated with large woody debris and large-sized substrates. These habitats would have been used by native trout and sculpin species and by aquatic insects adapted to high gradient, fast moving streams, and coarse-woody-debris food sources.

Habitat complexity in the valley portions of tributary streams would have been more influenced by riparian vegetation and channel slope and pattern. These habitats would have been used by native trout and minnow species and to some extent mountain whitefish. Insect populations would have been adapted to slower moving waters with a wide range of substrates and smaller organic matter food sources.

Habitat in the mainstem Bitterroot River would have been highly variable with deep pools, woody-debris complexes, and numerous sloughs, backwaters, and side channels connected to the river during portions of the year. Riparian vegetation in the floodplain would have reflected the shifting diversity of geomorphic features within a large, dynamic river system. Riparian vegetation would have also played a large role in habitat formation within and along the Bitterroot River. Pulses of sediment associated with natural disturbances would have occurred, but the magnitude and frequency would have been within a natural range of variability. These habitats would have been used by a variety of aquatic and terrestrial species, including large migratory native trout, mountain whitefish, and suckers.

Beavers would have played an integral role in valley bottom and mainstem river habitats (Kudray and Schemm 2008). Beaver altered aquatic environments by building dams on river and stream channels, creating ponds with unique aquatic environments. These areas often support a diverse community of companion species, including insects, fish, waterfowl, heron, mink, muskrat, otter, and many types of aquatic vegetation (CSKT and MFWP 2004). Beaver activity influences water and materials transported downstream, increases retention of sediment and organic matter, modifies nutrient cycling and decomposition, channel geomorphology and hydrology, and aquatic habitat conditions (Naiman et al. 1986 as reported in Kudray and Schemm 2008).

Currently, aquatic habitats maintain approximately the same distribution as they did during pre-settlement times; however, portions of existing habitats have been significantly altered.
Table 3.1 lists aquatic habitat types present in the subbasin. They are based on the Montana Comprehensive Fish and Wildlife Conservation Strategy (MFWP 2005), which ranks the Bitterroot Subbasin as a Tier 1 (highest priority) Aquatic Conservation Focus Area. According to this strategy, streams and rivers can be divided into the following general categories: mountain headwater streams, mountain reservoirs and lakes, intermountain valley streams, intermountain valley rivers (MFWP 2005). Figure 3.3 shows the main streams and rivers within the subbasin. Most tributary streams consist of both mountain headwater and intermountain valley habitat components. In addition, many tributary streams on the west side of the valley support natural or impounded high-elevation lakes or reservoirs.

Table 3.1. Aquatic habitat types associated with the Bitterroot River Focus Area.

Habitat Type	Habitat Tier[1]	Acres	Miles
Intermountain Valley Rivers	II	N/A	84
Intermountain Valley Streams	II	N/A	325
Lowland lakes	III	1,260	N/A
Mountain Lakes	III	2,946	N/A
Mountain Reservoirs	III	27	N/A
Mountain streams	I	N/A	3,304

[1]Tier I =greatest need, Tier II=moderate need, Tier III=lower need.
N/A = Not Applicable.
From: MWFP (2005).

The Bitterroot River itself is a dynamic alluvial river supporting a very large floodplain (as wide as one mile in some places, see Figure 2.13 in Chapter 2). Boyd and Thatcher (2008) documented lateral bend migration distances of up to 1,500 feet since 1995 that resulted from high bedload transport conditions. These events are beneficial for the recruitment of large woody debris to the active channel, the creation of complex fish habitat and cover, and the regeneration of woody riparian plant communities such as cottonwood and willow (Boyd and Thatcher 2008). Included in the mainstem Bitterroot floodplain ecosystem is a hierarchy of channel types that include the primary active channel, secondary overflow channels, and intricate capillary floodplain channels that are supported by a shallow groundwater table (Boyd and Thatcher 2008). The Bitterroot River floodplain and riparian corridor provide some of the most productive wildlife and aquatic species habitat in the subbasin.

The Bitterroot River and its tributaries have been altered by a variety of land uses and other disturbances over the last 100 years. These impacts have resulted in degraded habitats and a reduced distribution of native aquatic species.

3.1.3 Limiting Factors and Disturbances

The primary disturbance factors affecting aquatic habitats in the Bitterroot Subbasin include:

- Sedimentation from a variety of land uses and roads
- Water diversion and irrigation impoundments
- Stream infrastructure (bridges, culverts, riprap, barbs, dikes and diversion structures)
- Agricultural practices and grazing
- Residential development and floodplain encroachment
- Non-native species introduction

While one of the main impacts has been an increase in the amount of fine sediments entering streams, other disturbances have also taken a toll. For example, in addition to adding fine sediments to streams, past forestry practices have increased peak flows, caused hydrograph and thermal modifications, and contributed to the loss of instream woody debris and channel stability. A variety of other land uses, ranging from agriculture to road infrastructure to urban development, have contributed to extensive lengths of bank erosion along the mainstem Bitterroot River. Boyd and Thatcher mapped bank erosion on the river between Darby and Florence, Montana in 2002 (Boyd and Thatcher 2008). Table 3.2 shows the results of their work.

Table 3.2. Length of eroding bank by severity for the mainstem Bitterroot River between Darby and Florence, Montana.

Mapped Erosion Severity	Length Eroding Bank (feet)	Length Eroding Bank (miles)	Percent of Total Bank Length
Mild	110,425	20.9	17
Moderate	90,909	17.2	14
Severe	32,052	6.1	5
Total	**233,386**	44.2	36

From: Boyd and Thacher (2008).

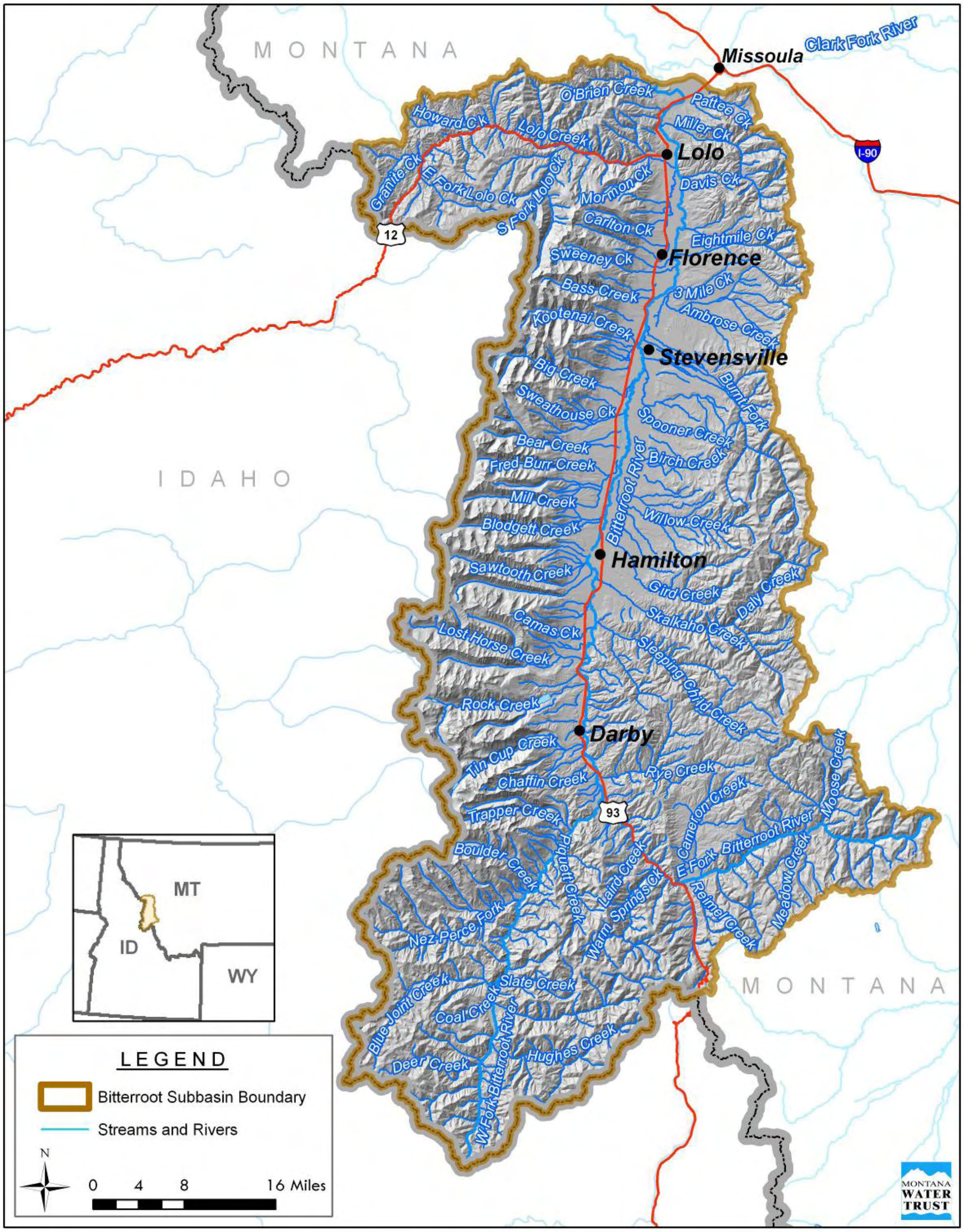


Figure 3.3. Primary streams and rivers representing the range of aquatic habitats in the Bitterroot River Subbasin. *Data Sources: USGS (2002) National Hydrography Dataset and USGS National Elevation Dataset.*

The Bitterroot Subbasin has an extensive irrigation network with several large volume reservoirs. This system has locally altered the timing and distribution of channel flow in the valley. Impacts include: loss of fish into irrigation ditches; late season dewatering of tributary streams, causing fish mortality and interruption of fish passage; increased water temperatures from irrigation return flows; and a general decrease in water availability to support the aquatic ecosystem. Except for some westside streams, subbasin tributary streams are mostly dry in May and June in their lower courses because of diversions for irrigation and rapid seepage into the unconsolidated terrace alluvium (McMurtrey et al. 1972). A study completed in 2002 reported a total of 17 diversion structures on the mainstem Bitterroot River between Darby and Florence (Boyd and Thatcher 2008). The diversion structures include boulder and concrete sills, gravel berms, and rock weirs. These structures served a variety of ditches, with one of the largest diversions located immediately below the confluence with Sleeping Child Creek at river mile 65.5 (from the confluence with the Clark Fork River). This diversion, which serves the Republican Ditch, consists of about a 12-foot drop constructed from large concrete and boulders. Other major diversion structures identified as part of this study served the Hedge Ditch at river mile 69.5 and the Woodside Ditch at river mile 55.8 immediately downstream of the former Silver Bridge in Hamilton (Boyd and Thatcher 2008).

The stream channel network has also been altered by culvert and bridge crossings and by extensive channelization on tributaries (such as the lower reaches of Lolo Creek) and along the main channel (such as much of East Fork Bitterroot River). A study completed in 2008 evaluated the effects of bridges on Bitterroot River geomorphology. It concluded that while roadway encroachments and bridge spans locally impact channel alignment and pattern, they do not appear to control or trigger reach-scale change in channel pattern (Boyd and Thatcher 2008). The study states that systemically, channel pattern appears to recover after a short distance (1,000 to 3,000 feet) below bridge spans (Boyd and Thatcher 2008).

Stream channels, both tributaries and the mainstem Bitterroot River, have been lined with rip-rap along extensive reaches. For example, between 1990 and 2002, permits were issued by the Army Corps of Engineers to allow 62 bank-stabilization structures on 18,298 linear feet of bank stabilization on the mainstem of the Bitterroot River (Ellis 2005). These projects generally included the following types of structures: riprap (approximately 8,759 feet), barbs (15), vanes (approximately 12), weirs (approximately 2), dikes (1,300 feet), rootwads (approximately 178), and revetments (1,500 feet) (Ellis 2005). A study completed in 1999 for the portion of the Bitterroot River within Missoula County, including Lolo Creek, identified 28 bank-stabilization projects totaling 4.8 miles. This study estimated that 12 percent of this section of the river had bank-stabilization structures present (Brandt and Ringleberg 1999). A study completed in 2002 for the portion of the Bitterroot River in Ravalli County also reported 12 percent of the bank was armored by some form of bank protection, the majority (78 percent) consisting of full bank riprap (Boyd and Thatcher 2008).

Agriculture can result in concentrations of nutrients and sediments being delivered either directly or indirectly to streams during precipitation events. Riparian grazing and pasture management has reduced riparian vegetation and its beneficial effects on streams. Ehrhart and Hansen (1998) suggest this loss of riparian vegetation has resulted in erosion and increased sedimentation in streams. Loss of riparian vegetation can also result in increase water temperatures that can adversely affect aquatic habitats.

The Bitterroot Valley is experiencing rapid growth in residential development. Development that occurs along streams has the potential to negatively impact fish and aquatic habitat (Ellis 2008). Preserving buffers along streams is a high priority to maintain these habitats. In addition to degrading fish and aquatic habitat, development near streams often results in a reduction in the area of the floodplain, further limiting the stream system's potential to sustain its functions and increasing risks to public health and safety. For example, in the Bitterroot Valley, increased development along Mill Creek has resulted in increased maintenance costs to members of that irrigation district due to greatly increased downstream risks if wilderness dams were to fail (Parker pers. comm. 2008).

Perhaps the most significant single impact on aquatic habitats has been the introduction of non-native species. Non-native aquatic species now threaten the diversity and abundance of native species and the ecological stability of ecosystems in many areas of the subbasin.

3.2 Riparian and Wetland Habitats

The riparian and wetland habitats described in this section include the Riparian and Wetland Conservation Focus Habitats described in Chapter 4. In Chapter 4, riparian and wetland habitats are related to the distribution of conservation aquatic species.

3.2.1 Critical Functions and Processes

While riparian and wetland areas are considered separately from aquatic habitats in this section, they are functionally tied to aquatic habitats in several ways (Ellis 2008 and Naiman et al. 2005). Vegetation adjacent to wetlands and streams provides a buffer, effectively filtering sediments and nutrients originating from nearby human activities. Aquatic habitat is formed to some degree by large woody debris as trees fall into a stream channel forming pools and other complex instream habitat features. Aquatic food webs are supported in part by leaves, twigs and other organic plant material that originate from riparian plant communities. Overhead canopies of trees and shrubs provide shade, contributing to cooler water temperatures during the summer. The deep, binding root masses of woody plants stabilize streambanks, influencing stream channel shape and creating overhanging banks that provide habitat for fish and other aquatic species.

The following list of riparian and wetland functions (Adamus et al. 1991 and MNHP 2003) represents the most common categories used as part of many formal riparian and wetland functional assessment schemes. These are presented here because they are important to consider as part of a conservation planning framework:

- Water storage and peak flow moderation
- Streamflow maintenance
- Groundwater recharge
- Nutrient cycling
- Sediment retention
- Bank and shoreline stabilization
- Terrestrial habitat support
- Aquatic habitat support
- Biodiversity support and maintenance

3.2.2 Historical and Current Distribution

The following section describes the general distribution of wetlands mapped by the United States Fish and Wildlife Service National Wetlands Inventory (USFWS NWI) (2007) and the United State Forest Service (USFS) (2001). Wetland descriptions are based on systems and classes defined by the USFWS (Cowardin 1979). Table 3.3 summarizes wetlands systems and classes currently and historically found in the Bitterroot Subbasin, including the current acreage of each wetland system and class. Descriptions of these systems and classes are included in Appendix 1. Table 3.4 lists the most common riparian and wetland plant associations for palustrine wetland systems in the Bitterroot Subbasin. Descriptions of the plant communities are also included in Appendix 1, following Hansen et al. (1995) and Montana Natural Heritage Program (2003).

The NWI and USFS wetlands data do not cover the entire Bitterroot Subbasin, and there is some overlap of data between the two data sets in portions of the subbasin (Figure 3.4). The NWI mapping is more recent than the USFS mapping and it includes more wetland classes than the USFS mapping (for example, palustrine aquatic bed, unconsolidated bottom, and unconsolidated shore classes). Both datasets mapped riverine wetlands, but the USFS mapping included many smaller tributary streams that were not included in the NWI mapping.Table 3.3 reports wetland and riparian acres by wetland class and riparian area for each mapping system.

Table 3.3. Acres of wetland mapped in the Bitterroot Subbasin by the National Wetlands Inventory and U.S. Forest Service.

Wetland Class or Riparian	NWI Acres	USFS Acres
Palustrine Forested Wetland (PFO)	15	8,097
Palustrine Scrub Shrub (PSS)	1,838	3,582
Palustrine Emergent (PEM)	3,953	6,000
Palustrine Aquatic Bed (PAB)	1,331	--
Palustrine Unconsolidated Bottom (PUB)	154	--
Palustrine Unconsolidated Shore (PUS)	3	--
Riverine	5,469	20,429
Lacustrine	2,120	701
Riparian – Non-wetland	22,275	17,248
Total	37,159	56,057

-- = No Data.
From: USFWS (2007) and USFS (2001).

Table 3.4. Common plant community associations in palustrine wetlands in the Bitterroot Subbasin.

Palustrine Wetland Class	Common Plant Association [1]	Predominant Location in Subbasin
Palustrine Forested Wetland (PFO)	Black cottonwood/ red-osier dogwood community type Ponderosa pine/ red-osier dogwood habitat type Douglas-fir/ red-osier dogwood habitat type Quaking aspen/ red-osier dogwood habitat type	Occurs primarily in the Bitterroot River floodplain (cottonwood and aspen stands) and within riparian areas along tributary streams to the Bitterroot River (cottonwood, aspen and Douglas-fir stands).
Palustrine Scrub Shrub (PSS)	Bebb willow community type Sandbar willow community type Woods' rose community type	Occurs primarily in the Bitterroot River floodplain (point bars and other recent deposition areas – sandbar willow or backwater), along irrigation and road-side ditches, along tributary streams, and on some slopes on the west side of the valley.
Palustrine Emergent (PEM)	Beaked sedge habitat type Common cattail habitat type Reed canarygrass habitat type	Occurs primarily near open water areas including large floodplain wetland complexes such as Lee Metcalf National Wildlife Refuge. Also occurs in road side ditches.

[1]Habitat and community types are from Hansen et al. (1995).

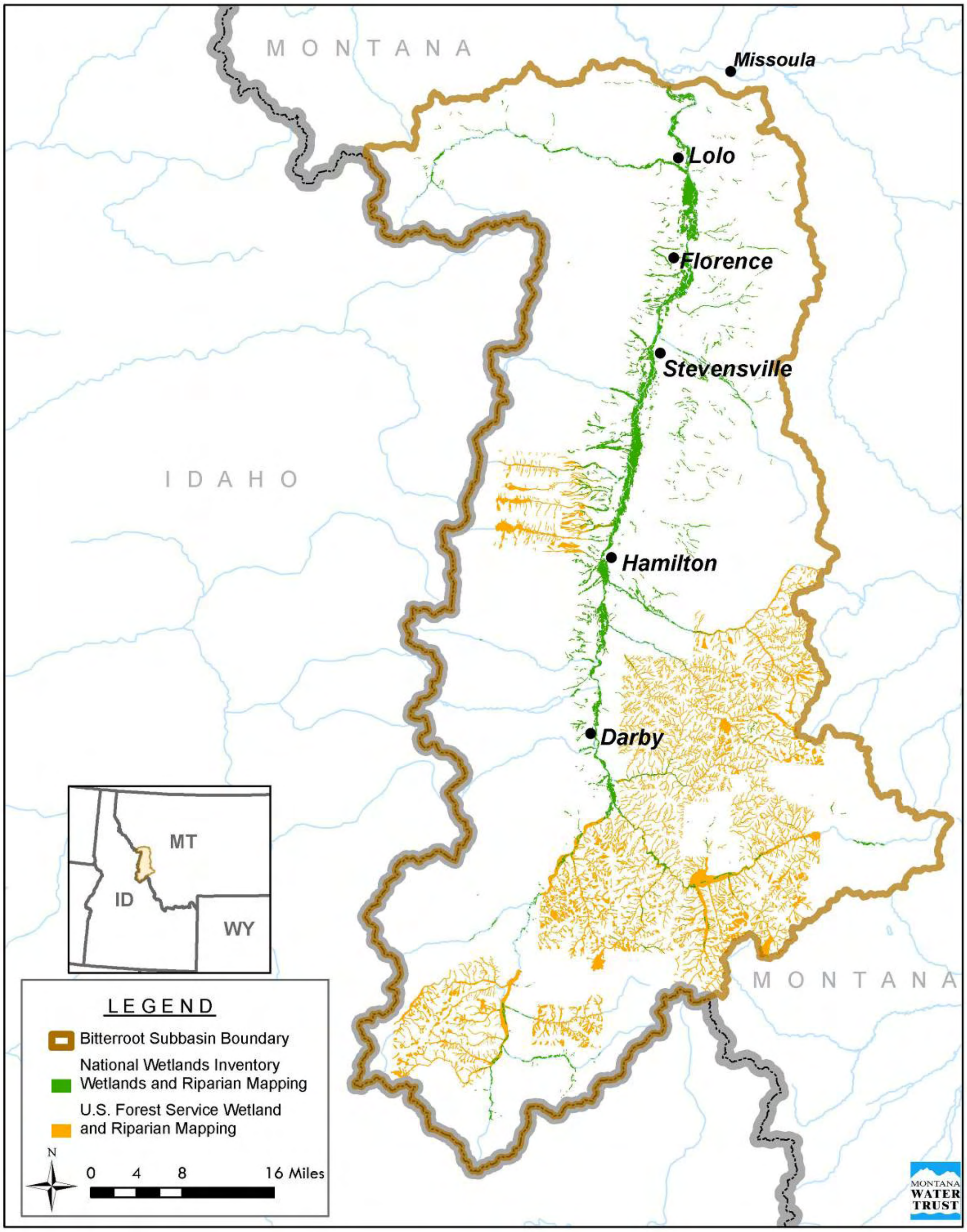


Figure 3.4. Current U.S. Forest Service wetland mapping and Montana Natural Heritage Program's National Wetland Inventory mapping.
Data Sources: USFS (2001) and USFWS (2007).

Four different data sources quantify wetland and riparian acreage in the Bitterroot Subbasin: (1) historical USFS vegetation mapping based on data collected between 1932 and 1940 (Losensky 1993); (2) current USFS wetlands (USFS 2001); (3) current GAP (USGS GAP Analysis Program 2005) data; and (4) National Wetland Inventory mapping completed by the Montana Natural Heritage Program in 2007 (USFWS 2007). These data cannot be compared because data were collected for different reasons, within different geographic areas, at different resolutions, using different protocols. Still, wetland and riparian acres mapped under each system are reported here because the information may be useful when considered in the context of figures that show the mapped areas. Figure 3.2 shows historical USFS wetlands (14,720 acres); Figure 3.4 shows current USFS wetlands (56,057 acres) and NWI wetlands (37,159 acres); and Figure 3.1 shows GAP wetlands and riparian areas (23,424 acres). However, more important than overall wetland and riparian acres is how wetland types are distributed across the landscape.

The following discussion of wetland type distribution in the Bitterroot Subbasin is summarized from the *Ravalli County Pilot Wetland Mapping Project* Report (Geum Environmental Consulting 2005). Palustrine forested (PFO) wetlands occur primarily in the Bitterroot River floodplain and along tributary streams. Along the Bitterroot River, PFO wetlands tend to be dominated by cottonwood, aspen, and sometimes conifers such as ponderosa pine or Douglas fir. Along the Bitterroot River and some larger tributaries, PFO wetlands are typically located on the inside of meander bends, mid-channel bars, along braided channel reaches, or along backwater or side channels. Tributary streams also have cottonwood and aspen dominated plant communities, but conifer species may be more common. Palustrine forested wetlands along tributary streams typically occur in a narrow band along portions of the channel that tends to be wider on the west side of the subbasin than on the east side. East side tributaries have fewer forested wetlands, with mostly palustrine scrub shrub or palustrine emergent wetlands occurring along the channel and within adjacent non-wetland forested communities. The understory of forested wetlands generally includes shrubs such as alder (*Alnus incana*) or red-osier dogwood (*Cornus sericea*) with wetland grasses, forbs, sedges, and/or rushes.

Palustrine scrub-shrub (PSS) wetlands occur primarily in the Bitterroot River floodplain, along irrigation and road-side ditches, along tributary streams, and on some slopes on the west side of the valley. Along the Bitterroot River, PSS wetlands appear to be primarily located on point bars and other recent-deposition areas directly along the river (sandbar willow, *Salix exigua*), or along side channels, off-channel open water ponds or abandoned oxbows (mixed willow species). Along irrigation ditches, PSS wetlands occur either within a narrow band directly along the ditch (sandbar willow) or in larger complexes downslope of the ditch (mixed willows, alder, and birch (*Betula* spp.). Palustrine scrub-shrub wetlands occur to a lesser extent on slopes outside of forested areas on the west side of the valley. Aerial photo observations of wetland patterns (generally near and extending towards streams) and shape (small irregular strips) indicate that larger shrub complexes may have existed in the past, extending out from tributary streams. Palustrine scrub-shrub wetlands also occur within roadside ditches.

Palustrine emergent (PEM) wetlands occur primarily along oxbows and open-water areas within the Bitterroot River floodplain, as fringe wetlands adjacent to created ponds and beaver ponds, within irrigated agricultural fields, along irrigation and roadside ditches, and to a lesser extent, along tributary streams. These wetlands are dominated by cattails (*Typha latifolia*), or a fringe of sedges (*Carex* spp.), rushes (*Juncus* spp.), bulrushes (*Scirpus* spp.), reed canarygrass (*Phalaris arundinacea*) and submerged vegetation along open water. PEM wetlands dominated by reed canarygrass are common along the

Bitterroot River. Along tributary streams they typically occur where riparian vegetation has been cleared or in small pockets along upper reaches and usually consist of diverse sedge, rush, and forb communities. In upper tributary reaches, PEM wetlands along the channel can be much wider than the shrub or forested areas up or downstream. The locations of these wetlands typically correspond with a slope break and decreased channel gradient. Similar to other palustrine wetland types, PEM wetlands are present as a narrow fringe along tributary streams on the east side. They are more variable in their size along tributary streams on the west side of the subbasin. Outside of the Bitterroot River floodplain, PEM wetlands consisting of cattails, reed canarygrass or sedges are also common at the margins of excavated ponds. Cattail-dominated PEM wetlands are common in roadside ditches.

A recent study, *Wetlands of the Bitterroot Valley: Change and Ecological Functions*, was completed by the Montana Natural Heritage Program (MNHP) (Kudray and Schemm 2008). The study evaluated wetland diversity and analyzed wetland change in the Bitterroot Subbasin, using 2005 aerial photo imagery to map wetlands and riparian areas. The following list highlights the study's main conclusions:

- Wetlands and associated wetland functions in the Bitterroot Subbasin are concentrated in the valley bottom and along riparian areas.
- No net estimated change in total wetland acreage was found since 1980s NWI mapping.
- An 80 percent decrease in beaver ponds between 1980 and 2005 has occurred.
- Nine-hundred-twenty-one new wetlands were mapped since the early 1980s, virtually all were small ponds with standing water constructed for recreation or irrigation. This represents a 75 percent increase in human-created palustrine wetland acreage between mapping dates.
- Wetlands and deepwater types compose 1.1 percent of the total study area (16,304 acres).
- Eleven percent (1,806 acres) of identified wetlands were determined to be isolated.
- Flooded shores and rivers were the most common mapped wetland type (34 percent).
- Palustrine emergent wetlands accounted for 26 percent of wetlands, deepwater habitats 13 percent, and shrub 12 percent.
- Palustrine forested wetlands were very uncommon (15.1 total acres mapped).
- Slope wetlands were also uncommon (38 total acres mapped).
- Lower-elevation wetlands exhibited more degraded wetland functions compared to that of higher-elevation wetlands.
- Higher-elevation wetlands are more ecologically intact. They are often peatlands with saturated water regimes that may provide habitat for Montana plant species of concern and northern bog lemming (*Synaptomys borealis*).

3.2.3 Limiting Factors and Disturbances

Over the past 100 years in unprotected parts of the subbasin, humans have reduced beaver populations; logged, cleared, and grazed riparian zones; filled wetlands; built dams; and initiated erosion control efforts, irrigation withdrawals, and road building. This has caused the loss of structural elements of all wetland types, impaired floodplain processes, and reduced vegetative diversity. It has eliminated thermal cover from some wetland and riparian areas, reduced streambank stability, and reduced vegetative cover and vigor. The result is wider and more open stream channels with lower, warmer, more turbid flows during runoff. This in turn has adversely affected fish and wildlife populations.

The most significant disturbances and limiting factors affecting the restoration and conservation of riparian and wetland systems in the subbasin include:

- Residential development and associated infrastructure, resulting in clearing of riparian areas and filling of non-regulated wetlands.
- Conversion of agricultural lands to subdivided residential lands. This conversion results in changes in the timing and spatial distribution of irrigation water. Because some wetlands are created by irrigation ditches, elimination of some irrigation ditches will result in loss of associated wetlands.
- Loss of federal regulatory protection for some wetlands under the Clean Water Act. Due to recent court decisions, some isolated wetlands are no longer under federal jurisdiction. Because there are no State or local regulations protecting these wetlands, the only existing protection for some wetlands is case-by-case no build/alteration zones instituted during the County subdivision review process;
- The spread of invasive species, particularly reed canarygrass.
- Wetland type conversion, particularly the conversion of shrub and emergent wetlands to open water ponds
- Streambank stabilization using rip-rap or other hard materials that directly impacts unconsolidated shore wetlands and may reduce adjacent riparian wetlands extent and function. Section 3.1.3 above noted Army Corps of Engineers permitted 18,900 linear feet of bank stabilization projects in Ravalli County between 1990 and 2002 (Ellis 2005).

3.3 Grassland and Shrub Habitats

The habitats described in this section include the Grassland and Sagebrush Conservation Focus Habitat described in Chapter 4. In Chapter 4, grassland and sagebrush habitats are related to the distribution of conservation species.

3.3.1 Critical Functions and Processes

Grassland ecosystems in the Bitterroot Subbasin are an eastern extension of the Palouse prairie intermountain bunchgrass vegetation type abundant in southwest Canada and eastern Washington and Oregon (Barbour and Billings 1988). These grasslands are usually characterized by the dominant perennial bunchgrasses *Festuca scabrella* (rough fescue) and *Pseudoregnaria spicatum* (bluebunch wheatgrass—formerly *Agropyron spicatum*), although numerous other grass and forb species comprise this diverse ecosystem. Upland shrub ecosystems in the subbasin include dry terraces, located throughout the subbasin, that are dominated by *Artemisia tridentata* (big sagebrush) and steeper foothill slopes on the east side of the southern Bitterroot valley where *Purshia tridentata* (bitterbrush) forms open stands. These shrub habitats provide a number of critical functions, including serving as important corridors between native grasslands and riparian and forested habitats. Grasslands provide a rich nutrient base where the natural digestive recycling of consumed grasses facilitates the transfer of carbon, nitrogen, and phosphorous back into the soil where it can be reabsorbed in a mineral state (Connor et al. 2001). The introduction and spread of noxious and invasive weeds results in the deterioration of native species composition, leaving unpalatable invasive species as the dominant ground cover. With less palatable forage, natural nutrient transfer becomes compromised, resulting in soils that can no longer support healthy native vegetation.

The ability of natural grasslands to capture precipitation and prevent runoff serves the dual purpose of replenishing natural ground-water sources and mediating soil erosion. As grasslands are converted to grazing lands or invaded by exotic species, their role in the hydrological cycle diminishes. Groundcover decreases, less water is retained, and soil erosion increases significantly. Erosion and soil loss have been shown to increase by up to 60 times over that of natural cover in areas that have been converted to agriculture or experienced significant exotic invasion (Conner et al. 2001 and Krishna et al. 1988). This increased erosion simultaneously affects water quality because heavy sediments are introduced to local waterways in much greater volume (Welch et al. 1991).

Native grasslands are important habitat for a number of small rodents and ground-nesting birds. They also provide vital forage for virtually all of western Montana's big game. Elk, mule deer, white-tail deer, and moose all rely on grasslands as a year-round food source. Similarly, large predators such as black and grizzly bears, bobcats, mountain lions, wolves, and coyotes frequent these areas to search for prey. In the case of bears, grasslands border forested and shrub lands that often contain numerous fruit-bearing species such as hawthorn (*Crataegus douglasii*), currant (*Ribes* spp.), huckleberry (*Vaccinium* spp.), and others that make up a significant percentage of their diet. While riparian and forested ecosystems garner more attention when it comes to habitat preservation, grasslands act as important corridors for species travelling between riparian and forested zones. The fragmentation of these corridors due to agricultural and grazing-land conversion severely alters or limits the natural land-use patterns of these species.

3.3.2 Historical and Current Distribution

When the Lewis and Clark party first saw the Bitterroot Subbasin in the fall of 1805, they noted the undulating prairies that extended from the east bank of the Bitterroot River up to the foothills of the rolling Sapphire Mountains. The prairies had little timber but were thickly covered in grasses and wild "hysop" (the Biblical term the American explorers used for sagebrush) along with some prickly pear cactus (Flores 2001). John Mullan of the Isaac Stevens Pacific Railroad Survey (1853-1854) also noted the large area of grassland in the Bitterroot Subbasin that was grazed by cattle and horses. The large areas of grasslands were influenced by cultural burning practices of the local Salish peoples, who regularly burned the lower elevations to create as much savanna as possible for their horse herds and the buffalo that spilled out across the Divide. The grasses noted in these historical accounts were likely bunchgrasses: Idaho fescue, rough fescue, oatgrass, Sandburg bluegrass, needle-and-thread, and bluebunch wheatgrass (Flores 2001).

The first quantitative reporting of grassland and shrub habitats in the subbasin is from vegetation mapping by the USFS done in the 1930s (Losensky 1993). It shows approximately 241 square miles of shrub and grasslands. Current GAP data show nearly double that area—478 square miles. The difference between the two surveys is probably not caused by an increase in shrub and grasslands since the 1930s. Rather it is more likely the result of different mapping methods and purposes. The USFS survey reported nearly double the acreage of agricultural lands reported by the current GAP data, which could account for some of the difference. The Forest Service survey also contained some map units without a vegetation type description. These map units occur near the valley floor at the grassland and forest interface (Figure 3.2). Some of this land may have been interpreted as grassland in the more recent GAP survey, and this may account for the apparent increase in shrub and grassland area.

Subbasin intermountain valley floors are mostly flat, and originate from old lake bottoms. They are sometimes gently rolling from wind-blown deposits. The line between open grasslands and coniferous forests in most places is regular and distinct. On the west side of the valley, the thin lower border of coniferous forest closely follows the lowest part of the slopes. On the east side, the outlying foothills are bare of forest up to a distance of 500 and sometimes 1,000 feet above the valley floor. At the mouths of the lateral canyons on the east side, the line between grasslands and forests is abrupt, with forests on north aspects and prairie on those facing west. The smaller amount of forests on the east side of the Bitterroot Valley is partially the result of the east side having less annual rainfall than the west side as described in Chapter 2. Lack of drainage, alkalinity, and recurring fires also locally influence the distribution of grasslands and forested communities (Larsen 1930).

Mueggler and Stewart (1980) provide a comprehensive classification of undisturbed grassland habitat types found in the subbasin. They note that as a result of grazing, similar grassland habitat types may exhibit a wide range of variability. Despite that, the classification serves as a useful reference for identifying the dominant grassland habitat types in the subbasin. The regional distribution and relative abundance of these habitat types is discussed here, while recent changes and resulting ecosystem disturbances are described in the following section.

Mueggler and Stewart's classification employs a dominant-species-naming approach. Plant communities are identified by the two species that account for the majority of the aerial cover. Other species are present in these areas but are not included in the habitat type name. Grassland habitat types present in the subbasin are generally categorized as occurring either frequently or infrequently. Habitats types are listed below and described in more detail in Appendix 1.

Frequently occurring grassland habitat types include:

- *Festuca idahoensis/Agropyron spicatum* (Idaho fescue/Bluebunch wheatgrass)
- *Purshia tridentata/Agropyron spicatum* (Bitterbrush/Bluebunch wheatgrass)
- *Artemesia tridentata/Festuca scabrella* (Big sagebrush/Rough fescue)
- *Artemesia tridentata/Festuca idahoensis* (Big sagebrush/Idaho fescue)
- *Artemesia tridentata/Agropyron spicatum* (Big sagebrush/Bluebunch wheatgrass)
- *Festuca scabrella/Festuca idahoensis* (Rough fescue/Idaho fescue)

Infrequently occurring grassland habitat types include:

- *Artemesia arbuscula/Festuca idahoensis* (Little sagebrush/Idaho fescue)
- *Festuca idahoensis/Deschampsia caespitosa* (Idaho fescue/Tufted Hair grass)
- *Festuca idahoensis/Stipa richardsonii* (Idaho fescue/Stiff needlegrass)
- *Festuca idahoensis/Carex filifolia* (Idaho fescue/Threadleaf sedge)

These habitat types occupy a broad range of elevations, soil types, and precipitation levels. The fescues and other grass species are desirable species that provide the primary forage for both native game and livestock. Sagebrush co-dominance in these areas is common. Overgrazing of sagebrush areas decreases grass and forb health and may result in an increase in sagebrush cover, which may reduce the value of these areas for native wildlife.

In most instances, the bunch grasses and forbs interspersed with the dominant species play an integral role in providing forage, reducing the competitiveness of exotic invaders, and preserving overall cover viability. The diversity and complexity of these grassland ecosystems are important considerations when discussing the implications of widespread ecosystem disturbance and conservation priorities.

3.3.3 Limiting Factors and Disturbances

Native grass and shrublands in the Bitterroot Subbasin are increasingly threatened. Many pasture sites have been overgrazed, and large areas have been converted to cropland or other uses. Soil crusts have been disturbed, which has adversely affected the rate of nitrogen fixation, soil stability, fertility, structures, and water infiltration. Native plant species have been significantly reduced, as has the value of grasslands to native wildlife.

The widespread loss of native grasslands in the Bitterroot Subbasin can be attributed to the following changes: residential construction, conversion to cropland and grazing land, wildfire exclusion, and introduction of weeds and other invasive plant species.

These disturbances impact the critical functions discussed earlier. Nutrient cycling is diminished in areas converted to agricultural use (Conner et al. 2001). Water quality is compromised through increased runoff and the introduction of heavy sediments to waterways (Welch et al. 1991). Important primary habitat and wildlife corridors are lost due to increased fragmentation.

Ravalli County, encompassing the vast majority of the Bitterroot Subbasin, has experienced rapid development over the past thirty years (see section 2.10.1). Corresponding commercial and residential construction has resulted in the irretrievable loss of some native grasslands. Conversion of grasslands to agricultural uses or livestock pasture results in conversion from diverse, native species composition to a simpler array of non-native species, reducing grassland function. Native grasslands are an integral part of the ecosystem on a year-round basis, providing habitat and forage for a number of species. When converted to crops or grazing land, their utility is limited to seasonal applications or infrequently used wildlife corridors (CSKT and MFWP 2004).

Preservation of property and concerns over human safety have led to an aggressive policy of wildfire exclusion. Over the past one hundred years fires have been mostly excluded, leading to invasions of grasslands by fire-intolerant tree species and non-native forb and grass species (Arno 1980).

During pre-settlement times, natural and cultural fire frequencies cleared organic debris, encouraged perennial grasses, and played key thermal and nutrient cycling roles. In drier environments, dead organic materials cannot rely on decomposition alone to release their nutrient potential back into the soil. In these areas, fires are often the primary mechanism for nutrient cycling. Compounding this problem is the fact that, as fires are excluded, debris clutter in both grasslands and forested areas make future fires significantly more volatile (Arno 1980).

Climate change appears to be influencing native grass and shrublands in the western United States. Climate change impacts to these habitats include: less winter snowfall, earlier snowmelt, larger and more frequent wildfires (Saunders et al. 2008).

3.4 Coniferous Habitats

The habitats described in this section include the Dry Forest and Mesic Forest Conservation Focus Habitat described in Chapter 4. In Chapter 4, forest habitats are related to distribution of terrestrial conservation species.

3.4.1 Critical Functions and Processes

Critical functions and processes of coniferous forests include:

- Wildlife habitat and connectivity
- Fire regime
- Water storage
- Nutrient cycling
- Insects and disease
- Carbon sequestration

In the Bitterroot Subbasin many wildlife species use coniferous habitat for food and shelter year-round. The continuum of forested habitat types throughout the mountainous elevations provides cover for a variety of wildlife species, enabling them to move between habitats more safely. Low-elevation ponderosa pine forests connecting with riparian habitat types on the valley floor provide habitat connectivity between the Bitterroot and Sapphire mountain ranges. Many streams originate in forested areas where conifer trees provide a number of aquatic habitat benefits including: shading and cooling, bank stabilization, and the creation of pools and other in-stream habitat features from roots and fallen trees.

Fire regimes, water storage, nutrient cycling, insects and disease, and carbon storage are all interrelated. Changes in any one can have cascading effects on other functions. Changes in these functions can also affect fish and wildlife populations. For example, catastrophic fires can destroy native vegetation, impacting wildlife habitat. Loss of native vegetation and damage to soils can alter soil water-holding capacity which can result in increased erosion and sedimentation to streams. Loss of vegetation can also impact water temperatures in streams, impacting fish populations.

In the Bitterroot Subbasin, natural fire regimes were relatively frequent with low burn severity on low elevation, drier slopes. These fires maintained open ponderosa pine stands by killing some young ponderosa pine and most Douglas-fir. On north-facing slopes, fires were more intense because of more abundant, young Douglas-fir, but these fires were generally not severe enough to cause stand replacement; mature ponderosa pine, Douglas-fir, western larch, and some lodgepole pine often remained. Lower subalpine forests tended to burn with low to moderate severity, and higher subalpine forests have the least frequent and least severe fires. Stand replacing fires did and do occur in the Bitterroot Subbasin (Arno 1976).

The ecological effects of forest fires vary and are influenced by many factors, including fire behavior, vegetation type, topography, climate, and pre- and post-burn weather (McCullough et al. 1998). The *Flathead Subbasin Plan* (CSKT and MFWP 2004) summarized some of the community responses that fire can trigger in forest habitats:

- Modifications of the microclimate
- Increases in the range of soil temperatures
- Changes in soil nutrients and microbial activity
- Regeneration of vegetation
- Forest succession and new vegetation patterns
- Changes in plant growth rates and competitive interactions
- Changes in wildlife habitat and the activities of invertebrates and vertebrates
- Changes in water storage capacity and the pattern of runoff (Paysen et al. 2000)

More than 60 percent of the Bitterroot Subbasin has coniferous or other forested communities (Table 2.10). Nutrient cycling, including carbon sequestration, along with water storage are important ecological functions in forests. Standing live and dead trees, fallen trees, understory vegetation, forest litter, and organic material in the soils all have the ability to sequester carbon (Climate Change Advisory Committee 2007).

3.4.2 Historical and Current Distribution

Pfister and others (1977) developed a classification system, *Forest Habitat Types of Montana*, for forested areas in Montana, including the Bitterroot Subbasin. Appendix 1 includes general descriptions and locations of forest series and habitat types from this classification that historically and currently occur in the Bitterroot Subbasin. In general, coniferous forest habitat types transition with elevation zones, slope aspects, and moisture regimes. Low elevation coniferous forests are typically dominated by ponderosa pine habitat types that transition to Douglas-fir habitat types as elevation increases. Grand fir (*Abies grandis*) and spruce habitat types are scattered in the low to mid-elevation forests where suitable site conditions, including aspect, moisture regime, and soils are present (most often in riparian areas). At higher elevations, lodgepole pine habitats become more common, transitioning to subalpine fir habitat types just below the treeline. Alpine meadows and barren rock occur above the treeline.

The same forested habitat types have been present in the Bitterroot Subbasin over the last 100 years. However, the relative abundance of each habitat type has changed over time with natural and human-caused changes to the landscape, primarily due to fire suppression, timber harvest, and road building (Hartwell et al. 2000). Over the last nearly 100 years the presence of fire-tolerant species such as ponderosa pine have decreased, and the presence of fire-intolerant species such as Douglas-fir have increased. Historical forested communities were dominated by ponderosa pine at the lowest forested elevations; a mix of lodgepole pine, western larch, Douglas-fir, and subalpine fir at middle forest elevations; and whitebark pine (*Pinus albicaulis*) and lodgepole pine at higher elevations (Hartwell et al. 2000). Historically, ponderosa pine was the dominant species, but it has now been replaced by Douglas-fir, which was the third most common species in 1900. A study by Twer (2001) also reported Douglas-fir to be the most common forest type in the subbasin. It now comprises approximately 25 percent of the total forested area.

Historical vegetation mapping of the Ravalli County portion of the subbasin reported 1,281 square miles of conifer forest, 446 square miles of alpine and subalpine forest habitats, and 34 square miles of other forest habitats that appear to occur at the grassland and forest interface (Losensky 1993). The GAP data for the Ravalli County portion of the subbasin reports 1,087 square miles of conifer forest, 428 square miles of alpine and subalpine forest habitat, and 30.4 acres of other forested habitats. While both the 1930s Forest Service mapping and GAP mapping show conifer forest as the most abundant cover type in the Bitterroot Subbasin, it appears that since the 1930s forested areas have decreased by approximately 200 square miles.

For a longer view of the history of forests in the subbasin, a study completed by Mehringer and others in 1977 pieced together the postglacial bog, forest, and fire history of the Bitterroot Mountains spanning the last 12,000 years by analyzing sediment sampled from the Lost Trail Pass Bog. Through analysis of pollen found in these sediments the study provided the following general history based on data from this location in the Bitterroot Mountains. Approximately 12,000 years ago, glacial ice withdrew from the Bitterroot Valley leaving a lake and sagebrush-steppe dominated landscape for the next 400 to 500 years. Lodgepole and whitebark pine were present in the sediment record, and approximately 11,500 years ago whitebark pine forests replaced the sagebrush steppe. They persisted for the next 3,000 to 4,000 years under climatic conditions that were probably cooler than present. Approximately 7,000 years ago climatic conditions warmed, and Douglas-fir and lodgepole pine replaced whitebark pine. Climatic conditions cooled again about 4,000 years ago, and Douglas-fir was no longer common in the forested community. The study showed little change in vegetation over the next 4,000 years.

3.4.3 Limiting Factors and Disturbances

Most forested lands in the Bitterroot Subbasin are located on the Bitterroot National Forest (BNF). Forest Service-administered lands are managed for recreation, wildlife, fisheries, water, cultural resources, as well as timber, minerals, and grazing. Large, continuous areas of forested lands administered by the Forest Service provide habitat for both fish and wildlife species. However, disturbances such as road building, logging, mineral extraction and grazing that impact these habitats have occurred and still occur on Forest Service and private forested lands. Additional primary disturbances include fire suppression, insects and disease, drought, development, and recreation.

Logging activities, including removing dead or diseased trees, are conducted for commercial and salvage timber harvest and forest fuels management. Section 2.10.6 describes timber production in the Bitterroot Subbasin. Past and current logging practices include clearcutting, and past logging in the subbasin has left some areas devoid of conifer trees and with a network of roads built to access timber harvest sites. The wildlife habitat value of these areas has been reduced. The impacts may also affect aquatic habitats through reduced stream cover and increased runoff, both of which have the potential to deliver increased levels of fine sediment and nutrients to the stream.

Gold mining began in the subbasin in the 1860s, and the Overwhich-Hughes Creek Mining District in the upper West Fork Bitterroot Drainage was one of the most prominent operations (BNF 2008). Mining continues in the subbasin and is discussed in more detail in Section 2.10.10.

Grazing of cut-over forested lands occurs on both Forest Service and private lands in the subbasin. Grazing of forest lands may not entirely alter a native plant community or reduce wildlife value, but some grazing lands are seeded with non-native species to improve forage or combat non-native, invasive species. Grazing can also result in the spread of non-native, invasive species, which may reduce the wildlife habitat value of a forested area.

Natural fire regimes historically ranged from low-intensity under burns, to mixed severity burns, to stand replacement fires (Brown 1995 as cited in Hartwell et al. 2000). Since 1973, lightning caused fires have been allowed to burn in the Selway Bitterroot Wilderness when they do not pose a threat to development in the Bitterroot Valley (Brown et al. 1994 as cited in Hartwell et al. 2000). The Forest Service and other land management agencies practice fire management, including fire suppression near private lands. Fire suppression can result in a surplus of fuels, resulting in more severe fires that can damage fish and wildlife habitat by destroying habitats and forage and reducing water quality. Section 2.10.7 also discusses forest fire history in the subbasin.

Some forest insect and disease outbreaks result in significant mortality of coniferous tree species. Forest insects reported in the subbasin and the tree species they affect include mountain pine beetle (*Dendroctonus* *ponderosae*) – lodgepole, ponderosa pine, whitebark pine; Douglas-fir beetle (*Dendroctonus pseudotsugae)* – Douglas-fir; western pine beetle (*Dendroctonus brevicomis)* – ponderosa pine; western balsam bark beetle (*Dryocetes confusus*) – subalpine fir (USFS 2008). Forest insects and diseases are also influenced by climate change, as evidenced by increases in mountain pine beetles, the outbreaks of which are usually limited by extreme cold temperatures. Mountain pine beetles, which often kill their host trees, generate more dead fuels in the forests, and that in turn can result in more severe forest fires (Saunders et al. 2008).

Western Montana has recently experienced a period of drought. Long-term drought can influence plant community composition and structure and also increase the risk of wildfire damage to plant communities and wildlife habitat. Climate change may worsen drought conditions in portions of the western United States (Saunders et al. 2008).

Development (agricultural, residential and commercial) has increased in forested areas over the last 100 years. Development at the forest edge decreases the overall area of forest present and impacts wildlife habitat and wildlife movement between forested areas and adjacent grass and shrublands. Development at the forest edge also influences fire management strategies as managers seek to minimize property damage and loss when fires occur close to development.

Recreation also impacts forested areas because trails and roads are constructed through forested environments, increasing human activity within wildlife habitats.

3.5 Agricultural and Farmland Habitats

The habitats described in this section are included as a portion of the Grassland Conservation Focus Habitat described in Chapter 4. In Chapter 4, grassland habitat is related to the distribution of terrestrial conservation species. Figure 3.4 shows the distribution of agricultural and farmland habitats in relation to the Grassland Focus Habitat.

In the Bitterroot Subbasin, agriculture includes forestry, farming, and ranching. This section addresses agriculture related to farming and ranching, while forestry or timber management is addressed in Section 3.4.

Prior to European settlement, the Bitterroot Salish used fire and light domestic grazing to maintain valley bottomlands as native bunchgrass and low shrub “savannah” habitat (see Section 3.3). After European settlement, early settlements engaged in isolated agricultural activities. Then in the late 1800s, Marcus Daly enlarged the Hedge Irrigation Ditch and acquired the Republican Irrigation Ditch. He also built a canal from the Bitterroot River to lands near Hamilton (Bitterroot Irrigation District 2008). Between 1905 and 1918, the Big Ditch Company (later Bitter Root Irrigation District) constructed the Big Ditch, running from Lake Como on the west side, across the Bitterroot River via siphon, northward along the east side of the valley to east of Florence. While originally intended to supply water for apple orchards being marketed to easterners as a contemporary lifestyle product, the Big Ditch set the stage for later agricultural development (Lawrence 1999). By distributing abundant water across the dry east side with its pockets of deep and highly fertile soil, the Big Ditch provided the backbone for a complex irrigation infrastructure.

Another side effect of the Big Ditch Company's land development plan was the creation of 10-acre orchard tracts. While historically these tracts were intended as apple orchards either for sufficiency homesteads or second homes, they currently function as pre-subdivided land in an area under high pressure from residential development. While agricultural lands typically function to limit habitat fragmentation, the 10-acre orchard tracts have high potential to contribute to habitat fragmentation.

The total acerage of agricultural lands in the subbasin has decreased. According to 2004 Montana Department of Revenue data, Ravalli County included approximately 210,000 acres of agricultural land. This reflected a decrease from 240,000 acres in 1990 and from 258,000 acres in 1980. Based on these trends, researchers at the University of Montana projected that agriculture lands could be reduced to 172,000 acres by 2024, which would be a loss of approximately one-third of Ravalli County's agricultural land base since 1980 (Swanson 2006).

On the surface, this trend suggests the potential for some areas to revert to a more natural condition. Whether this is realized in the coming years depends largely on the conscientiousness with which new urban and industrial development is undertaken. While a loss of native composition and the threat of invasive species is a concern for native Bitterroot grasslands, most agricultural lands can still be used to some extent by native wildlife. Irreversible conversion via new construction however, greatly reduces the viability of these areas as forage, habitat, and wildlife corridors.

In addition to supporting a significant component of the valley's economic base (Swanson 2006) agricultural lands are recognized as being important in the Bitterroot Subbasin for open lands and wildlife habitat. The Ravalli County Open Lands Bond Program (Ravalli County 2007) assigns 30 out of 100 points to Agricultural Values as part of its scoring criteria for potential Open Lands projects. Other scoring categories also include agricultural components (e.g. water rights and weed management), and agricultural land can receive high scores for wildlife and water quality values, emphasizing how important agriculture is to maintaining wildlife habitat and aquatic resources in the subbasin.

Other documents provide recommendations to protect agricultural lands and associated values in the subbasin. Swanson (2006) recommended focusing development near population centers, clustering development in rural areas (leaving significant open space), integrating pasture commons (functioning agricultural areas within developments) as part of development, implementing an open-space bond that includes agricultural lands as a primary objective, and preserving water resources by establishing streamside setbacks for new development.

Agricultural land overlaps spatially with wildlife habitat (Figure 3.5). Most intact wildlife corridors connecting public land and the Bitterroot River are associated with large, contiguous areas of agricultural land, so these lands should be a high priority for conservation.

Limiting factors and considerations for the conservation of agricultural land in the subbasin include:

- Residential development has reduced and will continue to reduce overall agricultural land and will contribute to the fragmentation of agricultural lands that are currently functioning as wildlife habitat or wildlife movement corridors.
- Irrigation infrastructure influences wildlife movement patterns by providing water sources. A shift from agricultural to residential use will result in changes in the irrigation system.

- Irrigation infrastructure creates barriers for fish movement and causes some fish to move out of the river and tributary streams.
- Irrigation infrastructure drives distribution of some riparian and wetland habitats, particularly on the east side of the subbasin.
- Agriculture is being conducted using a range of Best Management Practices (BMPs). Where BMPs such as riparian buffers are being applied, agriculture can contribute to wildlife and aquatic habitat. Where BMPs are not being applied, agriculture can degrade wildlife and aquatic habitat.

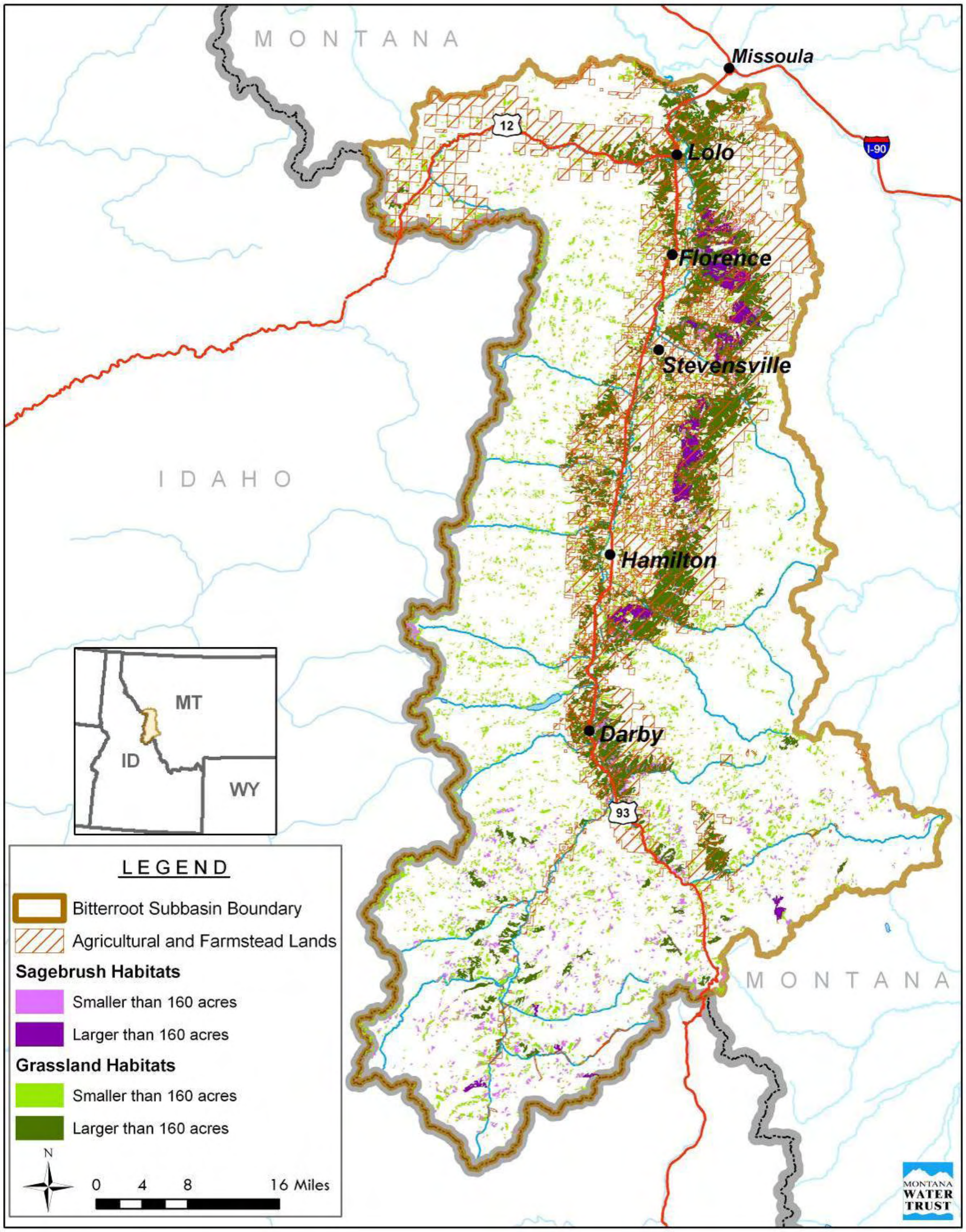


Figure 3.5. Distribution of agricultural and farmlands in relation to the grassland and shrubland focus habitats.
Data Sources: USGS GAP Analysis Program (2005).

3.6 Chapter 3 References

Adamus, P. R., L. T. Stockwell, E. J. Clairain, M. E. Morrow, L. D. Rozas, and R. D. Smith. 1991. Wetland evaluation technique (WET), Volume I; Literature review and evaluation rationale. Technical Report WRP-DE-2, U.S. Department of the Army, Waterways Experiment Station, Vicksburg, Mississippi. 287 pp.

Arno, S. F. 1976. The historical role of fire on the Bitterroot National Forest. *Research Paper* INT-187. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 29 pp.

Arno, S. F. 1980. Forest Fire History in the Northern Rockies. Journal of Forestry. 78(8): 460-465.

Barbour, M. G. and W. D. Billings. 1988. North American terrestrial vegetation. Cambridge University Press. New York, NY. 434 p.

Bitterroot Irrigation District. 2008. Bitterroot Irrigation District Website. Accessed September 2008 at: http://bitterrootirrigationdistrict.net/History.html.

Boyd, Karin and Tony Thatcher. 2008. Bitterroot River geomorphic summary: mainstem channel and bridge crossings: Ravalli County, MT. For Montana Dept. of Transportation, Helena, MT.

Brandt, T. and E. Ringleberg. 1999. Inventory of bank stabilization projects on reaches of the Clark Fork River, Bitterroot River, Blackfoot River, Lolo Creek, and Nine Mile Creek in Missoula County, Montana. Report prepared for the Watershed Education Network, Missoula, MT.

Climate Change Advisory Committee. 2007. Montana climate change action plan, final report of the Governor's Climate Change Advisory Committee. Accessed November 2008 at: http://www.deq.state.mt.us/ClimateChange/plan.asp.

CSKT and MFWP. 2004. Flathead Subbasin Plan. A report prepared for the Northwest Power Conservation Council. Portland, OR.

Conner, Richard, Andrew Seidl, Larry VanTassell, and Neal Wilkins. 2001. United States grasslands and related resources: an economic and biological trends assessment. Texas Agricultural Extension Service, Texas A&M University. College Station.

Cowardin L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Report # FWS/OBS/-79/31. U.S. Fish and Wildlife Service report, Washington.

Ehrhart, R. C. and P. L. Hansen. 1998. Successful strategies for grazing cattle in riparian zones. Montana BLM Riparian Technical Bulletin No. 4. Montana Forest and Conservation Experiment Station. University of Montana. Missoula.

Ellis, J. H. 2005. Impacts of the 404 permit program on wetlands and waterways in Montana and recommendations for program improvement. Montana Audubon. Helena, MT. 89 pp.

Ellis, J. H. 2008. Scientific recommendations on the size of stream vegetated buffers needed to protect fish and aquatic habitat, Part Two, the need for stream vegetated buffers: What does the science say? Report to Montana Department of Environmental Quality, EPA/DEQ Wetland Development Grant. Montana Audubon. Helena, MT. 20 p.

Flores, D. 2001. The Natural West: Environmental History in the Great Plains and Rocky Mountains. University of Oklahoma Press.

Geum Environmental Consulting. 2006. Ravalli County Pilot Wetland Mapping Project. Prepared for the Bitter Root Water Forum. Prepared by Geum Environmental Consulting. Hamilton, MT.

Hansen, P., R. Pfister, K. Boggs, B. Cook, J. Joy and D. Hinckley. 1995. Classification and Management of Montana's Riparian and Wetland Sites. Montana Forest and Conservation Experiment Station Misc. Publication No. 54. School of Forestry, University of Montana, Missoula.

Hartwell, Michael G., Paul Alaback, and Stephen F. Arno. 2000. Comparing historic and modern forests on the Bitterroot Front. USDA Forest Service Proceedings RMRS-P-17.

Krishna, J. H., J. G. Arnold, and C. W. Richardson. 1988. Modeling agricultural, forest and rangeland hydrology. Proceedings of the 1988 Symposium. American Society of Agricultural Engineers Publication 07-88. St. Joseph, MI. 324-329.

Kudray, G. M. and T. Schemm. 2008. Wetlands of the Bitterroot Valley: change and ecological functions. Report to the Montana Department of Environmental Quality. Montana Natural Heritage Program. Helena. 32 p. plus appendices.

Larsen, J. A. 1930. Forest types of the northern Rocky Mountains and their climatic controls. Ecology. 11(4): 631-672.

Lawrence, Russ. 1999. Montana's Bitterroot Valley. Stoneydale Press Publishing Co. Stevensville, MT. 158 p.

Losensky, John B. 1993. Legend for Maps and Data for the Forest Survey of 1932 – 1940. United States Forest Service, Region 1. Missoula, MT

McCullough, D. G., R. A. Werner and D. Neumann. 1998. Fire and insects in northern and boreal forest ecosystems of North America, Annual Review of Entomology. 43:107-27.

McMurtrey, R. G., R. L. Konizeski, M. V. Johnson, and J. H. Bartells. 1972. Geology and water resources of the Bitterroot Valley, Southwestern Montana: U.S. Geological Survey. Water-Supply Paper 1889. 80 p.

Mehringer, Peter J., Stephen F. Arno, and Kenneth L. Peterson. 1977. Postglacial history of Lost Trail Pass Bog, Bitterroot Mountains, Montana. Arctic and Alpine Research. 9(4): 345-368.

Montana Department of Fish Wildlife & Parks. 2005. Montana's comprehensive fish and wildlife conservation strategy. Montana Fish, Wildlife and Parks. Helena.

Montana Natural Heritage Program. 2003. Community ecology field guide. Accessed 2008 at: http://nhp.nris.state.mt.us/Community/guide.asp

Mueggler, W. F. and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA Forest Service General Technical Report INT-66. Intermountain Forest and Range Experiment Station. Missoula, MT

Naiman, R. J., J. M. Melillo, and J. Hobbie. 1986. Ecosystem alteration of boreal forest stream by beaver (*Castor canadensis*). Ecology 67: 1254-1269.

Naiman, R. J., H. Decamps, and M. E. McClain. 2005. Riparia: ecology, conservation, and management of streamside communities. Elsevier Academic Press. Burlington, MA. 430 p.

Parker, Tom. 2008. Letter addressed to Streamside Setback Committee from Tom Parker of Mill Creek Irrigation District.

Paysen, T. E., R. J. Ansley, J. K. Brown, G. J. Gottfried, S. M. Haase, M. G. Harrington, M. G. Narog, S. S. Sackett, and R. C. Wilson. 2000. Fires in western shrubland, woodland, and grassland ecosystems. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-volume 2 (ed. by J.K. Brown and J.K. Smith), pp. 121-159. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT.

Pfister, Robert D., B. L. Kovalchik, S. F. Arno, R. C. Presby. 1977. Forest habitat types of Montana. Gen Tech Report INT-34. Ogden, UT. USDA Forest Service. Intermountain Forest and Range Experiment Station. Missoula, MT. 174 p.

Ravalli County Open Lands Bond Program. 2007. Open lands guideline and procedure documents, adopted by the BCC on November 5, 2007. Accessed 2008 at: http://www.ravallicounty.mt.gov/planning/OpenLandsBoard.htm

Saunders, Stephen, Charles Montgomery, Tom Easley, Theo Spencer. 2008. Hotter and drier: The West's changed climate. The Rocky Mountain Climate Organization and the Natural Resources Defense Council. Denver.

Swanson, Larry. 2006. Growth and change in the Bitterroot Valley and implications for area agriculture and ag Lands. Prepared by the O'Connor Center for the Rocky Mountain West, University of Montana. Prepared for the Ravalli County Right to Farm and Ranch Board and the Bitter Root Land Trust. Hamilton, MT

Swanson, Larry. 2001. The Bitterroot Valley of western Montana area, economic profile. O'Connor Center for the Rocky Mountain West, The University of Montana. Missoula.

Twer, Martin. 2001. Design and comparison of quantitative alternative future landscape scenarios for the Bitterroot Front Area. Master of Science in Resource Conservation Thesis, University of Montana. Missoula.

U.S. Fish and Wildlife Service. 2007. National Wetlands Inventory website, Wetland and Riparian Mapping – Hamilton 100K Quadrangle. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/nwi/.

U.S. Department of Agriculture. Forest Service. 2008. Montana forest insect and disease conditions and program highlights 2007. United States Department of Agriculture Forest Service, Northern Region, Forest Health Protection Report 08-1.

U.S. Department of Agriculture. Forest Service, Bitterroot National Forest (BNF). 2008. Bitterroot National Forest Website, About Us. Accessed September 2008 at: http://www.fs.fed.us/r1/bitterroot/about/.

U.S. Department of Agriculture. Forest Service, Bitterroot National Forest (BNF). 2001. Wetlands in the Bitterroot Valley Complex, 2000 fire season, Bitterroot National Forest, Montana. Digital Geographic Information Systems (GIS) data.

U.S. Geological Survey (USGS) GAP Analysis Program. 2005. Land Cover Data for Montana. Published by National Biological Information Infrastructure.

U.S. Geological Survey (USGS). 2000. National Hydrography Dataset. U.S. Geological Survey in cooperation with U.S. Environmental Protection Agency and other state and local partners. Accessed 2008 at: http://nhd.usgs.gov/index.html.

U.S. Geological Survey (USGS). National Elevation Dataset for Montana. Accessed November 2008 at: http://seamless.usgs.gov.

Welch, T. G., R. W. Knight, D. Caudle, A. Garza, and J. M. Sweeten. 1991. Impact of grazing management on nonpoint source pollution. Texas Agricultural Extension Service Leaflet 5002. College Station. 4 p.

Chapter 4 Fish and Wildlife Communities and Target Species

4.1 Introduction

This chapter describes aquatic and terrestrial species and habitats present in the Bitterroot Subbasin and identifies conservation priority species. For aquatic environments, these are called Focal Species. For terrestrial environments, conservation target species are linked to key habitats, called Conservation Target Habitats. This section was developed using existing information and data sources. No new data sets were created. Descriptions of the Montana ranking systems and state and federal status are provided in Appendix 2. The primary sources that used to develop this section include:

- Montana Fish, Wildlife & Parks spatial data layers
- Montana Fish, Wildlife & Parks sampling databases
- Bitterroot National Forest and Lolo National Forest spatial data layers
- Montana Natural Heritage Program species databases
- Interviews with local wildlife and fisheries managers

The primary sources used to determine which species to include as focal species and conservation target species include:

- MFWP Comprehensive Fish and Wildlife Conservation Strategy (MFWP 2005)
- Recovery documents for federally listed species
- Management documents for other species
- Forest plans
- Montana Partners in Flight Bird Conservation Plan (Casey 2000)
- Montana Natural Heritage Program

For aquatic resources, two focal species were selected—bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*)—based on their current status, distribution, and ability to indicate overall ecosystem health. Both are native species with significantly reduced ranges, and both are listed as species of concern by the State of Montana or are designated as a Federal endangered or threatened species under the Endangered Species Act (ESA). For bull trout, the primary biological limiting factors include population isolation and competition with introduced species. For westslope cutthroat trout, the primary biological limiting factors include population isolation and genetic introgression with rainbow trout. Both species are limited by impaired habitats, primarily through dewatering and elevated stream temperature.

For the terrestrial environment, a two-tiered assessment approach was used: first, focus was placed on conservation target species, then on conservation target habitats that protect target species. This analysis identified a total of 78 terrestrial conservation target species for the subbasin based on four criteria: (1) they are a Montana Species of Concern (MSOC), (2) they have been identified as a conservation priority by a Federal or Montana agency; (3) they play a particularly important ecological or economic role in the subbasin (e.g. certain big game species), (4) they serve as an important habitat indicator for monitoring purposes. Based on the occurrence and distribution of these conservation target species or target species habitat requirements, six conservation target habitats were identified: riparian, wetland, sagebrush, grassland, dry forest, and mesic forest.

The terrestrial wildlife assessment is focused on the current distribution and condition of conservation target habitats. This process identified the major impacts affecting each target habitat. The impacts limiting wildlife populations in the riparian habitat on a subbasin scale include impacts to channels and floodplain function; destruction and fragmentation of riparian habitat from housing development, agriculture, and transportation infrastructure (including increased predation/parasitism); and loss of plant diversity due to livestock grazing. The primary impacts limiting wildlife populations in the wetland habitat on a subbasin scale include altered hydrology, altered channels and floodplain function, invasive plant species, and human disturbances. In the grassland habitat, the primary limiting factors include habitat destruction and fragmentation by agriculture and residential development, loss of productivity and weed invasion, and disturbance of grassland-associated wildlife. In the sagebrush habitat, the primary limiting factors include destruction and fragmentation of habitat by agricultural and residential development, alteration of fire regime, grazing, and weed invasion. In the dry forest habitat, the primary limiting factors include fire exclusion, loss of age-structure diversity to timber harvest, and weeds and exotic species. In the mesic forest habitat the primary limiting factors include fragmentation by roads, loss of older trees due to timber harvest and fire, an increase in stand-replacing fires, and insect invasion.

4.2 Wildlife Resources

Wildlife resources were analyzed at two levels. The first assesses species of conservation concern and their actual status in the Bitterroot Subbasin. The second identifies the particular habitats most in need of conservation. Most of this analysis is based on existing information from databases and recent analyses for the State of Montana, such as the Montana Natural Heritage Program (MNHP) database, the Montana Department of Fish, Wildlife & Parks (MFWP) Comprehensive Fish and Wildlife Conservation Strategy (MFWP 2005), and the Montana Partners in Flight Conservation Plan (PIF) (Casey 2000). These resources represent the best available knowledge about the current status and conservation issues concerning wildlife species and their habitats in western Montana. The Interactive Biodiversity Information System (IBIS) databases from Northwest Habitat Institute were also consulted, but the information was found to not be as current or accurate.

The first level of analysis yielded lists of potential conservation target species, their habitat associations, and their actual status in the Bitterroot, the latter of which were determined from personal and telephone interviews and email communication with wildlife biologists familiar with the Bitterroot Subbasin.

The second level of analysis compared the habitat categories used by different Montana-based conservation studies, assigned conservation target species to their primary habitats, and ranked these "conservation target habitats" based on the number of target species that depend on them in the Bitterroot Subbasin and the relative abundance of each habitat.

The Flathead Subbasin Assessment (CSKT and MFWP 2004) addressed ecological functions of wildlife species of the Flathead Subbasin in terms of "key ecological functions," "functional specialist species," "critical functional links," and "key ecological correlates." Their work includes all the target species in this assessment, and because these functions were adequately described for all those species in that document, they are not repeated here. Instead, that information is referenced to support later phases of conservation planning.

The species treated in this assessment are those known to have occurred historically or that presently occur in the subbasin. Fish and aquatic invertebrates are treated in the next section.

The Interior Columbia River Basin Ecosystem Management Project (ICBEMP) lists 548 vertebrates as present in the upper Columbia River basin (Quigley and Bigler-Cole 1997). The IBIS database lists 618 species. Their list includes marine mammals and birds. Table 4.1 summarizes by mammals, birds, reptiles, and amphibians the vertebrate species in the Bitterroot Subbasin as a percentage of the total species found in the Columbia River basin (see Appendix 3 for a list of wildlife species found in the subbasin according to the IBIS database).

Table 4.1. Vertebrate wildlife species present in the Bitterroot Subbasin.

Taxa	Number of Species Found in the ICBEMP* area	Approximate Number of Species Found in the Bitterroot Subbasin	Percentage of ICBEMP* Species Found in the Bitterroot Subbasin
Mammals	132	77	58
Birds	362 (283 regular and 79 casual)	267	74
Reptiles	27	9	33
Amphibians	26	7	27
Total	53	360	66

From: Raphael et al. (1998).
**Interior Columbia Basin Ecosystem Management Project (USFS-BLM).*

4.2.1 Conservation Target Species

Conservation target species are useful because their presence or known habitat needs can be used to define and rank functional and important habitats for conservation, and they can be used as elements of habitat evaluation, research, and monitoring. A number of relevant systems have been developed to classify the conservation status of Montana's wildlife species. The Montana Natural Heritage Program (MNHP) presents an excellent and recently updated summary of those classifications, called the Montana Species of Concern list (MNHP 2008). It includes the global Natural Heritage Program (NatureServe), USFWS Threatened and Endangered Species list, Montana's Comprehensive Fish and Wildlife Conservation Strategy (MFWP 2005), the U.S. Forest Service (USFS) Northern Region list, and the Bureau of Land Management (BLM) list.

4.2.1.1 Species of Conservation Concern

Conservation target species are defined primarily by their status as Montana Species of Conservation Concern. Table 4.2 lists mammal species of conservation concern within the Bitterroot Subbasin as defined by MNHP. Tables 4.3 and 4.4 list bird species of conservation concern. Table 4.4 is the Partners in Flight Conservation Plan for Montana (Casey 2000) list of additional bird species found in the subbasin but not listed by the State of Montana as Species of Concern or by the USFS and/or BLM as sensitive species. Tables 4.5 and 4.6 list reptile and amphibian species of conservation concern in the subbasin.

Table 4.2. Montana Mammal Species of Concern (MSOC) in the Bitterroot Subbasin.

Species: (Common Name)	Global/ State NHP Status[1]	MT CFWCS Tier[2]	USFWS Status	USFS/BLM Status	Distribution in Bitterroot Subbasin	Preferred Habitats
Townsend's big-eared bat	G4/S2	I	N/A	Sensitive	Unknown; historical records	Mesic forest, riparian deciduous forest
Fringed myotis bat	G4/S3	II		(BLM sensitive)	Unknown; historical records	Riparian & conifer forests
Preble's shrew	G4/S3	II		(BLM sensitive)	Unknown; historical records	Sagebrush, grassland
Northern bog lemming	G4/S2	I	N/A	Sensitive	Resident; East Fork	Mesic forest wetlands
Hoary bat	G5/S3	II			Unknown	Riparian and forest
Hoary marmot	Potential SOC	I	N/A	N/A	Resident, west side	Alpine
Spotted skunk	G5/S1	II	N/A	N/A	Unknown; historical records	Sagebrush, grassland
Wolverine	G4/S3	II	N/A	Sensitive	Resident	Mesic forest, alpine
Fisher	G5/S3	II	N/A	Sensitive	Resident	Mesic forest
Canada lynx	G5/S3	I	Threatened	Threatened	Likely; historical records	Mesic forest
Gray wolf	G4/S3	I	Endangered	Endangered	Resident; multiple packs	All
Grizzly bear	G4/S2	I	Threatened	Threatened	Migrant or Occasional	All

[1] G1/S1 is high risk and G/S5 is little risk
[2] Tier I =greatest need, Tier II=moderate need, Tier III=lower need
From: MNHP and MFWP (2008).

Table 4.3 Montana bird Species of Concern in the Bitterroot Subbasin.

Species (Common Name)	Global/ State NHP Status[1]	MT CFWCS Tier[2]	USFS/ BLM Status	PIF Status I=high II=medium III=local importance	Distribution in Bitterroot Subbasin	Preferred Habitats
American Bittern	G4/S3	II	N/A	III	Unknown	Wetlands
Bald eagle	G5/S3	I	N/A	II	Resident	Riparian forest
Barn Owl	G5/S1	IV	N/A	N/A	One breeding record	Sagebrush/ grassland
Black swift	G4/S3	II	N/A	II	Likely breeder	Alpine & cliffs
Black tern	G4/S3	I	(BLM sensitive)	II	Migrant	Wetlands
Black-backed woodpecker	G5/S2	I	Sensitive	I	Resident	Conifers-burns
Black-crowned night heron	G5/S	II	N/A	III	Unknown	Wetlands
Bobolink	G5/S2	III	N/A	III	Breeder	Grassland
Brewers sparrow	G5/S2	II	(BLM sensitive)	II	Breeder	Sagebrush
Burrowing owl	G4/S2	I	N/A	I	Former breeder	Grassland
Cassin's finch	G5/S3	II	N/A	III	Breeder	Conifers
Clark's nutcracker	G5/S3	III	N/A	III	Resident	Conifers
Common loon	G5/S2	I	Sensitive	I	Migrant	Wetlands-lakes
Flammulated owl	G4/S3	I	Sensitive	I	Breeder	Dry conifer-ponderosa
Grey-crowned Rosy finch	G5/S2	II	N/A	N/A	Unknown	Alpine
Great gray owl	G5/S3	II	(BLM sensitive)	III	Breeder	Forest
Harlequin duck	G4/S2	I	Sensitive	I	Migrant	Riparian-conifer
Lewis' woodpecker	G4/S2	II	N/A	II	Breeder	Riparian forest
Long-billed curlew	G5/S2	I	(BLM sensitive)	II	Breeder	Grasslands
Loggerhead shrike	G4/S3	II	(BLM sensitive)	II	Unknown	Sage or shrublands

Species (Common Name)	Global/ State NHP Status[1]	MT CFWCS Tier[2]	USFS/ BLM Status	PIF Status I=high II=medium III=local importance	Distribution in Bitterroot Subbasin	Preferred Habitats
Northern goshawk	G5/S3	II	Sensitive	II	Breeder	Conifers
Olive-sided flycatcher	G4/S3	I	N/A	I	Breeder	Conifers-burns
Peregrine falcon	G4/S2	II	Sensitive	I	Breeder	Cliffs
Swainson's hawk	G5/S3	II	(BLM Sensitive)	III	Possible Breeder	Sagebrush grassland
Western Yellow-billed Cuckoo	G5/S1	II	N/A	II	Unknown	Riparian forest
Trumpeter swan	G4/S3	I	(BLM sensitive)	I	Migrant and winter	Wetlands

[1] G/S1 is high risk and G/S5 is little risk
[2] Tier I =greatest need, Tier II=moderate need, Tier III=lower need
From: MNHP and MFWP (2008), Casey (2000), and MFWP (2005).

Table 4.4. Additional Bitterroot Subbasin bird species listed by Montana Partners in Flight Program as priority I or II species for conservation.

Species (Common Name)	PIF Priority	Distribution in Bitterroot Subbasin	Species (Common Name)	PIF Priority	Distribution in Bitterroot Subbasin
Horned grebe	II	Migrant	Pileated woodpecker	II	Resident
Clark's grebe	II	Migrant	Williamson's sapsucker	II	Breeder
Barrow's goldeneye	II	Migrant	Red-naped sapsucker	II	Breeder
Hooded merganser	II	Breeder	Cordilleran flycatcher	II	Breeder
White-faced ibis	II	Migrant	Willow flycatcher	II	Breeder
Marbled godwit	II	Migrant	Hammonds flycatcher	II	Breeder
Franklin's gull	II	Migrant	Winter wren	II	Resident
Forster's tern	II	Migrant	Brown creeper	I	Resident
Common tern	II	Migrant	Veery	II	Breeder
Ruffed grouse	II	Breeder	Red-eyed vireo	II	Breeder
Vaux's swift	II	Breeder	Lazuli bunting	II	Breeder
Calliope hummingbird	II	Breeder	Grasshopper sparrow	II	Breeder
Three-toed woodpecker	II	Breeder			

From: Casey (2000).

Table 4.5. Montana reptile and amphibian species of concern found in the Bitterroot Subbasin.

Species (Common Name)	Global/ State NHP Status [1]	MT CFWCS Tiers[2]	USFS/BLM Status	Distribution in Bitterroot Subbasin	Preferred Habitats
Northern alligator lizard	G5/S3	II	N/A	Resident	Xeric forests
Western skink	G5/S3	II	N/A	Resident	Grassland Sagebrush Xeric forests
Coeur d'Alene salamander	G4/S2	I	Sensitive	Resident	Riparian-conifers
Northern leopard frog	G5/S1	I	Sensitive	Extirpated-historical records	Valley wetlands
Western toad	G4/S2	I	Sensitive	Resident	Wetlands

[1] G/S1 is high risk and G/S5 is little risk
[2] Tier I =greatest need, Tier II=moderate need, Tier III=lower need
From: MNHP and MFWP (2008).

Table 4.6. Key locations of reptiles and amphibian Montana Species of Concern in the Bitterroot Subbasin.

Species	General Distribution	Watersheds with Recorded Occurrence
Northern alligator lizard	3,500-5,000 feet in western canyons and foothills. Rare.	Records from Bass Creek south to Rock Creek
Western skink	3,500-4,800 feet in valley and foothills. Rare.	Foothill locations on east and west sides of valley
Coeur d'Alene salamander	4,000-5,000 feet in west side canyons. Rare--few sites.	Rock Creek, Sweathouse Creek, and Chaffin Creek
Northern leopard frog	Last known site in tributary pond—now extirpated	Last reported site in Bitterroot was from Skalkaho Creek
Western toad	3,000-8,000 feet throughout, breeding from valley floor to high elevations, now rare.	Key breeding sites in Rock Creek, Little Blue Joint Creek, and Willow Creek,

From: Maxell (2004) and Maxell (2008).

Table 4.7. Montana invertebrate species of concern found in the Bitterroot Subbasin.

Species (Common Name)	Global/ State NHP Status [1]	MT CFWCS Tiers[2]	USFS/BLM Status	Distribution in Bitterroot Subbasin	Preferred Habitats
Marbled Jumping-slug	G2G3/S1Sw	N/A	N/A	Resident	Mesic/moist conifer forests
Sheathead slug	G3G4/S2S3	N/A	N/A	Resident	Mesic/moist conifer forests
Lyre mantleslug	G2/S1	N/A	N/A	Resident	Moist conifer forests
Smoky Taildropper	G3/S2S3	N/A	N/A	Resident	Moist conifer forests
Magnum Mantleslug	G3/S2S3	N/A	N/A	Resident	Moist conifer forests
Bitterroot Mountainsnail	G1G2/S1S2	N/A	N/A	Resident	Talus, dry conifer forests

[1] G/S1 is high risk and G/S5 is little risk
[2] Tier I =greatest need, Tier II=moderate need, Tier III=lower need
From: MNHP and MFWP (2008).

4.2.1.2 Threatened, Endangered, Locally Extinct and Introduced Terrestrial Wildlife Species and Plants

In the Bitterroot Subbasin there are two federally-listed threatened and endangered mammal species and one threatened plant species. The threatened mammal species—Canada lynx (*Lynx canadensis*) and grizzly bear (*Ursus arctos*)—are species with wide ranges in northern North America but very restricted ranges in the continental United States (the gray wolf (*Canis lupus*) was delisted in Montana in March 2009). The large areas of lightly populated, mostly forested landscape in the National Forests of western Montana and north Idaho are a major reason for the continued presence of these species, although the grizzly bear (and gray wolf) has also benefited from intensive Federal and State conservation and reintroduction actions for the last twenty to thirty years. The one listed plant species, Water Howelia (*Howellia aquatalis*), is included because it potentially occurs in Missoula County. However, it is not known to occur specifically in the Bitterroot Subbasin.

The current Canada lynx critical habitat proposals for Montana do not include the Bitterroot Subbasin, but do include areas immediately to the northeast of the subbasin on Lolo National Forest (LNF) lands (USFWS 2008). Lynx are not currently confirmed as present in the Bitterroot National Forest (BNF), although they continue to be reported occasionally (Ormiston pers. comm. 2008). The 2006 BNF *Forest Plan Monitoring and Evaluation Report* reports the most recent lynx sightings in the subbasin. They include: Forest personnel identified a set of lynx tracks in the upper Larry Creek drainage in 2004; a hunter reported seeing a lynx in the upper Lick Creek drainage in 2002; and MFWP trapping records indicate one lynx was taken during the 1994-to-1995 trapping season in Hunting District 270 (BNF 2006). In an amendment to the 2005 Canada Lynx Conservation Agreement, the BNF was classified as "Unoccupied Lynx Habitat" by the USFWS and the Forest Service. Lynx are no longer included on the USFWS list of threatened and endangered species that may occur in the BNF (BNF 2006).

The grizzly bear is not known to be resident in the Bitterroot Subbasin, although this species' range is thought to be expanding in Montana, and isolated grizzly bears have recently been recorded near the boundaries of the Bitterroot Subbasin (Ormiston pers. comm. 2008). Historical records indicate that grizzly bears were once abundant in the Bitterroot Mountains but did not survive the intense pressure designed to eliminate them as threats to domestic sheep and cattle (BNF 2006). The last known grizzly bear was hunted and killed in the area in 1956 (BNF 2006). The only recent confirmed sighting of a grizzly bear in the subbasin was an apparent transient bear on private land on Sunset Bench southeast of Stevensville in late September 2002 (BNF 2006). Biologists assumed this bear crossed the Sapphire Range from the Rock Creek drainage (BNF 2006).

The gray wolf, which was delisted in March 2009, was reintroduced to the Selway-Bitterroot area of Idaho in 1995. That population has expanded, and perhaps in combination with the natural population of wolves in northwestern Montana, recolonized the subbasin. Currently there are at least eight packs of wolves using most forested parts of the subbasin (Sime et al. 2008).

In addition to the gray wolf, species with substantial populations in the subbasin that have been recently removed from the Federal threatened and endangered list include peregrine falcon (*Falco peregrinus*), which was reintroduced after becoming locally extirpated, and bald eagle (*Haliaeetus leucocephalus*).

Species of conservation concern in Montana that are suspected to have been present in historical times but are now absent include the Columbia sharp-tailed grouse (*Tympanuchus phasianellus columbianus*), which was present until the 1920s (Hackett 2008) and the northern leopard frog (*Rana pipiens*), last documented in the late 1960s (Maxell 2004). Both have been eliminated from many areas of the upper Columbia River Basin and from most areas of Montana west of the Continental Divide.

Table 4.7 lists invertebrate species of concern found in the subbasin. These include: lyre mantleslug (*Udosarx lyrata*), smoky taildropper (*Prophysaon humile*), magnum mountainslug (*Magnipelta mycophaga*), marbled jumping-slug (*Hemphillia danielsi*), sheathead slug (*Zacoleus idahoensis*) and Bitterroot mountainsnail (*Oreohelix amariradix*). All are rare species, G1 to G3 in rank, and are restricted-range species of northwestern Montana and adjacent areas of Idaho. The Bitterroot mountainsnail is one of the only known animal species endemic to the Bitterroot Subbasin.

A number of wildlife species have been introduced to the subbasin (Table 4.8). Several of these, for example European starling and house sparrow, compete with native species for habitat components such as cavity nest sites. The bullfrog is a notorious predator of native amphibians and other small vertebrates.

Table 4.8. Terrestrial vertebrate species introduced into the Bitterroot Subbasin.

Common Name	Scientific Name
Eastern fox squirrel	*Sciurus niger*
House mouse	*Mus musculus*
Ring-neck pheasant	*Phasianus colchicus*
Gray partridge	*Perdix perdix*
Chukar	*Alectoris chukar*
Wild turkey	*Meleagris gallopava*
California quail	*Callipepia californica*
European starling	*Sturnus vulgaris*
House sparrow	*Passer domesticus*
Bullfrog	*Rana catesbeiana*

4.2.1.3 Big Game Species

The subbasin is home to numerous native big game species (Table 4.9) that MFWP intensively manages for resident and non-resident hunting. Big-game hunting is a major economic and recreational activity in Montana and in the Bitterroot Subbasin in particular. Hence, the existence of abundant and diverse big-game species is a major natural asset of the subbasin highly appreciated by local residents. It contributes significantly to the local economy, especially during fall hunting season, but also through year-round wildlife observation opportunities. Elk are a big game species of pre-eminent cultural importance; however, other large ungulates are also important to both hunting and wildlife observation.

Four big-game species—elk, mule deer, moose, and bighorn sheep—are recommended conservation target species. These ungulates are of the greatest economic and cultural importance, and are also probably most limited by habitat needs (particularly elk). All four use summer habitats at higher elevations, mostly within national forests, but have significant areas of their winter habitat on lower-elevation private lands.

Table 4.9. Native big game species in the Bitterroot Subbasin with four species of greatest economic and cultural importance in bold.

Common Name	Scientific Name
White-tail deer	*Odocoileus virginianus*
Mule deer	***Odocoileus hemionus***
Elk	***Cervus elaphus***
Moose	***Alces alces***
Mountain goat	*Oreamnos americanus*
Rocky Mountain bighorn sheep	***Ovis canadensis canadensis***
American black bear	*Ursus Americanus*
Mountain lion	*Puma concolor*

Elk is a particularly important big-game animal in the subbasin both for the positive economic impact of large numbers of elk hunters visiting the area and as a local hunting tradition. MFWP elk management is guided by their 2004 State Elk Management Plan (MFWP 2004). MFWP manages hunting by geographic hunting units, four of which are located entirely within the Bitterroot Subbasin (Units 240, 250, 270, and 261). A large portion of deer and elk hunting units 204 and 260 also fall within the subbasin. Elk populations are generally much greater than they were 30 years ago, partly due to changes in hunting regulations and habitat-protection measures. Table 4.10 provides data on elk populations and harvest.

Table 4.10. Elk populations and hunting recreation in the Bitterroot Subbasin.

Elk Hunting Unit	Former Elk Populations (dates)	Current Elk Populations (dates)	Current Elk Harvest (years)	Hunter Recreation Days per Year (years)
240/260 (Westside Bitterroot)	280 (1965-1979)	600-1,000 (1995-2004)	141 (1999-2001)	10,755 (1999-2001)
250 (West Fork)	497 (1965-1983)	1,200-1,600 (1996-2004)	130 (1999-2001)	10,500 (1999-2001)
270 (East Fork)	1,500-2,000 (1983-1990)	2,501 (1999-2002)	300-500 (estimated between 1999-2001)	Approximately 25,000 (estimated)
261 (Skalkaho to Burnt Fork)	No data	Estimated at 825 (1998-2003)	No data	No data
204 (Burnt Fork to Missoula and other areas)	No data	Estimated at 625 (1998-2003)	No data	No data
TOTAL		5,751 to 6,551		Over 46,000

From: MFWP (2004).

Current challenges in elk management in the subbasin include:

- Residential housing development. Elk management is negatively affected in three ways by housing development: (a) loss of winter range grassland and sage habitat; (b) landowner limits to hunting access; (c) the “refuge” effect of private lands closed to hunting causes localized increases in the elk population that can result in crop and fence damage.
- Road management on private and public lands. Due to the need that elk have for “security” or freedom from harassment in winter and spring, increased road access into elk habitat is an issue, especially on winter-range grasslands.
- Off-road vehicle use. Off-road vehicles displace and harass elk, cause soil erosion, and spread weeds during and after hunting season.
- Winter range productivity declines. Conifer invasions of shrublands and grasslands, aging shrub plants, and invasion of noxious weeds all contribute to productivity declines in native grassland range.

While much of the most valuable summer and fall big-game habitat is on National Forest lands and commercial timberlands, critical winter range, especially for elk and mule deer, is often on private land in the valleys and foothills (Figure 4.1). Approximately two thirds of the elk wintering in the middle and lower Bitterroot Valley use primarily private land for winter range (Ormiston 2008 pers. comm.). This situation exacerbates the above mentioned conservation issues for elk. Figure 4.2 shows the distribution of big horn sheep and moose winter range in the subbasin.

Habitat Connectivity for Big Game

Habitat connectivity between the important big game habitats in the Sapphire Mountains and foothills on the east side of the subbasin, the centrally-located Bitterroot River riparian forests and wetlands, and the Bitterroot Range on the west side of the subbasin is an issue of concern for wildlife managers and stakeholders. Suburban development, roads, and small-scale farms are increasingly occupying the valley grasslands, large-scale agricultural lands and riparian lands that formerly served as big-game winter range (especially for elk and mule deer) and as wildlife travel corridors (for all big-game species, including carnivores).

Due to extensive agricultural and residential development, few areas in the northern and middle portions of the Bitterroot Subbasin have relatively undeveloped natural habitats. Therefore, there is a general lack of contiguous habitat—particularly shrublands and stream-associated riparian habitats—between National Forest lands in the Bitterroot Mountains and National Forest Lands in the Sapphire Mountains and the broad Bitterroot River floodplain and its wide riparian habitat. Some large-scale mountain-to-valley habitat connectivity does remain, for example in areas near Sleeping Child Creek in the southeast (Sleeping Child and Skalkaho subwatersheds), the Bass Creek area on the west side (Bass Creek subwatershed), the Davis Creek-Miller Creek area in the northeast (Eightmile and Bitterroot River North subwatersheds), as well as the Blue Mountain area in the extreme north (O'Brien Creek and Bitterroot River North subwatersheds). Figure 4.9 provides an overview of target habitat connectivity in the subbasin.

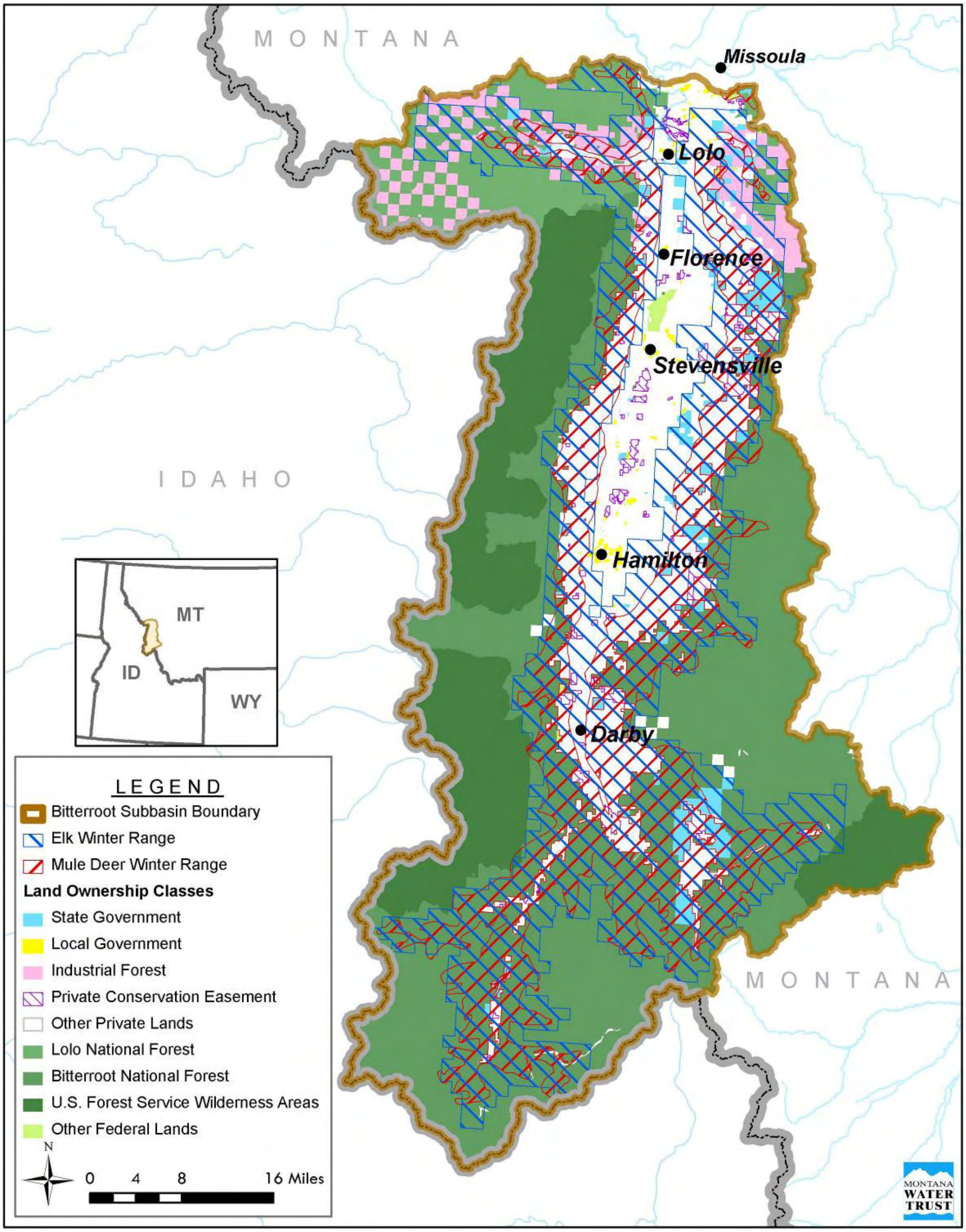


Figure 4.1. Elk and mule deer winter ranges in the Bitterroot Subbasin.
Data Sources: MFWP (2004) and Montana Department of Administration (2008).

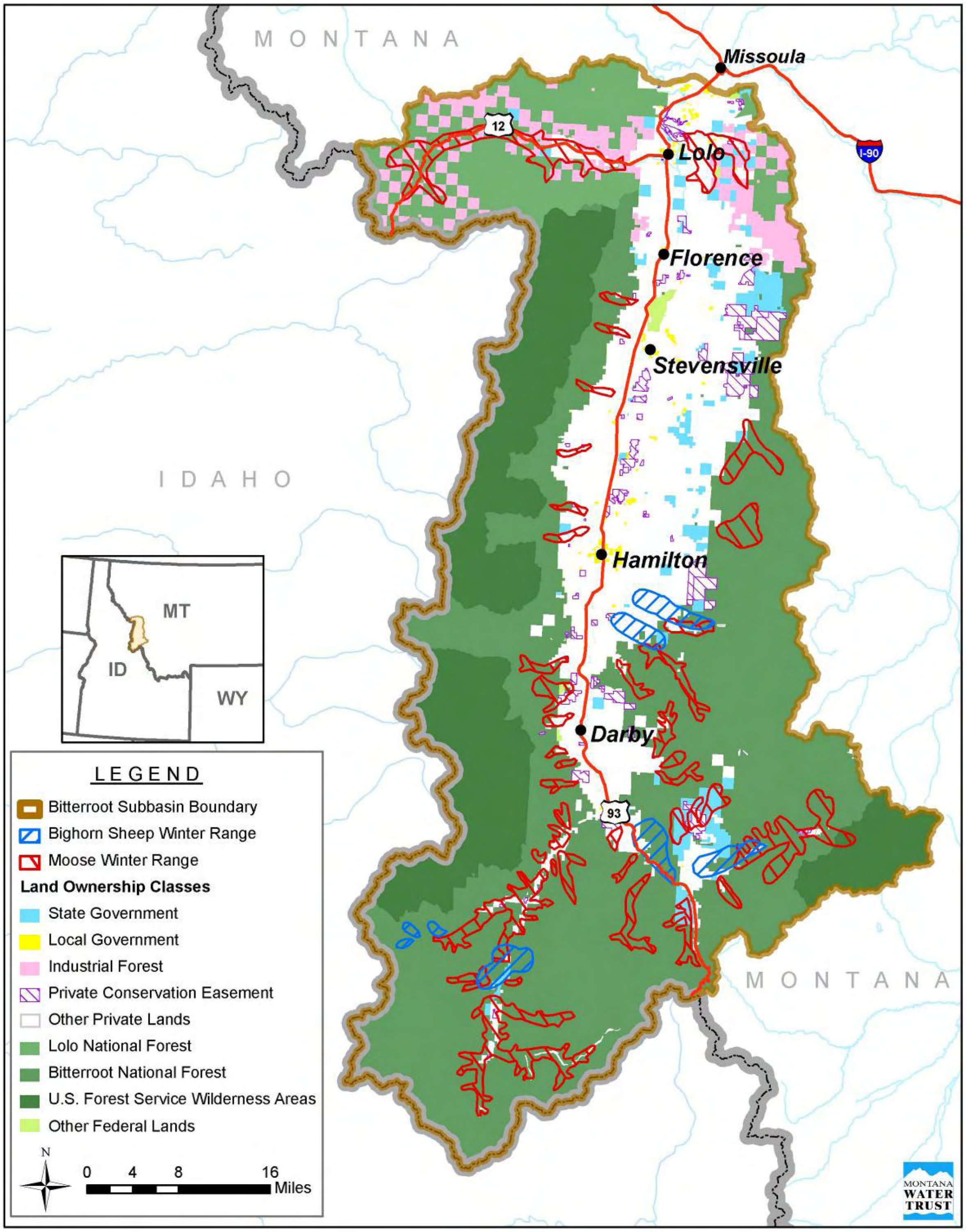


Figure 4.2. Rocky Mountain big horn sheep and moose winter ranges in the Bitterroot Subbasin.
Data Sources: MFWP (2003) and Montana Department of Administration (2008).

4.2.1.4 Wildlife Relationships with Focal Aquatic Species (Salmonids)

Integrating the analysis of terrestrial target wildlife species with the focal aquatic species is an important aspect of subbasin assessment. A large number of wildlife species have ecological relationships with salmonid fish; for example the Flathead Subbasin Plan (CSKT and MFWP 2004) includes 63 bird species, 21 mammals, and two reptiles in western Montana with significant relationships to salmonids, and all of these species are also found in the Bitterroot Subbasin. Most are predators or scavengers of some life stage of salmonids.

Other native vertebrates, particularly amphibians, are preyed upon by salmonids. In fact, salmonid predation can be so significant that the distribution of breeding sites for certain native amphibians has been shown to be mostly exclusive of waters inhabited by salmonids (Maxell 2004).

Although numerous wildlife species can be opportunistic predators of salmonids at various life stages of the fish, several species—including river otter, great blue heron, osprey, bald eagle, and belted kingfisher—are specialized predators of juvenile and mature fish. These major fish predators are all fairly common and widely distributed in the Bitterroot Subbasin. In particular, great blue heron rookeries are found at several sites along the mainstem of the Bitterroot River, and osprey nesting densities are high along the river.

Beaver play a vital ecological role in riparian and aquatic ecosystems, including those in the Bitterroot Subbasin. Beaver dams/ponds create wetland and aquatic habitats, alter hydrology and geomorphology of riparian areas, and can alter the distribution of riparian and aquatic habitat types. Beaver are relatively common in the Bitterroot Subbasin, but their population is subject to trapping both for fur and to eliminate nuisance dams interfering with irrigation works and road culverts.

4.2.2 Conservation Target Habitats

Several systems have been developed recently to rank the importance of distinct wildlife habitats in Montana. The most prominent recent statewide effort is that of the Montana Comprehensive Fish and Wildlife Conservation Strategy (MFWP 2005). That system ranks Montana wildlife habitats into tiers based on conservation need. The State also designated specific geographic areas as “terrestrial conservation focus areas” due to their concentration of high-ranking habitats.

The habitat categories used by the MFWP strategy are broad. A more specific system for categorizing wildlife habitats was developed by Montana’s PIF bird conservation program. Each system is described below. For purposes of this assessment, the two habitat ranking systems were combined to take advantage of the strong overlap in general habitat categories, while preserving some of the descriptive power of the more specific habitat types in the PIF system. These categories were used to determine conservation target habitats. Target species described in section 4.2.1 were assigned to target habitat categories. This section concludes with a table describing the key limiting factors for each habitat category.

4.2.2.1 Montana Tier I and II Terrestrial Conservation Habitats and Conservation Focus Areas

The Montana Comprehensive Fish and Wildlife Conservation Strategy (MCFWCS) includes five terrestrial Tier I habitats and 14 terrestrial Tier II habitats. The five Tier I habitats (communities) are defined as those habitats that are in greatest need of conservation due to decline in area and severity of threats statewide. Of these Tier I habitats, three of them—the wetland and riparian, sagebrush, and grasslands—are well-represented in the Bitterroot Subbasin.

The State of Montana recognizes that the complex of grasslands, wetlands, riparian broadleaf forests, and low-elevation conifer forests in the valley portion of the subbasin is one of the most important areas for habitat and species conservation in the entire state (MFWP 2005). The Bitterroot-Frenchtown Valley Conservation Focus Area (including all the lowlands of the Bitterroot Subbasin) is one of only four Terrestrial Conservation Focus Areas listed in the MCFWCS for the Columbia River basin portion of Montana (others include the Flathead River Valley, Deer Lodge Valley, and Mission-Swan Valley).

Tier II habitats found in the Bitterroot Subbasin (Bitterroot-Frenchtown Valley Conservation Focus Area) include Douglas-fir, mixed mesic forest, ponderosa pine forest, mixed mesic shrubs, and altered herbaceous. Higher elevation portions of the subbasin include other Tier II habitats: alpine meadows, mixed whitebark pine, western red cedar, western larch, and standing burnt forest.

The Montana Tier I habitats are considered conservation target habitats. A brief description of each follows.

Wetland and Riparian Tier I Habitat

Figures 4.3 through 4.6 display the distribution of wetland and riparian habitats in the Bitterroot Subbasin. Wetland and riparian is a diverse category including various open-water wetlands (ponds, lakes, sloughs), conifer-dominated riparian, broadleaf riparian (e.g. cottonwoods), mixed riparian (cottonwood with ponderosa pine), herbaceous riparian (e.g. sedges, cattails), and shrub riparian (e.g. alder and willow).

The largest riparian habitat area in the subbasin is along the Bitterroot River itself. A significant portion of this 40-mile-long area consists of mature riparian deciduous (broadleaf riparian) forest dominated by black cottonwood. This extensive area is a National Audubon Society Important Bird Area (IBA), with breeding populations of Lewis' woodpeckers (*Melanerpes lewis*) and Red-naped Sapsuckers (*Sphyrapicus nuchalis*) of "continental significance" (Cilimburg 2008). A variety of other associated wetlands and riparian types also exist within the Bitterroot River floodplain.

Riparian deciduous forest and riparian shrub habitats are key wildlife habitats and are used by a large proportion of Montana bird species during some part of the annual cycle. They are especially important for migratory birds, which concentrate in them during spring and fall, and provide important breeding habitats for many neotropical songbirds, including PIF priority species such as willow flycatcher, cordilleran flycatcher, veery, and red-eyed vireo.

Open-water wetlands are mostly small in the Bitterroot Subbasin, except for the complex of large impoundments at the Lee Metcalf National Wildlife Refuge near Stevensville, several subalpine glacial lakes, and the two large reservoirs—Lake Como and Painted Rocks Reservoir—found in the southern portion of the subbasin.

Sagebrush Tier I Habitat

Figure 4.7 shows the distribution of sagebrush habitats, which are of limited extent in the subbasin. They are restricted to the foothills of the Sapphire Range, with important sagebrush areas near Sleeping Child and Skalkaho Creeks, to Willoughby Creek north of Corvallis, and in the Ambrose-Threemile area, as well as the Davis Creek foothills east of Lolo. The Bitterroot Subbasin is disjunct from other large areas of sagebrush habitat in Montana, the nearest being the Big Hole Valley (upper Missouri River drainage to the southeast). Sagebrush mixed with native grasses is an important habitat type for big-game winter range, especially elk and mule deer. Brewer's sparrow (*Spizella breweri*), a Species of Concern is nearly restricted to sagebrush habitats. Other Species of Concern, such as Swainson's hawk (*Buteo swainsoni*), spotted skunk (*Spilogale gracilis*), and Preble's shrew (*Sorex preblei*), use sagebrush habitats, as do some Montana Tier II species such as western rattlesnake (*Crotalus viridus*) that are uncommon in western Montana.

Grassland Complex Tier I Habitat

Figure 4.8 shows the distribution of grassland habitats in the Bitterroot Subbasin. Because they have been replaced by agriculture, native grasslands are restricted to a fraction of their original extent. Animal species dependent on them include big game (particularly elk and bighorn sheep during winter), species of concern such as long-billed curlew (*Numenius americanus*), grasshopper sparrow (*Ammodramus savannarum*), burrowing owl (*Athene cunicularia*) and Montana Tier II species such as western skink (*Eumeces skiltonianus*). Wetter grasslands are found on the river floodplain, while the largest areas of grasslands are on drier sites in the foothills, especially the Sapphire Mountain foothills from Skalkaho Creek north to Miller Creek.

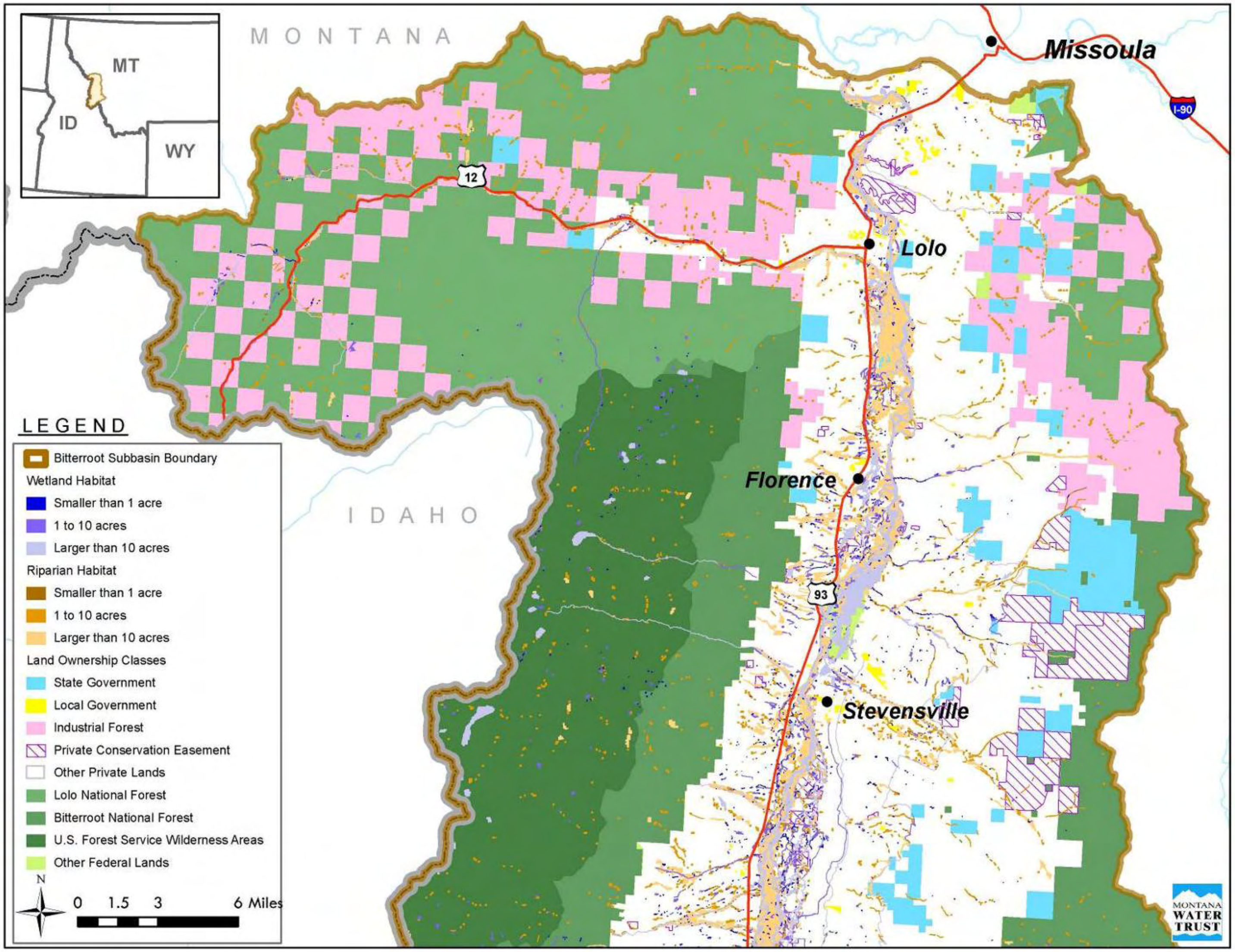


Figure 4.3. Distribution of wetland and riparian habitats in the Bitterroot Subbasin, northern section.
Data Sources: USFWS (2007), USFS (2001), Geum Environmental Consulting, Inc. (2005), USGS Gap Analysis Program (2005), and Montana Department of Administration (2008).

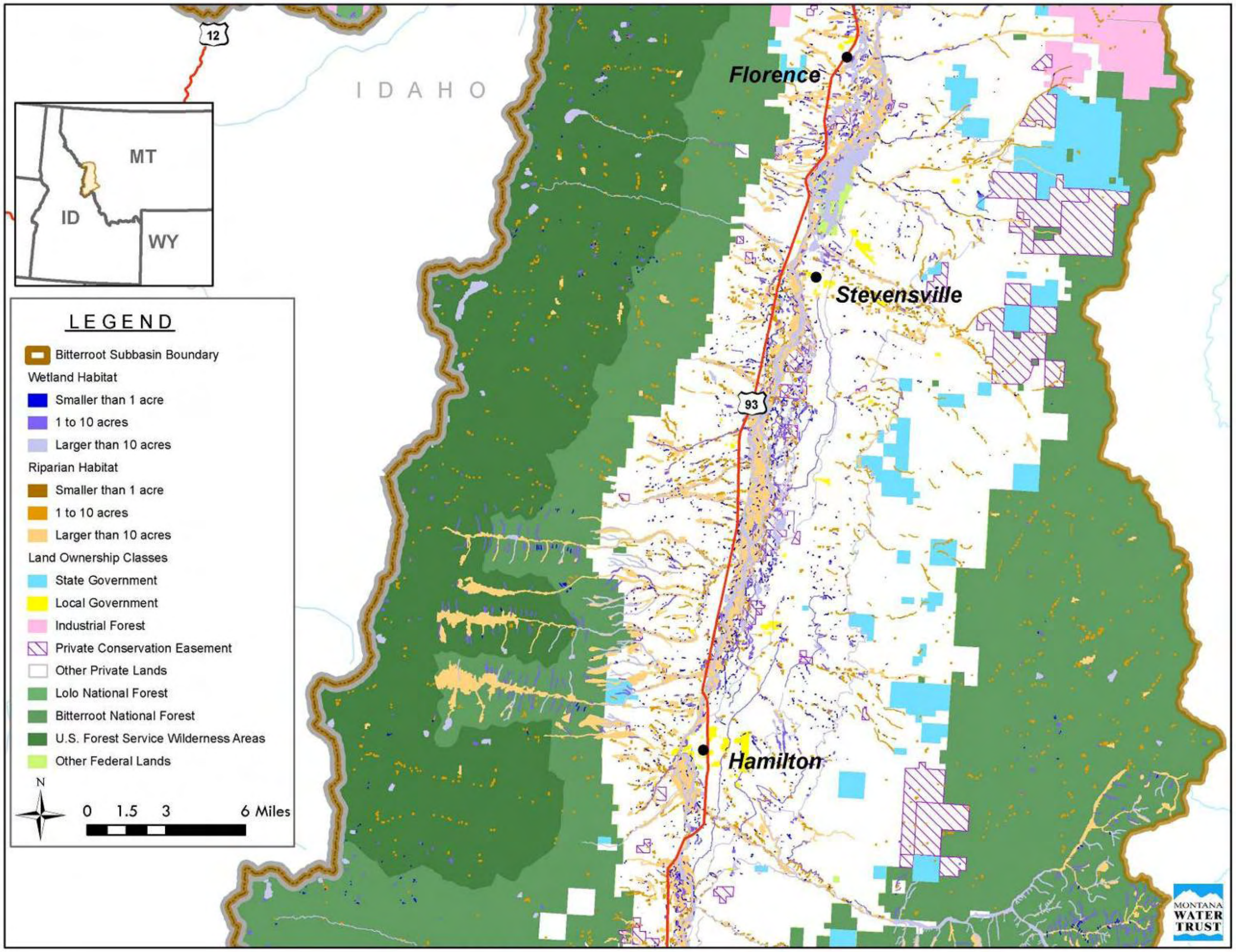


Figure 4.4. Distribution of wetland and riparian habitats in the Bitterroot Subbasin, Stevensville to Hamilton section.
Data Sources: USFWS (2007), USFS (2001), Geum Environmental Consulting, Inc. (2005), USGS Gap Analysis Program (2005), and Montana Department of Administration (2008).

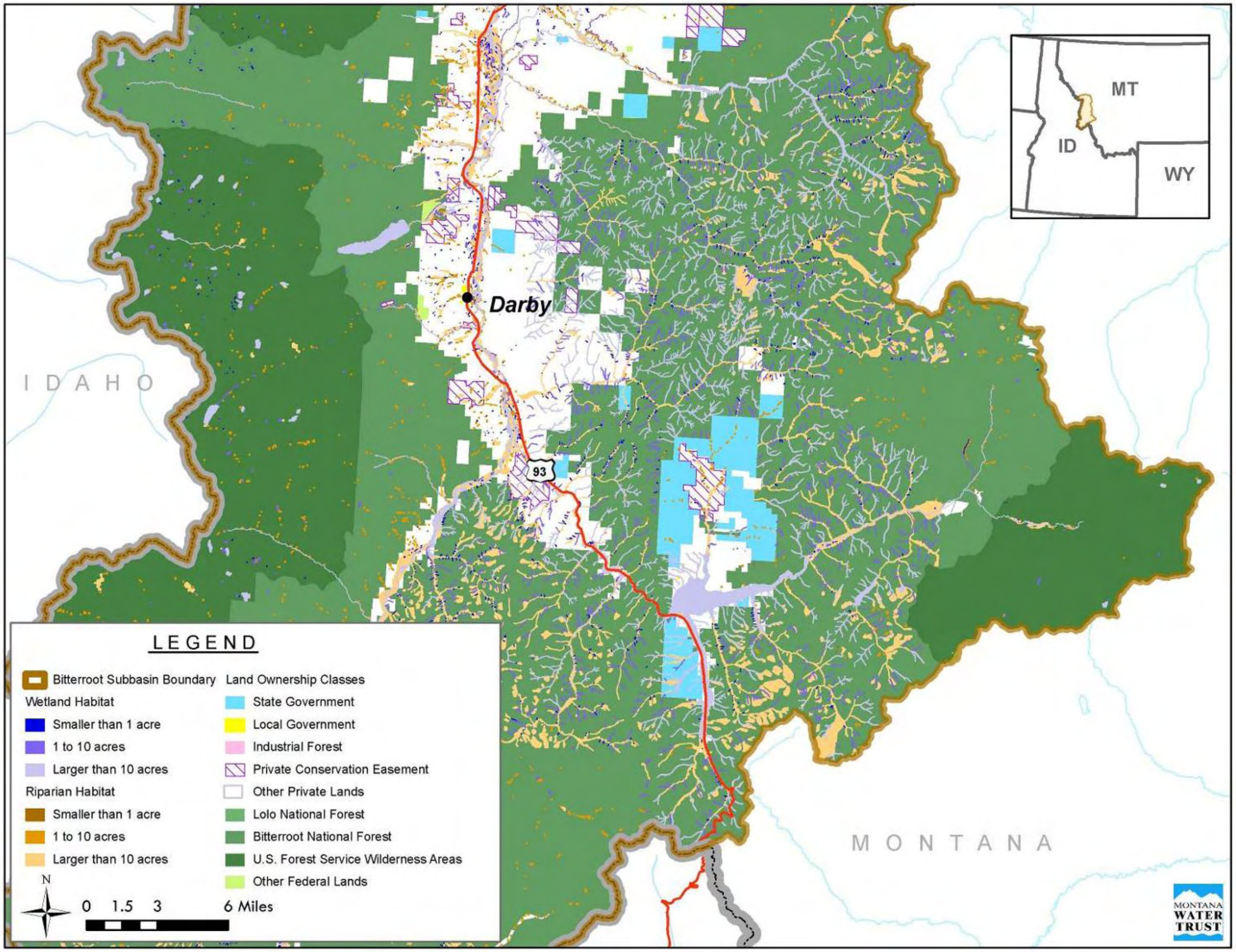


Figure 4.5. Distribution of wetland and riparian habitats in the Bitterroot Subbasin, south of Hamilton to south of Darby section.
Data Sources: USFWS (2007), USFS (2001), Geum Environmental Consulting, Inc. (2005), USGS Gap Analysis Program (2005), and Montana Department of Administration (2008).

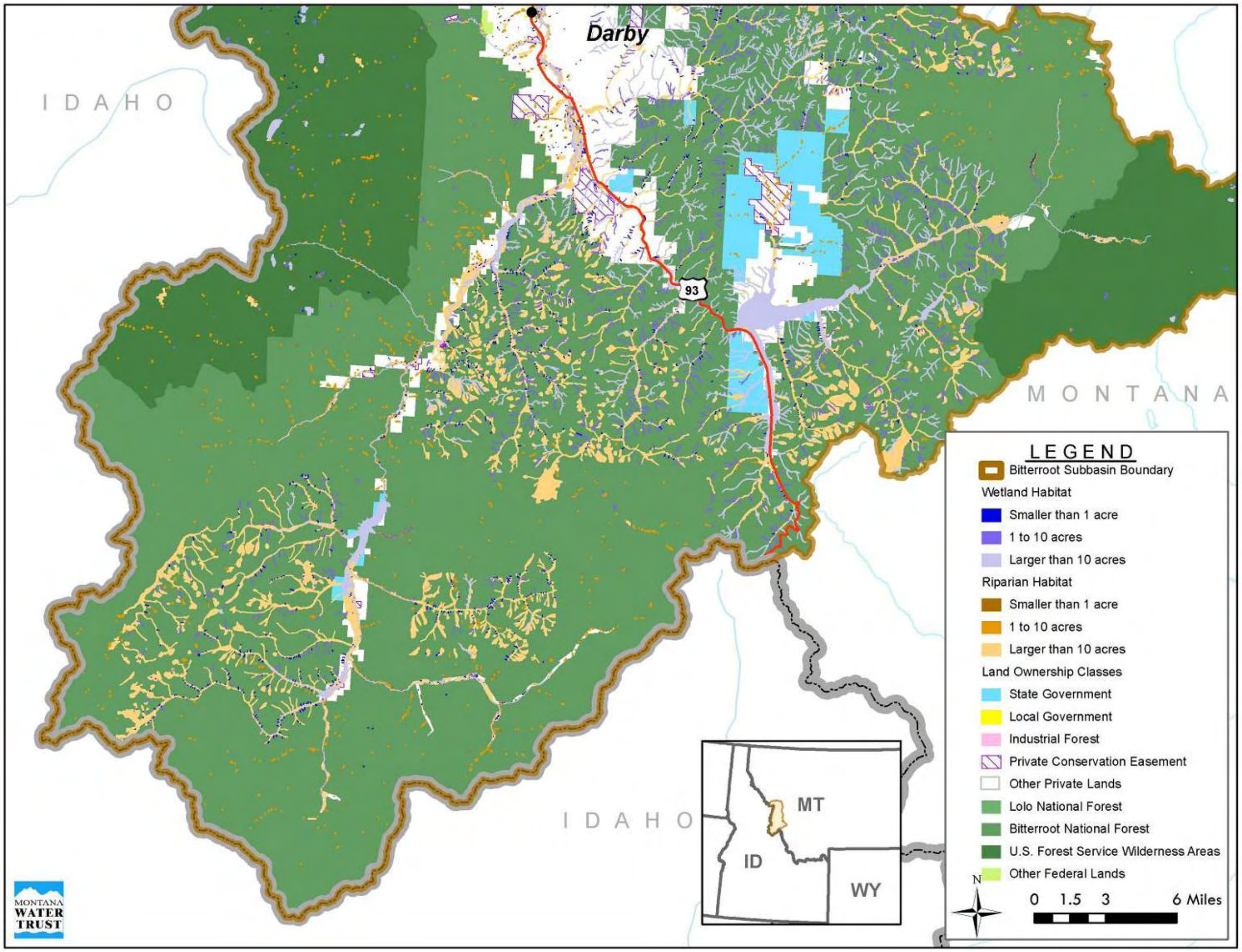


Figure 4.6. Distribution of wetland and riparian habitats in the Bitterroot Subbasin, southern section.
Data Sources: USFWS (2007), USFS (2001), Geum Environmental Consulting, Inc. (2005), USGS Gap Analysis Program (2005), and Montana Department of Administration (2008).

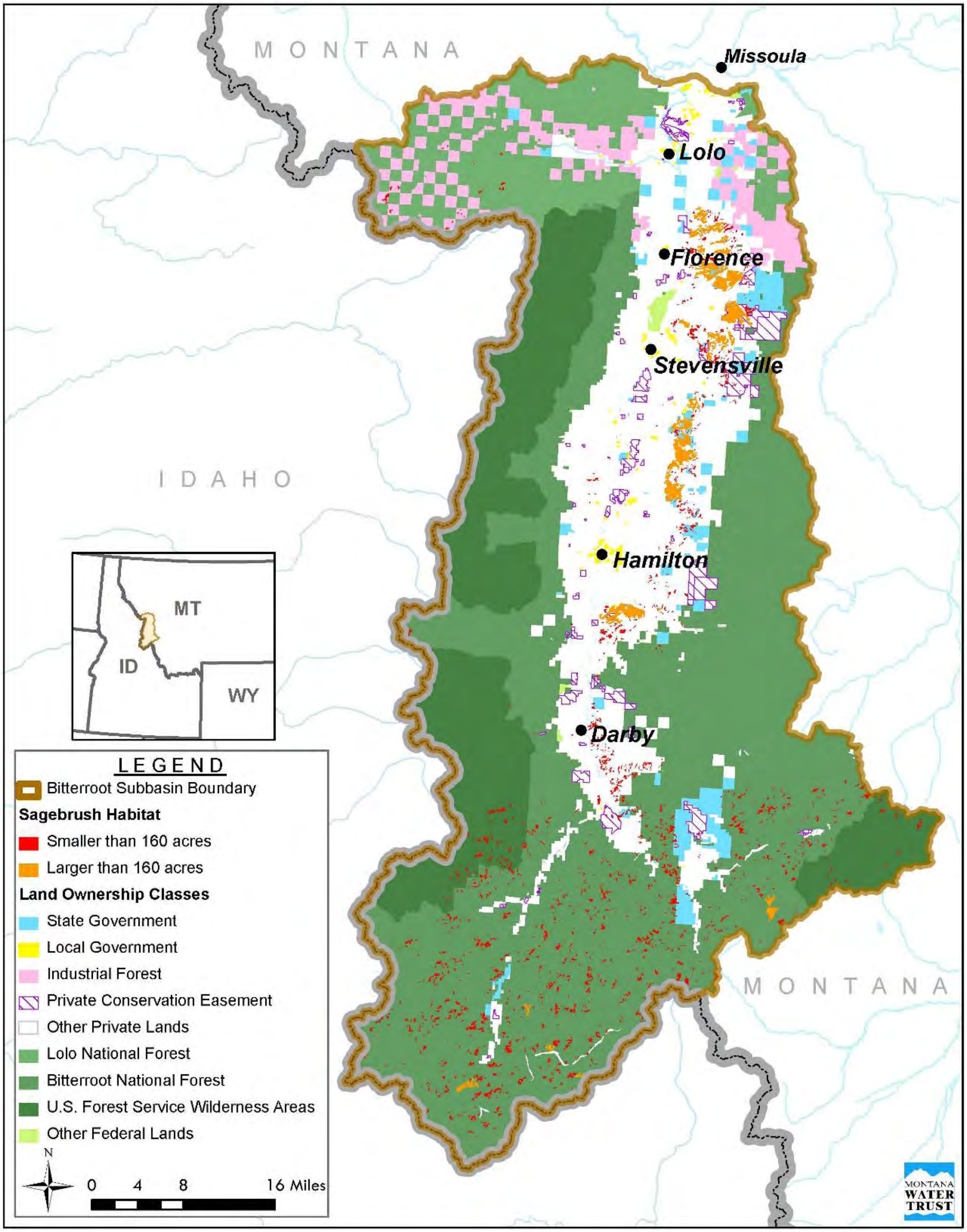


Figure 4.7. Distribution of sagebrush habitats in the Bitterroot Subbasin.
Data Sources: USGS GAP Analysis Program (2005) and Montana Department of Administration (2008).

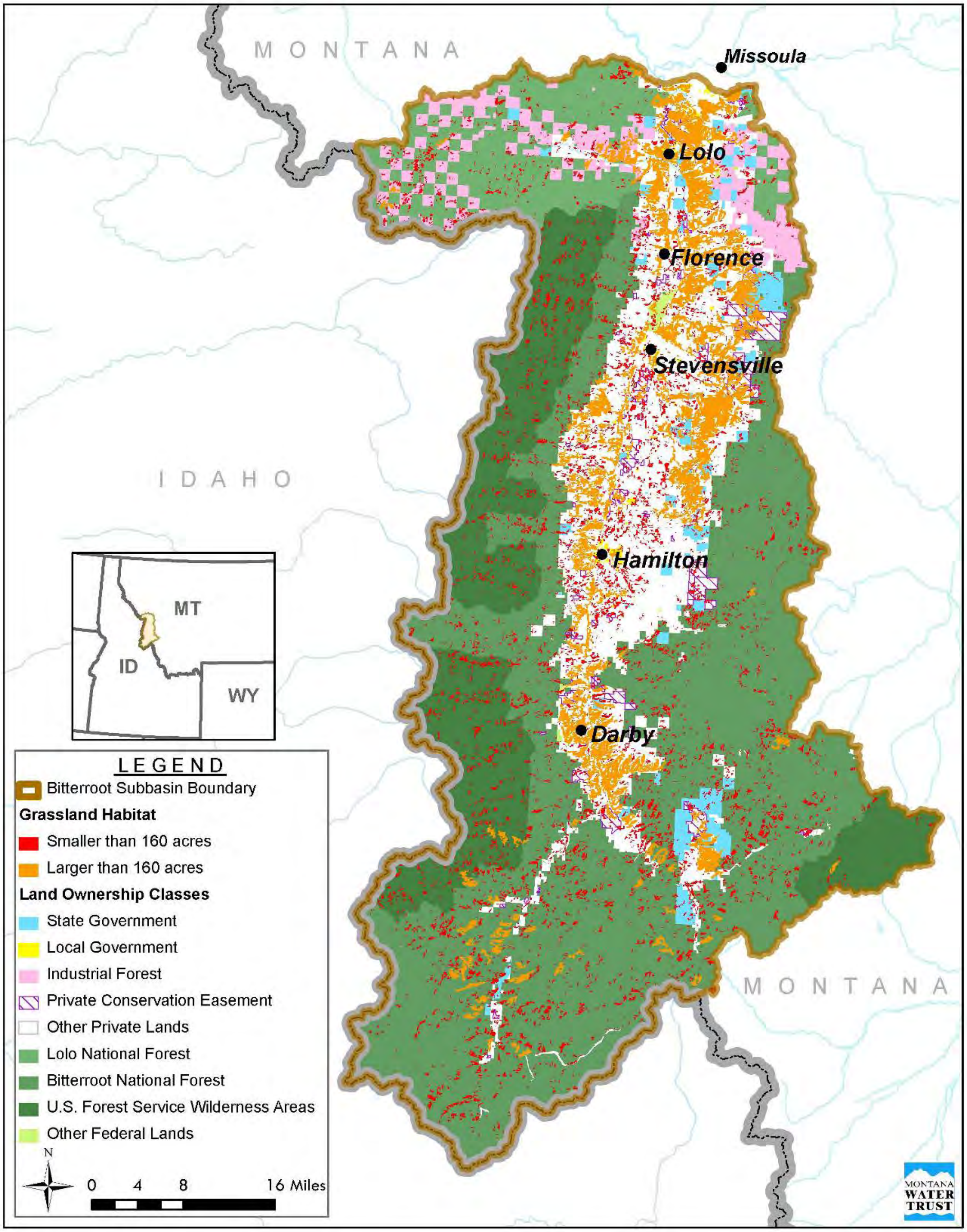


Figure 4.8. Distribution of grassland habitats in the Bitterroot Subbasin.
Data Sources: USGS GAP Analysis Program (2005) and Montana Department of Administration (2008).

4.1.2.2 Partners in Flight Terrestrial Bird Conservation Habitats

The Montana Partners in Flight (PIF) bird conservation plan includes a detailed breakdown of bird species at risk in Montana by habitats (Casey 2000). The PIF plan includes a Priority I status for bird species that require conservation action and a Priority II status for species that require monitoring and/or conservation action. These priorities are based on criteria such as threats, declining populations, and proportion of the species range found in Montana. The plan describes 57 Priority I and II bird species, 34 of which are found in the Bitterroot Subbasin (Tables 4.3 and 4.4).

The PIF plan uses five major habitat categories (grassland, shrubland, forest, riparian, and wetland) and prioritizes specific habitats that exist within each. These habitat categories correspond well to the Montana Comprehensive Fish and Wildlife Strategy categories, and prioritized specific habitats correspond closely to Montana GAP analysis vegetation units (Casey 2000 includes a table explaining the relationship to GAP units). The detail in the PIF habitat associations allows a closer look at the specific habitats preferred by target bird species.

Table 4.11 lists the PIF habitat categories and the priority bird species associated with each. The general habitat category with the largest number of PIF Priority I and II birds in the Bitterroot is forest, with 14 species. Wetland habitat has 11 PIF species, but they are all migrants in the subbasin, meaning that the habitat in the Bitterroot is used opportunistically, and considered a lower priority than breeding habitat. Riparian habitat has 10 species, eight of which are breeding species. Given that 64 percent of the subbasin is covered in conifer forest, while only 1.7 percent of the total land area is in wetland and riparian habitats combined, wetland and riparian habitats are vastly more important for priority birds per unit area than forested habitats.

The five highest priority *specific* bird habitats in the PIF statewide analysis are: riparian deciduous forest, dry forest (ponderosa pine/Douglas fir), mixed grasslands and sagebrush steppe, and prairie pothole wetlands. The first four of these are found in the Bitterroot Subbasin, and should be a high priority for conservation at the subbasin scale. The PIF high Priority (I and II) bird species for two of these specific habitats—riparian deciduous forest and dry forest—are extremely well represented in the Bitterroot Subbasin's occurrences of those habitats.

Prairie potholes do not exist in the subbasin, although artificial ponds like those found on the Lee Metcalf National Wildlife Refuge are analogous. The majority of the priority bird species tied to prairie pothole habitat are migratory water birds breeding on the Great Plains. They only occur briefly in the Bitterroot Subbasin as they migrate through.

Mixed grassland and sagebrush steppe habitats have the fewest priority bird species in the subbasin. Many of the PIF-Montana species are not found in the Bitterroot (e.g. Baird's sparrow (*Ammodramus bairdii*) and Sprague's pipit (*Anthus spragueii*)) because the continental centers of their distribution are in the Northern Great Plains. However, many of the PIF Priority III ("local importance for conservation planning") grassland bird species are present in the grasslands of the Bitterroot (e.g. Swainson's hawk, northern harrier (*Circus cyaneus*), short-eared owl (*Asio flammeus*), and bobolink (*Dolichonyx oryzivorus*)).

Table 4.11. Partners in Flight (PIF) habitat categories and associated priority I and II birds.

Habitat Category (by rank)	Specific Habitat	PIF Priority I and II Birds	Distribution in Bitterroot Subbasin
Riparian	Riparian deciduous forest	Barrows goldeneye Hooded merganser Bald eagle Cordilleran flycatcher Veery Red-eyed vireo Lewis woodpecker Yellow-billed Cuckoo	Migrant Breeding area Breeding area Breeding area Breeding area Breeding area Breeding area unknown
	Riparian shrub	Willow flycatcher	Breeding area
	Riparian conifer forest	Harlequin duck Hammonds flycatcher	Migrant (rare) Breeding area
Wetlands	Prairie pothole	Horned grebe Black tern Marbled godwit White-faced ibis Franklins gull Foresters tern Clarks grebe Willet	Migrant Migrant Migrant Migrant Migrant Migrant Migrant
	Intermountain valley	Common loon Trumpeter swan Common tern	Migrant Migrant/winter Migrant
	Irrigation/reservoirs<640 acres	Transient shorebirds (various)	Migrant
Forest	Dry forest (ponderosa pine/ Douglas fir)	Flammulated owl Lewis woodpecker	Breeding area Breeding area
	Cedar-hemlock	Brown creeper Vaux's swift Winter wren	Breeding area Breeding area Breeding area
	Burned forest	Black-backed Woodpecker Olive-sided flycatcher	Breeding area Breeding area
	Moist conifer	Northern goshawk Pileated woodpecker Williamsons sapsucker	Breeding area Breeding area Breeding area
	Aspen	Ruffed grouse Red-naped sapsucker	Breeding area Breeding area
Grassland	Mixed grass prairie	Long-billed curlew Grasshopper sparrow	Breeding area Breeding area
Shrublands	Sage steppe	Brewers sparrow Loggerhead shrike	Breeding area Migrant
	Montane shrublands*	Calliope hummingbird Lazuli bunting	Breeding area Breeding area
Specialized	Cliffs	Peregrine falcon Black swift	Breeding area Possible breeding

**Montane shrublands are not one of the high priority habitats in Montana, and are not treated here as a priority in the Bitterroot Subbasin, due to their abundance (e.g. clearcuts). These birds are widespread and fairly common in the Bitterroot Subbasin.*

From: Casey (2000), Goslin (2008), Lockman (2008), Storey (2008).

4.2.3 Correlation Between Conservation Target Species and Habitats

This section correlates the wildlife conservation target species with the conservation target habitats. Wildlife species are recommended as conservation target species if they are confirmed present in the Bitterroot Subbasin and if they meet at least one of the following six criteria:

- Montana Natural Heritage Program Species of Concern
- Montana Comprehensive Fish and Wildlife Conservation Strategy Tier I species
- U.S. Forest Service or BLM Sensitive Species
- Montana Partners in Flight Priority I or II bird species (primarily resident, breeding, and common migrant species—rare migrants not included)
- Key big-game species seasonally dependent on private land in the Bitterroot (elk, mule deer, moose, and bighorn sheep)
- Key habitat-specific species useful in monitoring

The "confirmed present" criteria eliminates species whose status is unknown, that were formerly present, or that are rare migrants or wanderers in the Bitterroot. Some birds classified as Species of Concern were not included if both MCFWCS and PIF regarded them as Tier III species (lowest priority).

Table 4.12 matches conservation target species with their conservation target habitats. The habitat associations are based on MNHP (2008), MFWP (2005), and Montana PIF (Casey 2000), and confirmed by local biologists. In a few cases, biologists recommended that additional species be added to the target species list, either because of their functional importance (beaver), or because they will facilitate monitoring and evaluation of their obligate habitat type (least flycatcher, long-toed salamander, and marsh wren).

The habitat categories were ranked in order of their importance for conservation in the subbasin based on the following criteria: (a) the number of Species of Concern found in that habitat; (b) the number of other target species found in that habitat; (c) the habitat's tier rank in Montana's Comprehensive Fish and Wildlife Conservation Strategy; and (d) the relative rarity of the habitat type on the Bitterroot landscape (scarcer habitats are more critical for immediate conservation action). The rankings are as follows:

Riparian	1
Wetland	2
Grassland	3
Sagebrush/Shrubland	4
Dry forest	5
Mesic forest	6

Another consideration for conservation planning is that the vast majority of the forest habitats in the subbasin are under the ownership and management control of the U.S. Forest Service, which has certain mandates to conserve species and habitats. The riparian, wetland, grassland and sagebrush habitat categories, on the other hand, are primarily on private lands, and therefore subject to more serious threats of alteration or destruction.

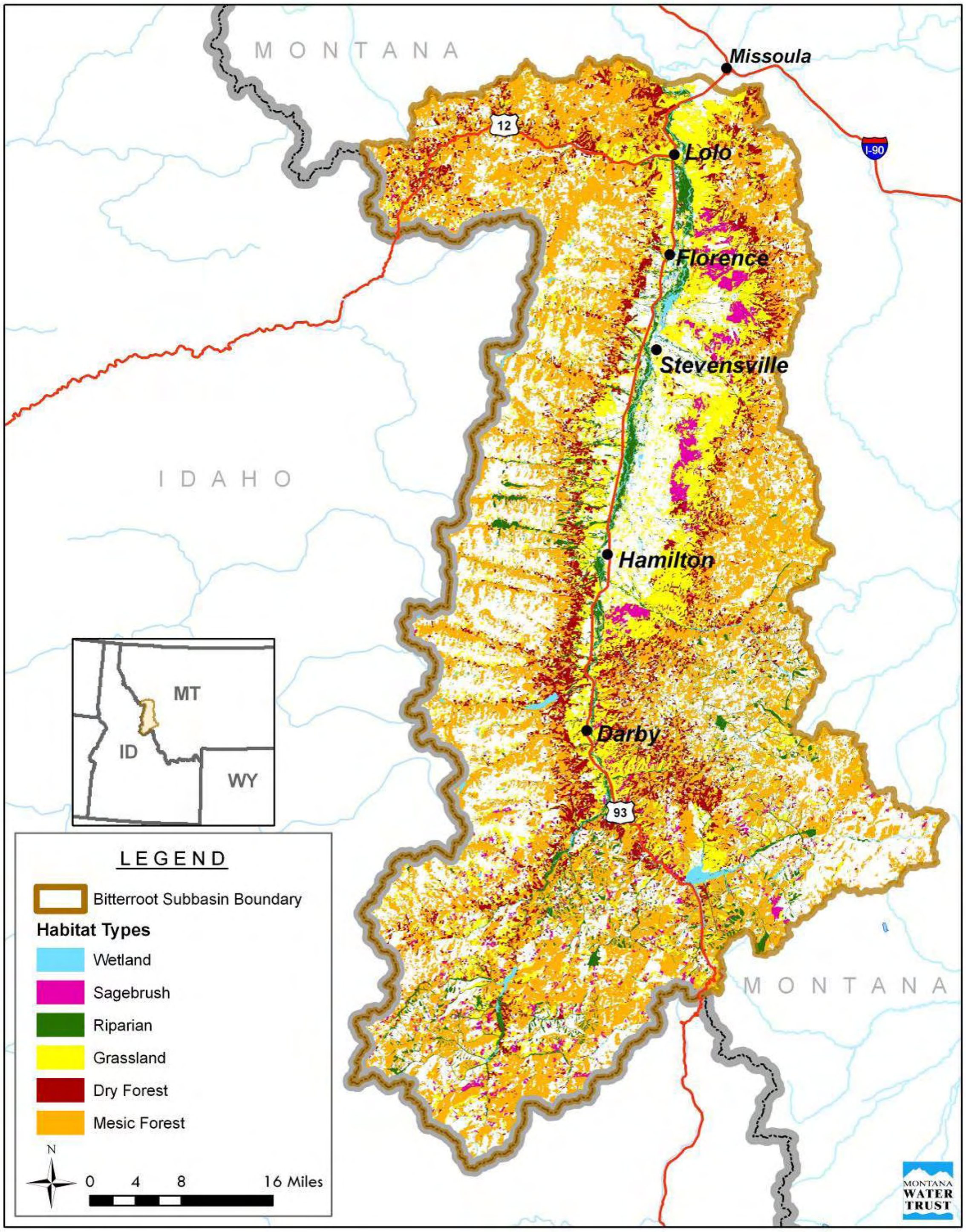


Figure 4.9. Overview of target habitat connectivity in the Bitterroot Subbasin.
Data Sources: USGS GAP Analysis Program (2005).

Table 4.12. Conservation target habitats and associated target wildlife species.

Target Habitat	MFWP Habitat Tier	Specific PIF Habitat & MFWP Habitat Type (if any)	Target Species M = monitoring species
1. Riparian	Tier I	PIF-Riparian Deciduous Forest (cottonwood) MFWP-Wetland and Riparian	Hooded merganser
			Bald eagle
			Least flycatcher-M
			Veery
			Red-eyed vireo
			Lewis' woodpecker
			Red-naped sapsucker
			Hoary bat/Fringed Myotis/ Townsends Big Eared bat
			Beaver-M
		PIF-Riparian Shrub MFWP-Wetland and Riparian	Moose (seasonal)
			Willow flycatcher
		PIF-Riparian Coniferous Forest MFWP-Wetland and Riparian/Conifer Riparian	Cordilleran flycatcher
			Northern bog lemming
			Long-toed salamander-M
2. Wetland	Tier I	PIF-Prairie Pothole MFWP-Wetland and Riparian	American bittern
		PIF-Intermountain Valley Wetland MFWP-Wetland and Riparian	Trumpeter swan
			Common loon
			Marsh wren-M
			Western toad-breeding
		PIF-Irrigation reservoirs MFWP-Wetland and Riparian	Transient shorebirds
3. Grassland	Tier I	PIF-Mixed Grass Prairie MFWP-Low to Moderate Cover Grasslands	Elk (winter)
			Bighorn sheep
			Preble's shrew
			Barn Owl
			Long-billed curlew
			Grasshopper sparrow
			Bobolink
			Western skink
4. Shrubland	Tier I	PIF-Sage Shrub Steppe MFWP-Sagebrush (also understood to include bitterbrush and mtn. mahogany in Bitterroot)	Elk (winter)
			Mule deer
			Brewer's sparrow
5. Dry Forest	Tier II	PIF-Dry Forest MFWP- Ponderosa Pine, Low-density Xeric Forest	Flammulated owl
			Cassin's finch
			Northern alligator lizard
			Western skink

Target Habitat	MFWP Habitat Tier	Specific PIF Habitat & MFWP Habitat Type (if any)	Target Species M = monitoring species
6. Mesic Forest	Tier II	PIF-Moist Conifer (Douglas fir, grand fir); and Western cedar-hemlock MFWP-Douglas fir, Mixed Mesic Forest, Western cedar, Western larch	Fisher
			Hoary bat/Fringed Myotis/ Townsends Big Eared bat
			Brown creeper
			Vaux's swift
			Winter wren
			Northern goshawk
			Williamson's sapsucker
			Pileated woodpecker
		PIF –Subalpine fir-spruce	Great gray owl
			Clark's Nutcracker
		PIF-Burned Forest MFWP-Standing Burnt Forest	Black-backed woodpecker
			Olive-sided flycatcher
			Three-toed woodpecker
		PIF-Aspen Forest (Broadleaf) MFWP-Mixed Broadleaf Forest	Ruffed grouse
			Red-naped sapsucker
		Conifer forests—General	Gray wolf
		Subalpine-alpine (rocky habitats near or above mesic forests)	Wolverine
			Mountain goat-M
			Pika-M
			Gray-crowned Rosy Finch
			Peregrine falcon
			Black swift

The Montana Tier II specific habitats include dry forest-ponderosa pine (also recognized as a high-priority specific habitat for PIF) and a variety of mesic forest types, including moist conifer (Douglas-fir and grand fir), western cedar-hemlock, subalpine fir-spruce, burnt forest, and aspen forest. Although this report regards dry forest and mesic forests as distinct conservation target habitats, more specificity in forest habitat types is difficult to justify. The dry forest and mesic forest types present a number of challenges for analysis including:

- The specific forest habitat types are difficult to distinguish in remote sensing, and the Montana GAP analysis admits a relatively high degree of error in identifying these types.
- Some of the target species have broad habitat use patterns that span many of these forest types (e.g. fisher and northern goshawk).
- Some bird species identified as having a specific habitat preference by PIF (e.g. brown creeper, Vaux's swift, and winter wren), either have broader habitat preferences or their habitat preferences are unknown.
- Habitat types and suitability can change drastically in response to fire, e.g. burned forest is a temporal habitat on the landscape.
- The key habitat factor for many of these forest species is not forest type, but forest structure, particularly age-class structure. In fact, many of the dry forest and mesic forest target species

were designated by various agencies as in need of conservation attention because of their dependence on older age classes of trees, including large snags, for some of their lifecycle needs (e.g. fisher, northern goshawk, Vaux's swift, pileated woodpecker, great gray owl, and flammulated owl). This means that maps of these specific habitats must be correlated with maps of age-class structure to understand the actual value of the remaining forest habitats to these species.

4.2.4 Limiting Factors and Primary Threats/Conservation Issues

Table 4.13 summarizes proposed limiting factors for the target wildlife habitat categories (major limiting factors are represented by an "X"). Limiting factors were developed through a consultation process with a team of local experts representing various agencies and conservation organizations working in the subbasin. Table 4.14 provides an expanded explanation of the causes of these limiting factors. Generally speaking, the limiting factors are affecting the wildlife target species because they reduce the amount and quality of habitat available and/or decrease the ability of wildlife to effectively use that habitat for each aspect of their lifecycle (e.g. interference with effective reproduction). Information on the specific impact of each limiting factor on a given target species is limited because of a lack of data. It is also beyond the scope of this analysis.

Table 4.13. Limiting factors identified for target habitats.

Limiting Factor	Riparian	Wetland	Grassland	Sagebrush	Xeric Forest	Mesic Forest
Water quality degradation (sediment, nutrient, agro-chemicals)		X				
Altered hydrology		X				
Altered channels (dikes, channelization)	X	X				
Agricultural land conversion			X	X		
Fragmented by development	X		X	X		
Fragmented by roads						X
Timber management					X	X
Fire regime					X	X
Insects and disease						X
Grazing regime	X			X		
Weeds & exotic species		X	X	X	X	
Wildlife/human conflicts (incl. pets, off-road vehicles, recreation)	X	X	X			

Table 4.14. Summary of limiting factors for conservation target terrestrial wildlife habitats in the Bitterroot Subbasin.

Target Habitats by Priority	Limiting Factors	Causes
1. Riparian	Altered channels causing floodplain to be non-functioning; cottonwood forest not regenerating	Flood/erosion control structures and resultant changes in channel form
	Destruction and fragmentation of riparian habitat by housing/transportation infrastructure (sometimes agriculture)	Subdivision and unplanned development near streams & rivers
	Grazing regime causing loss of plant diversity	Over-grazing shrubs, clearing riparian woody plants, trampling
	Conflicts causing disturbance of wildlife	Recreation, off-road vehicles, pets, etc.
2. Wetland	Altered hydrology or drainage of wetlands or cropfields	Irrigation uses, transportation infrastructure construction
	Altered channels preventing rivers and streams from accessing floodplain wetlands	Riprap or hardened flood and erosion control structures on channels, or incision of channels by erosion
	Noxious weeds and other invasive plant species	Disturbance, introduction of seeds from vehicles, water, livestock or other sources
	Conflicts causing disturbance of wildlife	Recreation, off-road vehicles, pets, etc.
3. Grassland	Conversion of grassland to cropland	Incentives or markets
	Fragmentation of habitat by development	Subdivision of land for residential use
	Loss of productivity due to weed invasion or invasive native species (e.g. conifers)	Roads, off road vehicles, over-grazing, and invasion by conifers (fire suppression)
	Conflicts resulting in disturbance of wildlife	Off-road vehicles, roads, domestic pets and other recreation
4. Sagebrush	Conversion of sagebrush to cropland	Incentives or markets
	Fragmentation of habitat by development	Subdivision of land for residential use
	Grazing regime altering species (enhancing weed invasion)	Fire regime changes (to improve grazing)
	Weed invasion (e.g. cheat grass) increasing vulnerability to fires	Roads and off-road vehicles
	Conflicts resulting in disturbance of wildlife	Off-road vehicles, roads, domestic pets and other recreation
5. Dry Forests	Extraction of old-growth age class and loss of structure	Unsustainable timber harvest policies on private and public lands
	Fire regime change: fuel load build-up/ over-growth of ladder fuels, more destructive fires	Fire suppression
	Weed invasion of grass understory	Roads, trails, and off-road vehicles
6. Mesic Forests	Over-harvest of older age-class trees	Unsustainable timber harvest policies on private and public lands
	Fragmented by roads: Wildlife security degraded by high density of forest roads	Past timber extraction policies; conflicts over road use, travel planning
	Stand-replacement fires increasing	Fire suppression, high fire intensity (climate change), and additional fuel loads
	Insect invasion	Stress from fire suppression and drought/ climate change

4.3 Fish and Aquatic Resources

4.3.1 Species of Conservation Concern

Table 4.15 lists the aquatic species of concern. This list includes species with the following status: (1) species identified as threatened or endangered under the Endangered Species Act; (2) species identified as either candidate or proposed species under the Endangered Species Act; (3) ranks of G1 through G3 on the NatureServe ranking system; (4) species that have been recently delisted; and (5) species included as Tier I in Montana's Comprehensive Fish and Wildlife Conservation Plan (MFWP 2005).

Section 4.3.2 describes the current status and distribution of aquatic species in the subbasin. Of the species listed in table 4.15 only bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are included as focal species. Both are discussed in greater detail in Section 4.3.3. Most of the information about fish and aquatic resources is presented by 6th-field HUCs (subwatersheds) (Figure 2.12).

Table 4.15. Aquatic species of concern found in the Bitterroot Subbasin.

Species	Scientific Name	Group	Global/ State NHP Status[1]	Montana CFWCS[2]	USFWS Status	USFS Status	Distribution in Bitterroot Subbasin	Preferred Habitats
Bull trout	Salvelinus confluentus	Salmonid	G3 S2	MT Species of Concern Tier 1	Listed Threatened	Threatened	Resident (all life history forms)	Mtn streams, rivers, & lakes
Westslope cutthroat trout	Oncorhynchus clarki Lewinski	Salmonid	G4T3 S2	MT Species of concern Tier 1	None	Sensitive	Resident (all life history forms)	Mtn streams, rivers, & lakes
A Stonefly	*Zapada cordillera*	Stonefly	G3 S2	None	None	Species of Concern	Unknown	Alpine mtn streams
Western pearlshell	Margaritifera falcata	Mollusk	G4 S2S4	Tier 1	None	Species of Concern	Resident	Mtn streams/ rivers

[1] G1/S1 rank is highest risk and G5/S5 rank is lowest risk
[2] Tier I =greatest need, Tier II=moderate need, Tier III=lowest need
Source: MFWP (2008a), MNHP (2008) and NRIS (2008).

4.3.2 Aquatic Species Occurrence and Distribution

Historical Conditions

Three species of salmonids are native to the subbasin: bull trout, westslope cutthroat trout, and mountain whitefish (*Prosopium williamsonii*). Historically, all three were widely distributed, including in the mainstem Bitterroot River and all accessible tributaries. No major barriers to fish migration and distribution are known to have been present historically (MBTSG 1995). Table 4.16 lists other native fish species in the subbasin. Section 3.1 provides information on the historical condition of aquatic species.

Current Fish Species Status and Distribution

Table 4.16 lists the common and scientific names of fish currently present in the Bitterroot Subbasin broken down between native and introduces species.

Table 4.16. Fish species present in the Bitterroot Subbasin.

Common Name	Scientific Name
Native Fish Species	
Bull trout*	*Salvelinus confluentus*
Westslope cutthroat trout*	*Oncorhynchus clarki lewisi*
Mountain whitefish	*Prosopium williamsoni*
Largescale sucker	*Catostomus macrocheilus*
Longnose sucker	*Catostomus catostomus*
Slimy sculpin	*Cottus cognatus*
Northern pikeminnow	*Ptychocheilus oregonensis*
Redside shiner	*Richardsonius balteatus*
Longnose dace	*Rhinichthys cataractae*
Peamouth	*Mylocheilus caurinus*
Introduced Fish Species	
Northern Pike	*Esox lucius*
Yellowstone Cutthroat Trout	*Oncorhynchus clarkii bouvieri*
Rainbow trout	*Oncorhynchus mykiss*
Kokanee salmon	*Oncorhynchus nerka*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*
Largemouth bass	*Micropterus salmoides*
Pumpkinseed	*Lepomis gibbosus*
Yellow perch	*Perca flavescens*
Goldfish	*Carassius auratus*

**Focal species*
Source: MFWP (2008a).

The Bitterroot River is an important sport fishery for anglers in western Montana. For this reason and because the distribution of non-native trout species is also a significant limiting factor to focal species restoration and conservation, the following discussion on non-native trout species is included. Bull trout and westslope cutthroat trout are addressed in later sections.

Table 4.17 lists the current status of rainbow trout (*Oncorhynchus mykiss*) in the subbasin by 6th-field HUC. Table 4.18 lists the current status of brown trout (*Salmo trutta*) and Table 4.19 lists the current status of brook trout (*Salvelinus fontinalis*). Figure 4.10 shows primary rainbow trout and brown trout spawning streams.

The primary sport fish in the Bitterroot Subbasin are rainbow trout and brown trout. The following is summarized from Clancy (2007). Pressure estimates from the statewide survey indicate that the Bitterroot River supported an estimated 113,700 angler days during 2005 (McFarland 2006). Due to high fishing pressure, fishing regulations have become more restrictive in recent years to protect the adult fish. A creel census was conducted in 1992 and 1993 to assess these impacts. Overall, it indicated that fishing harvest was not having a serious impact on the population of trout but that monitoring should continue; however, angling pressure has nearly doubled since that census.

Based on the most recent sampling completed by MFWP, Bitterroot River trout populations appear to have remained stable over the past few years with some exceptions. Rainbow trout in particular have declined in number in the East Fork Bitterroot River and upper Bitterroot River, while the number of brown trout has increased (BNF 2007). Overall, the most recent rainbow trout population estimates (2006) indicate a negative trend in the number of rainbow trout in the upper river and a stable population in the downstream sections. This decline may be due to the presence of whirling disease. During 2005 and 2006 sentinel cages were used to assess the presence and degree of whirling disease. This study concentrated on the East Fork and upper Bitterroot River (Clancy 2007).

Table 4.17. Abundance of rainbow trout in streams of the Bitterroot River Subbasin by 6th-field HUC.

HUC	Stream	Abundance
170102050602	Lost Horse Creek	Rare
170102050405	East Fork Bitterroot River	Abundant
170102050304	Trapper Creek	Rare
170102051409	Lower Lolo Creek	Common
170102051505	Eightmile Creek	Incidental
170102051502	Threemile - Ambrose	Rare
170102050108	West Fork Bitterroot River	Abundant
170102051104	Bear Creek	Abundant
170102051501	Bass Creek	Common
170102051202	Willoughby Creek	Unknown
170102051103	Sweathouse Creek	Common
170102051602	O’Brien Creek	Abundant
170102051603	Bitterroot River-Lower	Common
170102051404	Upper Lolo Creek	Common
170102051601	Miller Creek	Common
170102051407	South Lolo Creek	Common
170102051302	Kootenai Creek	Abundant
170102050703	Sleeping Child Creek	Rare
170102050401	Moose Creek	Incidental
170102050804	Tin Cup Creek	Rare
170102050202	Nez Perce Fork	Unknown (not present)
170102051507	Swan Creek	Unknown
170102051504	Sweeney Creek	Abundant
170102051506	Bitterroot River-Middle	Common
170102051201	Big Creek	Abundant
170102051301	McCalla Creek	Unknown
170102051004	Gird Creek	Rare
170102051102	Fred Burr Creek	Common
170102051101	Mill Creek	Abundant
170102050103	Hughes Creek	Unknown (not present)
170102051006	Willow Creek	Common
170102051005	Blodgett Creek	Common
170102050901	Skalkaho Creek	Rare
170102051002	Sawtooth Creek	Rare
170102051001	Roaring Lion Creek	Common
170102050807	Bitterroot River-South	Common
170102050805	Rock Creek	Rare
170102050802	Rye Creek	Incidental
170102050402	Martin Creek	Unknown (not present)

HUC	Stream	Abundance
170102050504	Cameron Creek	Unknown (not present)
170102050302	Boulder Creek	Unknown (not present)
170102050404	Meadow Creek	Unknown (not present)
170102050303	Piquette Creek	Rare
170102050505	Warm Springs Creek	Rare
170102050501	Tolan Creek	Rare
170102050502	Camp Creek	Common
170102050106	Blue Joint Creek	Unknown (not present)
170102050107	Slate Creek	Unknown (not present)
170102050104	Overwhich Creek	Unknown (not present)
170102050101	Deer Creek	Unknown (not present)
170102051304	Burnt Fork	Rare

Source: MFWP (2008a).

Table 4.18. Abundance of brown trout in streams of the Bitterroot River Subbasin by 6th-field HUC.

HUC	Stream	Abundance
170102050602	Lost Horse Creek	Rare
170102050405	East Fork Bitterroot River	Common
170102050304	Trapper Creek	Rare
170102051409	Lower Lolo Creek	Common
170102051505	Eightmile Creek	Unknown
170102051502	Threemile – Ambrose Creek	Rare
170102050108	West Fork Bitterroot River	Rare
170102051104	Bear Creek	Common
170102051501	Bass Creek	Unknown (absent)
170102051202	Willoughby Creek	Unknown
170102051103	Sweathouse Creek	Common
170102051602	O'Brien Creek	Unknown
170102051603	Bitterroot River-Lower	Abundant
170102051404	Upper Lolo Creek	Common
170102051601	Miller Creek	Rare
170102051407	South Lolo Creek	Unknown
170102051302	Kootenai Creek	Rare
170102050703	Sleeping Child Creek	Unknown
170102050401	Moose Creek	Rare
170102050804	Tin Cup Creek	Rare
170102050202	Nez Perce Fork	Unknown
170102051507	Swan Creek	Unknown
170102051504	Sweeney Creek	Unknown
170102051506	Bitterroot River-Middle	Abundant
170102051201	Big Creek	Common
170102051301	McCalla Creek	Unknown
170102051004	Gird Creek	Abundant
170102051102	Fred Burr Creek	Unknown (not present)
170102051101	Mill Creek	Unknown
170102050103	Hughes Creek	Unknown (not present)
170102051006	Willow Creek	Common
170102051005	Blodgett Creek	Common
170102050901	Skalkaho Creek	Abundant
170102051002	Sawtooth Creek	Unknown (Rare)
170102051001	Roaring Lion Creek	Rare
170102050807	Bitterroot River-South	Abundant
170102050805	Rock Creek	Unknown
170102050802	Rye Creek	Rare
170102050402	Martin Creek	Unknown

HUC	Stream	Abundance
170102050504	Cameron Creek	Unknown
170102050302	Boulder Creek	Unknown
170102050404	Meadow Creek	Unknown (not present)
170102050303	Piquette Creek	Rare
170102050505	Warm Springs Creek	Rare
170102050501	Tolan Creek	Rare
170102050502	Camp Creek	Rare
170102050106	Blue Joint Creek	Unknown (not present)
170102050107	Slate Creek	Unknown (not present)
170102050104	Overwhich Creek	Unknown (not present)
170102050101	Deer Creek	Unknown (not present)
170102051304	Burnt Fork	Common

Source: MFWP (2008a).

Table 4.19. Abundance of brook trout in streams of the Bitterroot River Subbasin by 6th-field HUC.

HUC	Stream	Abundance
170102050602	Lost Horse Creek	Common
170102050405	East Fork Bitterroot River	Rare
170102050304	Trapper Creek	Abundant
170102051409	Lower Lolo Creek	Common
170102051505	Eightmile Creek	Common
170102051502	Threemile – Ambrose Creek	Abundant
170102050108	West Fork Bitterroot River	Common
170102051104	Bear Creek	Abundant
170102051501	Bass Creek	Abundant
170102051202	Willoughby Creek	Unknown
170102051103	Sweathouse Creek	Common
170102051602	O'Brien Creek	Rare
170102051603	Bitterroot River-Lower	Incidental
170102051404	Upper Lolo Creek	Unknown
170102051601	Miller Creek	Common
170102051407	South Lolo Creek	Unknown
170102051302	Kootenai Creek	Common
170102050703	Sleeping Child Creek	Common
170102050401	Moose Creek	Incidental
170102050804	Tin Cup Creek	Abundant
170102050202	Nez Perce Fork	Abundant
170102051507	Swan Creek	Unknown
170102051504	Sweeney Creek	Common
170102051506	Bitterroot River-Middle	Incidental
170102051201	Big Creek	Rare
170102051301	McCalla Creek	Common
170102051004	Gird Creek	Common
170102051102	Fred Burr Creek	Abundant
170102051101	Mill Creek	Common
170102050103	Hughes Creek	Common
170102051006	Willow Creek	Unknown
170102051005	Blodgett Creek	Rare
170102050901	Skalkaho Creek	Incidental
170102051002	Sawtooth Creek	Rare
170102051001	Roaring Lion Creek	Common
170102050807	Bitterroot River-South	Common
170102050805	Rock Creek	Rare
170102050802	Rye Creek	Abundant
170102050402	Martin Creek	Unknown
170102050504	Cameron Creek	Abundant

HUC	Stream	Abundance
170102050302	Boulder Creek	Rare
170102050404	Meadow Creek	Unknown (not present)
170102050303	Piquette Creek	Abundant
170102050505	Warm Springs Creek	Rare
170102050501	Tolan Creek	Unknown (not present)
170102050502	Camp Creek	Common
170102050106	Blue Joint Creek	Unknown
170102050107	Slate Creek	Rare
170102050104	Overwhich Creek	Unknown
170102050101	Deer Creek	Common
170102051304	Burnt Fork	Common

Source: MFWP (2008a).

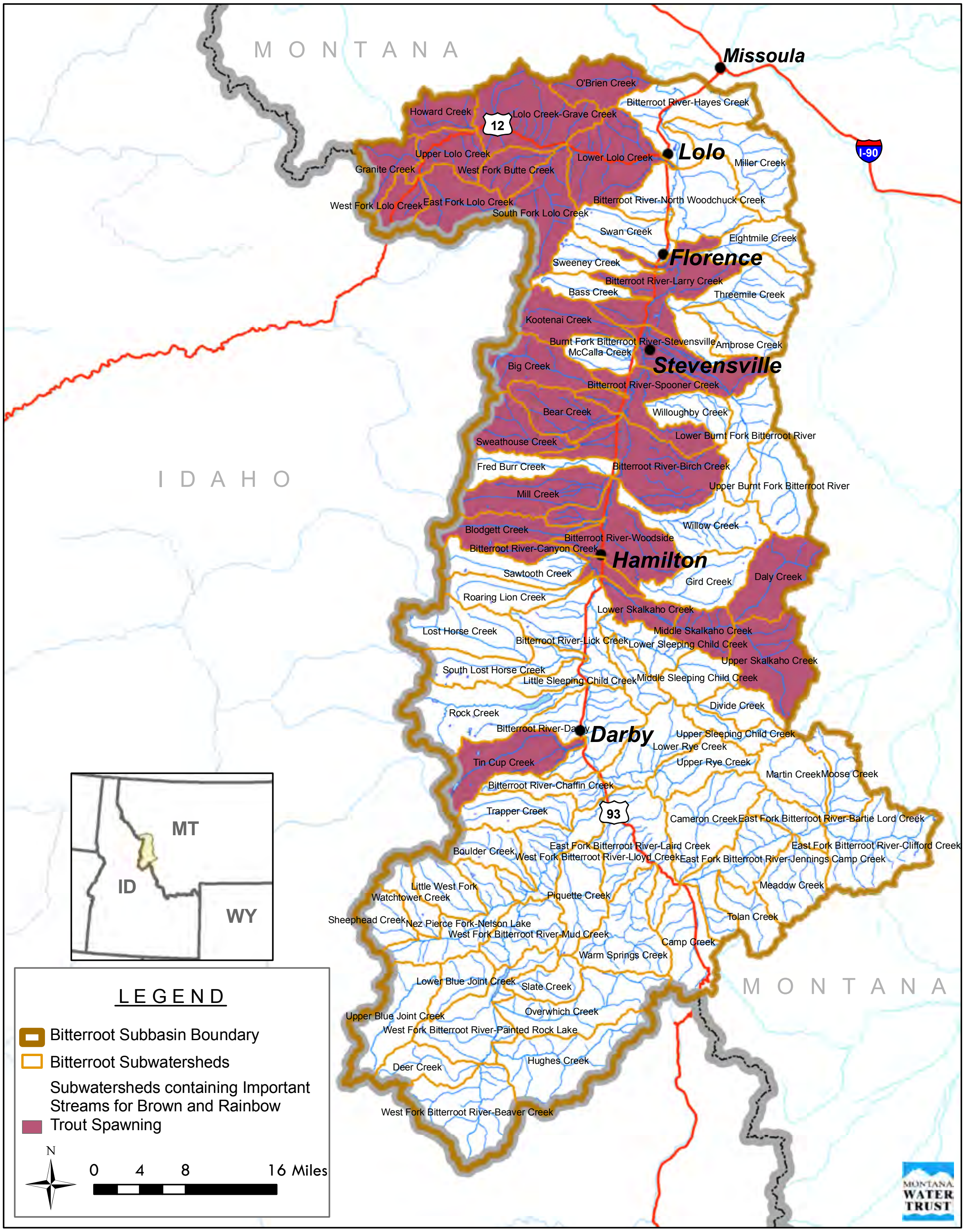


Figure 4.10. Key brown trout and rainbow trout spawning streams in the Bitterroot Subbasin.
Data Sources: Clancy pers. comm. (2007 and 2008) and Knotek pers. comm. (2008).

Aquatic Insects and Mollusks

Portions of the Bitterroot Subbasin are included in an area along the Montana/Idaho border that has been referred to by zoologists as the Northern Rocky Mountain Refugium (Gustafson 2001). It encompasses a large, diverse landscape that extends from Lookout Pass in the north to south of Lost Trail Pass. In simplest terms, it is the mountainous, forested area that was neither covered by northern ice sheets during the glacial periods nor paved with lava from eruptions to the south and west. Higher elevations within the area also allowed land animals to survive the fluctuating water levels of Glacial Lake Missoula. This "refugium" supports several endemic genera of invertebrates, with additional species that are endemic or widely separated (disjunct) from the Pacific mountain ranges of Oregon and Washington. The eastern slope of this area has been called the Missourian Refugium by fish zoogeographers, and is believed to have been a colonization point for the westslope cutthroat trout (MNHP 2007).

Table 4.15 lists the aquatic species of concern either found or thought to occur in the Bitterroot Subbasin. A stonefly, *Zapada cordillera*, is listed as a species of concern within the subbasin (MNHP 2008; Stagliano et al. 2007 and CNK 2006). Its preferred habitat is alpine mountain freshwater streams. Very little is known about the species in terms of presence, abundance, distribution, and life history requirements. It is even uncertain if the species occurs in the Bitterroot Subbasin. For this reason, it is not considered a focal species for conservation and restoration in this assessment.

In general, aquatic invertebrates that feed by grazing and scraping are intolerant of silt and sedimentation that tends to embed cobbles that contain their food source. Thus, impacts affecting vegetation in the riparian zone that would lead to streambank instability and increased fine sediment in the streambed substrate and otherwise degrade aquatic habitat, is the primary concern for these populations. The aquatic invertebrates and native fish species have very similar ecological requirements in terms of cool, clean water and diverse aquatic habitats. Therefore, focusing aquatic conservation and restoration on focal fish species should also improve habitat for sensitive or potentially sensitive aquatic invertebrates. Even though these assumptions seem reasonable, there is some uncertainty because of the limited amount of information on the life history of stream-dwelling invertebrates (CNK 2006). There is a risk that an individual mayfly or stonefly species may have a unique habitat requirement that is not accounted for by native fish species' habitat requirements.

In addition to the aquatic insect species described above, one aquatic mollusk (bivalve), the western pearlshell (*Margaritifera falcate*), is a Montana species of concern found in the Bitterroot Subbasin. The western pearlshell is also ranked as a Tier 1 species by the Montana Comprehensive Fish and Wildlife Conservation Strategy (MFWP 2005) due to declining populations.

The western pearlshell is Montana's only coldwater-trout-stream mussel, and the only native mussel found in the Montana portion of the Columbia River basin. The western pearlshell is often found in drainages occupied by trout, including westslope cutthroat trout, bull trout, rainbow trout, and brown trout, which are hosts to the mussel during the parasitic larval portion of its lifecycle. Movement of host fish can transport mussel larvae, benefiting the species long-term survival (MNHP 2008 and BNF 2007). The BNF surveyed for western pearlshell at 38 sites on 26 different streams in the subbasin in 2007. Distribution data collected by the BNF and MNHP for western pearlshell are shown in Figure 4.11. There are four known populations in the subbasin (Maxell pers. comm. 2008).

Conservation concerns for western pearlshell include habitat degradation and fragmentation (e.g., dams), point and nonpoint source pollution, and stream deterioration due to high sediment loads from agricultural runoff. Conservation strategies for this species include development of a management plan for the western pearlshell or including it in another comprehensive taxonomic plan, enforcement of regulations addressing dumping of pollutants into waterways, and restoration of stream channels and riparian areas (MFWP 2005).

Because the western pearlshell has similar habitat requirements as focal fish species, they are not included as a separate focal species in this assessment.

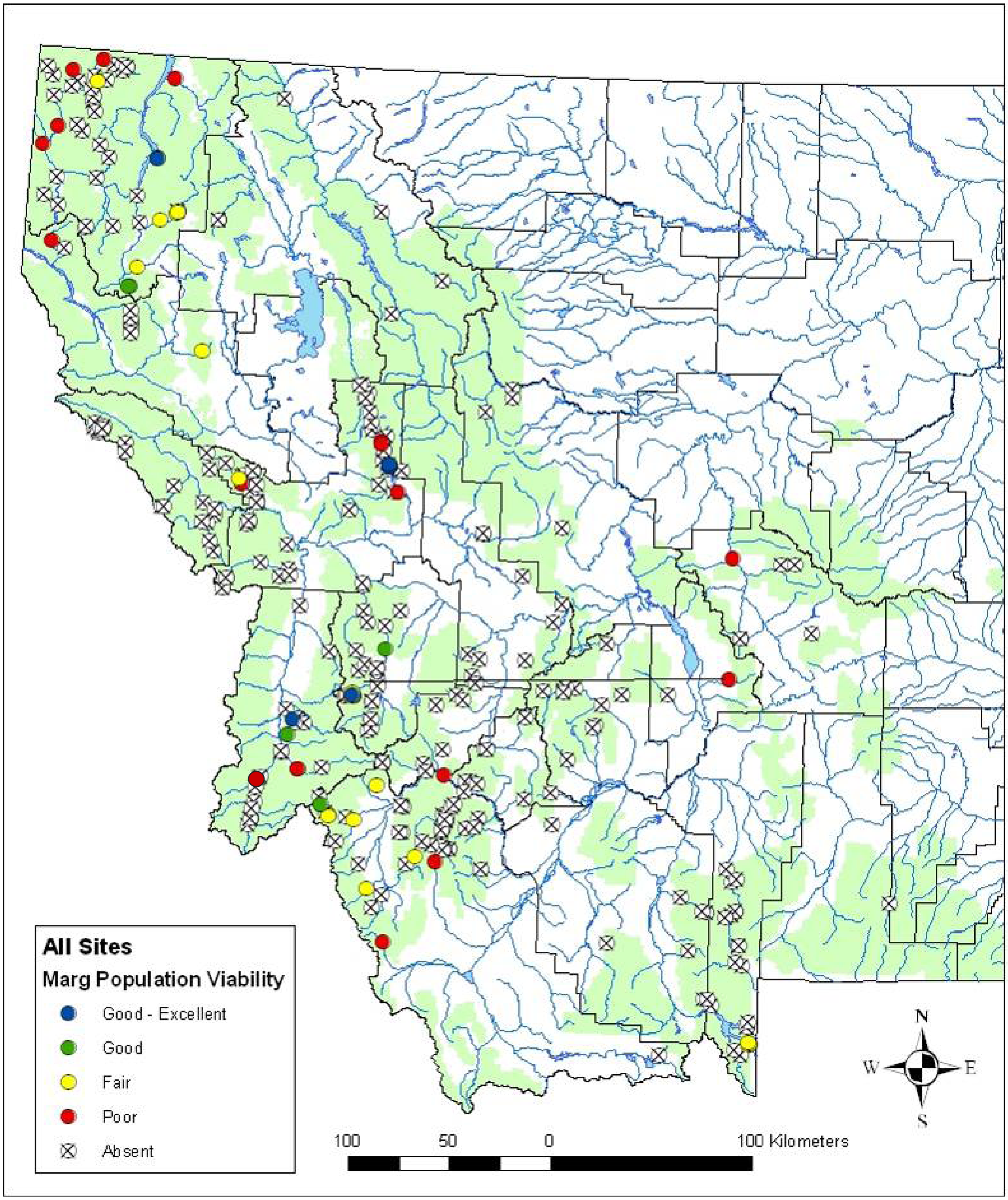


Figure 4.11. Montana Natural Heritage Program sampling sites and population viability for western pearlshell *(Margherita falcate*).
Data Sources: MNHP (2008).

4.3.3 Focal Species

Two aquatic focal species—bull trout and westslope cutthroat trout— were chosen based on the following criteria: they are native, have significantly reduced ranges, are listed as species of concern by the State of Montana, or are federally listed under the Endangered Species Act. Both are good indicators of ecosystem health. The paragraphs that follow describe the two species and provide information on methods for assessing ecological conditions related to their requirements and limiting factors.

4.3.3.1 6th-Field Hydrologic Unit Assessment

As part of assessing the ecological relationships between the current environment and focal species populations, the Bitterroot Subbasin planners and Aquatic Technical Subcommittee evaluated all the 6th-field hydrologic units (HUCs) in the subbasin, generally using the multi-scale assessment and planning framework developed by the Rocky Mountain Research Station. This assessment tool is being used in forest-plan revisions throughout U.S. Forest Service Regions 1 and 4. It includes a six step process for future management of aquatic resources: (1) documenting existing conditions; (2) determining desired conditions; (3) identifying risks and threats; (4) conducting an analysis of risks and threats; (5) developing a restoration strategy and (6) monitoring (see Appendices 6 and 7 for additional description and methodology). A modified version of this process was used to complete the following components of the subbasin assessment:

- Summarize population status of focal species in the subbasin by 6th-field HUCs;
- Describe existing environmental conditions within 6th-field HUCs; and
- Classify 6th-field HUCs according to the degree of anthropogenic disturbances and potential for restoration.

Existing environmental conditions within the subbasin were determined using the multi-scale aquatic assessment tool through an analysis of watershed integrity. This analysis ranks 6th-field HUCs according to the relative degree of anthropogenic disturbances that can potentially affect soil productivity, hydrologic and geomorphic processes, water quality, and ultimately aquatic habitats. The intent is to use anthropogenic disturbance as a surrogate for overall watershed condition (BNF 2006). Table 4.20 describes the disturbance indices used in the watershed integrity ranking. They play a dominant role in affecting surface and subsurface hydrologic patterns, surface erosion, channel stability, water quality, and aquatic habitat (BNF 2006). This assessment relies on the assumption that watersheds with the least amount of human disturbance continue to function within the natural range of variability under the present climatic conditions (BNF 2006).

At the focal species level, this assessment tool was used to determine the primary limiting factors or threats and risks to focal species. The assessment is based on ranking a series of risks and threats to focal species populations. Risks and threats are ranked on a scale from low (1) to extreme (4) by 6th-field HUC. Risks are intrinsic population characteristics such as genetic characteristics, recruitment, isolation, and population size. Threats are land uses or conditions that can directly, indirectly, or cumulatively affect watershed conditions or aquatic habitats. Table 4.21 provides a list of the risks and threats included in this planning tool.

The NWPCC subbasin technical guide recommends the use of Ecosystem Diagnosis and Treatment (EDT) model for use in describing environmental conditions within the subbasin. Other subbasins with only resident fish populations—the Kootenai and Flathead, for example—used an alternative habitat analysis tool called Qualitative Habitat Assessment (QHA) (Mobrand Biometrics as referenced in CSKT and MFWP 2004.). It involves ranking 6th-field HUCs on the basis of eleven stream habitat attributes considered key to resident salmonids (Table 4.22). The habitat attributes used in the stream version of QHA are generally thought to be the main habitat drivers of resident salmonid production and sustainability in streams (Parkin and McConnaha 2003 as referenced in CSKT and MFWP 2004). The Bitterroot Subbasin Aquatic Technical Subcommittee considered the use of both the EDT and QHA assessment tools, but ultimately decided not to use them and instead decided to modify the Forest Service Aquatic Multi-scale Assessment and Framework methodology for the following reasons:

- Both EDT and QHA would have required substantially more cost and time than was available for the aquatic assessment.
- The multi-scale assessment framework includes similar components as the subbasin plan (see Appendices 6 and 7).
- Sixty-eight percent of the land within the Bitterroot Subbasin is managed by the U.S. Forest Service. Therefore, there was a strong desire to coordinate the assessment methodologies used in the subbasin planning effort with those used by the Forest Service in their restoration planning.
- The multi-scale assessment had already been applied to Forest Service lands in the Bitterroot Subbasin which was appealing given the time and monetary constraints on developing this subbasin plan. Updating the rankings and applying the methodology to other lands in the subbasin was completed as part of developing the subbasin plan.
- The Aquatic Technical Subcommittee agreed that the watershed integrity index and threats ranked in the multi-scale assessment were adequate surrogates for the primary habitat factors influencing focal species populations, including those used in the QHA (Table 4.23).
- There are many streams for which habitat data are unavailable in the Bitterroot Subbasin. Much more is known about land uses. For this reason, the watershed integrity index was considered potentially more useful than speculation about habitat integrity, particularly within private land portions of HUCs.
- Almost every tributary has a distinct break in terms of habitat quality between the National Forest-administered portions of streams and privately owned portions. For this reason, a limiting-factors assessment tool that only considered habitat factors may have led to inappropriate results for determining restoration and conservation priorities. For example, by averaging habitat quality across an entire 6th-field HUC, it is possible that high-quality habitat on forested lands was underestimated and that on private lands it was overestimated, which could result in restoration priorities that do not reflect on-the-ground realities.
- By ranking 6th-field HUCs according to anthropogenic disturbance it provides a direct link to the effects of those disturbances, which can then be directly linked to restoration and conservation strategies.
- Assessing population viability risks at the 6th-field HUC assisted with development of biological objectives for each focal species.

For each 6th-field HUC, the technical subcommittee used quantitative data (if available) and professional knowledge and judgment to score each of the risks and threats. To assess the impact of these factors on focal species on a subbasin level, the subcommittee used the cumulative rankings for each category to calculate the percentage of HUCs ranked as either 'high' or 'extreme' (total number of HUCs with 'high' or 'extreme' rankings/total number of HUCs within subbasin boundary). The subcommittee then used these percentages to determine the primary factors limiting each focal species, based on the relative spatial distribution of the most harmful factors in relation to other threat/risk categories. This analysis was performed for both focal species (bull trout and westslope cutthroat trout) as well as on a subbasin-wide level. The latter, summarized as a 'watershed integrity' assessment, was used to evaluate overall subbasin environmental conditions. Figure 4.12 shows the results. Table 4.24 summarizes the rankings for each disturbance indicator, and Appendix 8 provides spatial displays of all other ranked risks and threats for each focal species. The following sections describe the results for each focal species assessment.

The watershed integrity assessment indicates that on a subbasin scale, the primary disturbance indicators affecting focal aquatic species habitat are related to roads and dewatering. The impacts of these disturbance factors on bull trout and westslope cutthroat trout are discussed in more detail in the following sections.

Table 4.20. Spatial indicators of anthropogenic disturbance used in Multi-scale Assessment Framework.

Disturbance	Measurement Parameter	Ranking	Data Source
Road/Stream Crossing Density	Percent composition of 30 meter pixels that contain a road/stream crossing	Low(1) Moderate(2) High(3) + Composite integrity ranking	GIS model
Road/Stream Proximity	Percent composition of 30 meter pixels that contain a road within 30 meters of a stream	Low(1) Moderate(2) High(3) + Composite integrity ranking	GIS model
Sediment Delivery Potential	Area-weighted average of sediment delivery values assigned to 30 sections of road	Low(1) Moderate(2) High(3) + Composite integrity ranking	GIS model
Dewatering	Expert panel ranking (low, moderate, high)	Low(1) Moderate(2) High(3) + Composite integrity ranking	Expert panel ranking
Urban Development	Percent composition of 30 meter pixels containing Urban Development	Low(1) Moderate(2) High(3) + Composite integrity ranking	GIS model using LANDFIRE vegetation layers
Agricultural Development	Percent composition of 30 meter pixels containing agricultural land within 30 meters of streams	Low(1) Moderate(2) High(3) + Composite integrity ranking	GIS model using LANDFIRE vegetation layers
Mining	Expert panel ranking (low, moderate, high)	Low(1) Moderate(2) High(3) + Composite integrity ranking	Expert panel ranking

Table 4.21. Description of risks and threats assessed to determine primary factors limiting focal aquatic species populations in the Bitterroot Subbasin.

Category/Element	Description	Ranking
Risks: Intrinsic population characteristics such as genetic characterization, recruitment, isolation and size		
R1: Temporal Variability in Recruitment and Survival	The likelihood of environmental disturbances and associated effects on variability and survival of the species. Low indicates short-lived disturbances and low variability in habitat conditions. High would indicate high variability in habitat conditions associated with unpredictable, relatively extreme events.	Extreme (4) High (3) Moderate (2) Low(1)
R2: Population Size	Low=population size of several thousand individuals in which all life stages are represented. Moderate = 500 individuals High=50 individuals.	Extreme(4) High (3) Moderate (2) Low (1)
R3: Growth & Survival	Assesses relative abundance and reproduction capability. Low=population is very resilient and can recover from exploitation and disturbances relatively fast (5-10 years), and habitat quality is very high. High=poor habitat conditions and little potential for recovery following disturbance events.	Extreme(4) High (3) Moderate (2) Low (1)
R4: Isolation	Assesses the relative connectivity of the population with other local populations.	Extreme(4) High (3) Moderate (2) Low (1)
R5: Overall Extinction Risk	Summary ranking, and is expressed as the maximum value found in R1-R4.	Extreme (4) High (3) Moderate (2) Low(1)
Threats: Environmental pressures that can ultimately effect native salmonids		
T1: Road Related	Road-related threats using Integrated Road Hazard which integrates (a) surface erosion and sediment delivery potential, (b)road-stream crossing density, and (c)road proximity to streams within 100 feet).	Extreme (4) High (3) Moderate (2) Low (1)
T2: Non Native Species	Species known to compete against or displace bull trout or westslope cutthroat trout including hybridization.	Extreme(4) High (3) Moderate (2) Low (1)
T3: Migration Barriers	Threat of barriers to fish migration. Primarily road stream crossings with culverts.	Extreme(4) High (3) Moderate (2) Low (1)
T4: Mining	Relative degree mining is impacting aquatic habitats, water quality, and native fish.	Extreme(4) High (3) Moderate (2) Low (1)
T5: Livestock Grazing	Effects of livestock grazing on water quality and aquatic habitat. Many on private lands.	Extreme(4) High (3) Moderate (2) Low (1)
T6: Mixed Ownership	High = other ownerships have substantial impacts, or make conservation efforts a challenge	Extreme(4) High (3) Moderate (2) Low (1)
T7: Dewatering	Effects of dewatering on aquatic habitat.	Extreme(4) High (3) Moderate (2) Low (1)
T8: Temperature*	Effects of elevated stream temperatures on focal fish species.	Extreme(4) High (3) Moderate (2) Low (1)

**This threat is not included separately in the Forest Service multi-scale assessment framework, but was added by the Aquatic Technical Subcommittee due to its significance as a threat to focal fish species.*

Table 4.22. Description of eleven habitat attributes determined to be key to resident salmonid habitat and used in the Quality Habitat Assessment (QHA) tool used by other subbasins with resident fish species.

QHA Habitat Attributes	Description
Riparian Condition	Condition of the stream-side vegetation, land form and subsurface water flow.
Channel Stability	The condition of the channel in regard to bed scour and artificial confinement. Measures how the channel can move laterally and vertically and to form a "normal" sequence of stream unit types.
Habitat Diversity	Diversity and complexity of the channel including amount of large woody debris (LWD) and multiple channels.
Fine Sediment	Amount of fine sediment within the stream, especially in spawning riffles.
High Flow	Frequency and amount of high flows.
Low Flow	Frequency and amount of low flows.
Oxygen	Dissolved oxygen in water column and stream substrate.
High Temperature Duration	High Temperature Duration and amount of high summer water temperature that can be limiting to fish survival
Low Temperature Duration	Low Temperature Duration and amount of low winter temperatures that can be limiting to fish survival.
Pollutants	Introduction of toxic (acute and chronic) substances into the stream.
Obstruction Barriers	Barriers to fish movement.

Table 4.23. Link between disturbance indices evaluated in Multi-scale Assessment Framework and threats and Quality Habitat Assessment (QHA) tool habitat attributes.

Aquatic Multi-Scale Assessment Framework Disturbance Indicator	Related QHA Habitat Attrbutes
Road/Stream Crossing Density	Obstruction barriers Fine Sediment
Road/Stream Proximity	Pollutants Riparian Condition Channel Stability Habitat Diversity Fine Sediment Temperature Dissolved Oxygen Flow Frequency
Sediment Delivery Potential	Pollutants Riparian Condition Channel Stability Habitat Diversity Fine Sediment Dissolved Oxygen
Dewatering	Obstruction Barriers Riparian Condition Channel Stability Habitat Diversity Temperature Dissolved Oxygen Flow Frequency

Aquatic Multi-Scale Assessment Framework Disturbance Indicator	Related QHA Habitat Attrbutes
Urban Development	Pollutants Riparian Condition Channel Stability Habitat Diversity Fine Sediment Temperature Dissolved Oxygen Flow Frequency
Agricultural Development	Obstruction Barriers (irrigation infrastructure) Riparian Condition Channel Stability Habitat Diversity Fine Sediment Temperature Dissolved Oxygen Flow Frequency
Mining	Pollutants Riparian Condition Channel Stability Habitat Diversity Temperature Dissolved Oxygen Flow Frequency

Table 4.24. Summary of disturbance indicator rankings for 6th-field HUCS in the Bitterroot Subbasin.

Disturbance Indicator	Ranking				% of 6th-field HUCS ranking as high or extreme
	Low (1)	Moderate (2)	High (3)	Extreme (4)	
Road Crossing	33	37	16	0	19%
Road Proximity	40	26	20	0	23%
Urban Development	65	15	6	0	7%
Sediment Delivery Potential	57	18	11	0	13%
Agricultural Development	63	13	10	0	12%
Dewatering	42	13	27	4	36%
Mining	85	0	1	0	1%
Overall Watershed Integrity	31	22	33	0	38%

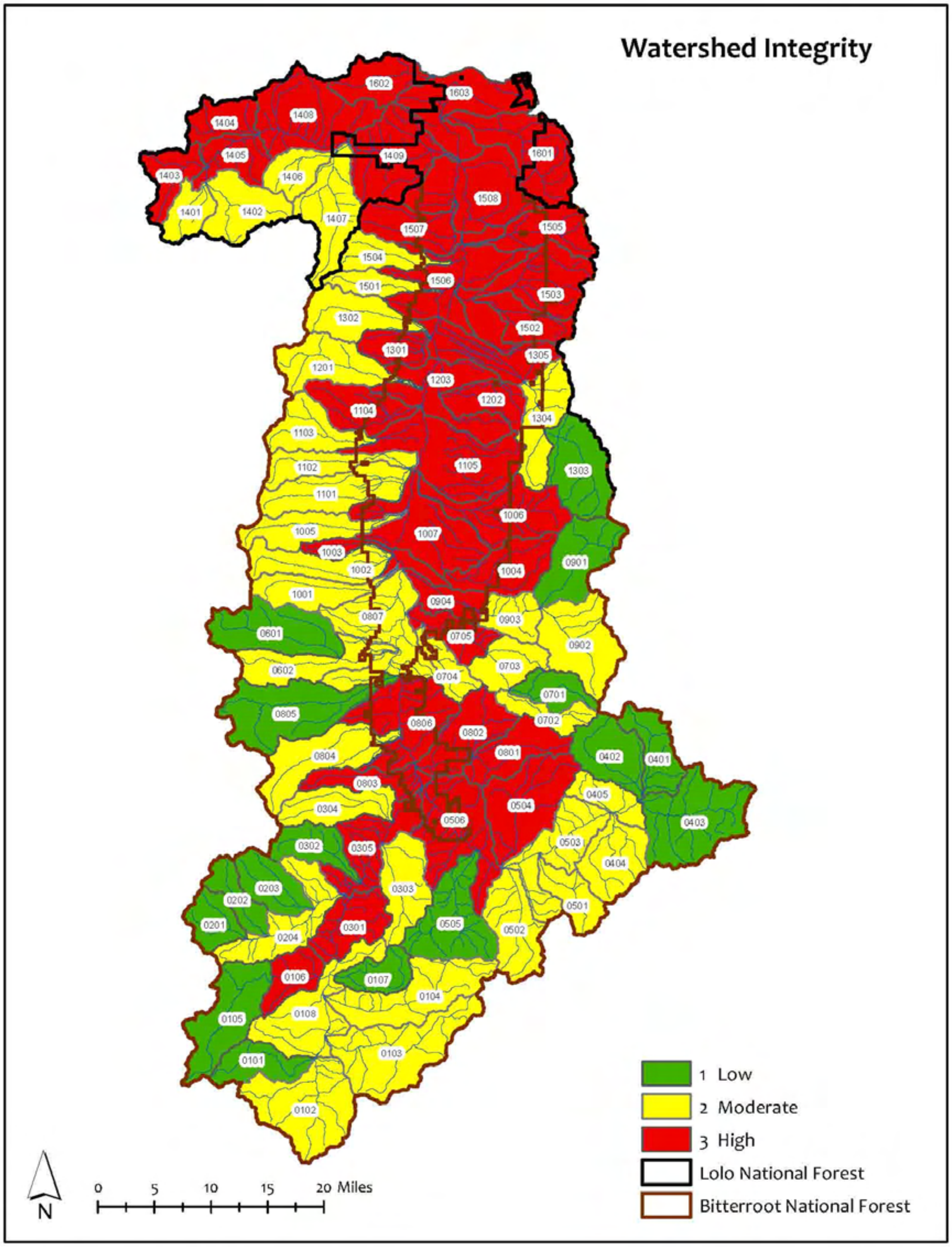


Figure 4.12. Results of Watershed Integrity assessment for the Bitterroot Subbasin by 6th-field HUC.

4.3.3.2 Bull Trout

Reasons for Selection as Focal Species

Globally, bull trout have a G3 ranking. The species is described as very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors (MNHP 2008). Bull trout, as part of the Columbia River population, was listed as Threatened under the Endangered Species Act in July 1998. The USFWS recovery priority number for bull trout in the coterminous United States is 9C, on a scale of 1 to 18, indicating that (1) taxonomically, these populations are distinct population segments of a species; (2) the populations are subject to a moderate degree of threats; (3) the recovery potential is high; and (4) the degree of potential conflict during recovery is high (USFWS 2002). The Forest Service lists bull trout as a sensitive species, primarily to emphasize habitat protection.

In Montana, bull trout have received a ranking of S2, meaning they are considered imperiled because of rarity or because of other factors demonstrably making them very vulnerable to extinction throughout their range. MFWP has designated them as a species of special concern due to their limited distribution, sensitivity to environmental disturbances, vulnerability to hybridization and/or competition with other fish species, and risk of over exploitation. Bull trout are a Tier 1 species, or species with the greatest conservation need, in MFWP's Comprehensive Fish and Wildlife Conservation Strategy (MWFP 2005).

Bull trout are considered an indicator of the health of the aquatic ecosystem. They have relatively strict habitat requirements, requiring high quality, cold water; high levels of shade; undercut banks; woody debris in streams; high levels of gravel in riffles with low levels of fine sediments; stable, complex stream channels; and connectivity among and between drainages (USFWS 2002). Bull trout also key in on groundwater upwelling areas, which often occur in functioning floodplains. These requirements make them a good indicator of the health of an aquatic environment. Because bull trout use the entire aquatic system in the subbasin, including the river and tributaries, they can reflect impacts to any single component of the system. Because of this and their federal and state conservation and protection status, bull trout were selected as a focal species.

Environmental-Population Relationships

The following bull trout habitat requirements are summarized from Montana Bull Trout Scientific Group (MBTSG 1995) and Montana Bull Trout Restoration Team (MBTRT 2000). Bull trout are generally migratory, spawning and rearing in smaller, higher-order streams, and then later rearing and overwintering in larger rivers or lakes. Migratory corridors link seasonal habitats for all bull trout life histories, and the ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Rieman et al. 1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Bull trout migrants can also reestablish local populations that have been extirpated by catastrophic events. Migratory forms of bull trout live in tributary streams for up to several years before migrating downstream into a larger river or lake, where they spend several years before returning to tributaries to spawn in early fall. Some or most juveniles move to larger rivers or to a lake by mid-summer, while others stay in spawning areas for two to four years. Adults return to the river or lake after spawning in small streams. Resident populations often occur in small headwater streams where they spend their entire lives. In lakes, bull trout inhabit all depths in fall, winter, and spring. They move to cooler, deeper water in summer.

Bull trout have very strict habitat requirements that are generally referred to as the four C's—clear, cold, complex, and connected. This includes clean, cold water; a high degree of shade, undercut banks, and habitat complexity (woody debris); gravel in riffles with very minimal fine sediment levels; stream channel stability and complexity; and the ability to migrate between drainages. Connectedness between populations allows periodic genetic exchange, as well as founding of new populations and recolonization of extirpated populations by migrants. The variety of bull trout life history strategies and their associated habitat requirements are important to the stability and persistence of populations, but these factors also complicate restoration and conservation.

Bull trout preferred habitat is the bottom of deep pools in cold rivers and large tributary streams, often in moderate to fast currents with temperatures of 45 to 50 degrees Fahrenheit (seven to 10 degrees Celsius). Large cold-water lakes and reservoirs are also preferred habitats.

Most bull trout spawning occurs between late August and early November (Pratt 1992; MBTSG 1998). Hatching occurs in winter or early spring, and alevins may stay in the gravel for extended periods, typically emerging from the gravel in April. Growth is variable with different environments, but first spawning is usually noted after age 4, and the fish may live 10 or more years (Pratt 1992; Rieman and McIntyre 1993). Although spawning typically occurs in second to fifth order streams, juveniles may move upstream or downstream of reaches used by adults for spawning, presumably to forage in other accessible waters (Fraley and Shepard 1989; Ratliff 1992). Seasonal movements by adult bull trout may range up to 300 kilometers as migratory fish move from spawning and rearing areas into over-winter habitat in large lakes or rivers in the downstream reaches of large basins (Bjornn and Mallet 1964; Fraley and Shepard 1989).

Bull trout usually spawn in gravel riffles of small tributary streams, including lake inlet streams. Spawning sites are often associated with springs or groundwater upwelling areas and the coldest streams in a given watershed. Spawning requires a large volume of cold water. Optimum temperatures for incubation are about 35 to 39 degrees Fahrenheit (two to four degrees Celsius) and 44 to 46 degrees Fahrenheit (seven to eight degrees Celsius) for rearing. Areas with large woody debris and rubble substrate are important as juvenile rearing habitat.

A number of sources report that all life-history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich 1996; Sexauer and James 1997; Watson and Hillman 1997). Jakober (1995) observed bull trout overwintering in the Bitterroot River in deep beaver ponds or pools containing large woody debris. Rich (1996) found that the distribution of bull trout in the subbasin was much more restricted than that of westslope cutthroat trout. Variables related to stream size, such as wetted width, stream order, basin area, average water depth, and habitat quality (frequency of woody debris and pool habitats) were the primary factors differentiating between bull trout presence and absence. In addition to these habitat variables, bull trout occurrence in the subbasin also appeared to be influenced by the presence of strong mainstem populations. Rich (1996) found that bull trout were more likely to be present in small streams adjacent to strong mainstem populations in the upper Bitterroot Subbasin relative to small streams not adjacent to strong mainstem populations.

Maintaining bull trout habitat requires stable stream channels and flow (Rieman and McIntyre 1993). Juveniles and adults frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989).

Population Characterization

Historical Distribution within the Subbasin

The Bitterroot Subbasin bull trout population is part of the Clark Fork River discrete population segment (USFWS 2002). The Clark Fork population has been physically separated from the rest of the Columbia River population by Albeni Falls, a natural falls forming Lake Pend Oreille, for at least 10,000 years. Upstream of Albeni Falls, there were no historical barriers to fish movement, thus bull trout in the Pend Oreille/Clark Fork drainage likely formed a large metapopulation (MBTRT 2000). Evidence of the separation of the Clark Fork and Columbia River populations includes lack of anadromous salmonids upstream of Albeni Falls. The Clark Fork River population, which includes Lake Pend Oreille and the entire Clark Fork River drainage upstream, was once perhaps the largest metapopulation in the historical range of bull trout. This metapopulation used several major drainages, including the Bitterroot, Blackfoot, Flathead, upper Clark Fork, and Rock Creek (Everman 1892). Bull trout from Lake Pend Oreille are known to have migrated upstream past Missoula to spawn, and probably also migrated up the Flathead, Bitterroot, and Blackfoot drainages. On-going research to genetically identify the geographic origins of bull trout captured in the Clark Fork River immediately downstream of Cabinet Gorge Dam in Idaho continues to document bull trout genetically assigned to populations in the upper Clark Fork (DeHaan and Hawkins 2008).

Bitterroot Subbasin bull trout were probably once widely distributed throughout the Bitterroot River and its tributaries. The following historical distribution of bull trout is summarized from MBTSG (1995). With the exception of barrier falls at higher elevations in tributary streams, there are no major natural barriers to fish migration that would have excluded bull trout from any significant portions of the Bitterroot River drainage. Historically, bull trout probably used the river, all of the major tributaries, and some of the smaller ones. Numerous authors mention the presence of bull trout in the Bitterroot River. Chalfant (1974) describes Native American use of bull trout in the Bitterroot River. He stated that historically, considerable fishing for bull trout, including the use of traps, occurred along the river and its tributaries in September and October.

Other authors describe bull trout from the Bitterroot River during more recent history (Evermann 1892; Anonymous 1929; Mitchell 1970). Oral histories from Salish tribal elders and local anglers who fished the river in the 1920s and 1930s describe large, migratory bull trout in the Bitterroot River. Whitney (1955) collected bull trout in Hughes Creek, Moose Creek, South Fork Skalkaho Creek, Meadow Creek, West Fork Bitterroot River, and Skalkaho Creek in 1952 and 1954. Unpublished data collected prior to 1970 by MFWP documented bull trout in the following waters (date of collection in parentheses): Burnt Fork Reservoir (1964), Painted Rocks Reservoir (1967), Nez Perce Fork Bitterroot River (1963, 1966), East Fork Bitterroot River (1952), Lolo Creek (1968), Lost Horse Creek (1961), and Lost Park Creek (1966).

Current Status and Distribution

Figure 4.13 shows the distribution and population status of bull trout in the subbasin based on current sampling. Figure 4.14 shows the location of critical habitat for bull trout (USFWS 2005). Designation of critical habitat is a regulatory process intended to provide additional protection for specific habitats of bull trout to help ensure the species recovery under the Endangered Species Act (USFWS 2005).

Bull trout are considered rare in the Bitterroot River (MBTSG 1995). The present distribution is reduced from historical levels, and the migratory lifeform has nearly disappeared. Bull trout appear to be absent, or nearly so, from the mainstem Bitterroot River from the mouth of the river to Blodgett Creek because few bull trout have been collected in this portion of the river in several years. From Blodgett Creek to the East Fork of the Bitterroot, they are rare, and in the upper reaches of the East and West Forks, some migratory fish (over 20 inches) exist, but in low numbers (MBTSG 1995).

In general, tributary streams now contain subpopulations of small bull trout in upper reaches that are isolated from other bull trout populations. Hence there is little or no genetic interchange among these subpopulations. Habitat degradation, dewatering, and other passage barriers have severed the connections between many of the tributaries and the mainstem Bitterroot River. The subbasin has 27 subpopulations of bull trout, indicating a high degree of habitat fragmentation where numerous groups of resident bull trout are restricted primarily to headwaters. In general, the 6th-field HUCs showing bull trout populations (Figure 4.13) contain small populations of small bull trout (rarely over 12 inches in length) in the upper reaches. These are isolated from other bull trout streams and often limited to headwater sections. Tributaries on the east side of the valley tend to have more bull trout than those on the west side (MBTSG 1995). Within tributary streams, various barriers, including the presence of competitive species such as brown trout, restrict bull trout distribution to upper reaches (Clancy pers. comm. 2008a). The strongest remaining migratory component of the bull trout population in the subbasin occurs in the East and West Forks of the Bitterroot River (Clancy 2008a and BNF 2008).

Core areas represent the closest approximation of a biologically functioning unit for bull trout. The combination of core habitat (habitat that could supply all elements for the long-term security of bull trout, including spawning and rearing, as well as foraging, migrating, and overwintering) and a core population (bull trout inhabiting a core habitat) constitutes the basic core area unit on which to gauge recovery within a recovery unit. In the Bitterroot Subbasin, core areas are the West Fork Bitterroot River drainage above Painted Rocks Reservoir (including all tributaries), the West Fork Bitterroot River downstream of Painted Rocks Reservoir, the upper East Fork of the Bitterroot River drainage above Bertie Lord Creek (including Meadow, Moose, Tolan and Warm Springs Creeks), Sleeping Child Creek drainage, Skalkaho Creek drainage, Fred Burr Creek drainage, Blodgett Creek, and Burnt Fork Creek drainage (MBTSG 1995).

Nodal habitats (containing critical overwintering areas and migratory corridors) are the East Fork of the Bitterroot River, the West Fork of the Bitterroot River, Painted Rocks Reservoir, and the entire Bitterroot River mainstem (MBTSG 1995). The entire mainstem is included because it provides connections between core populations.

Currently MFWP, BNF and the LNF conduct bull trout monitoring in the subbasin. Due to the lack of migratory fish, quantitative monitoring consists of time series population estimates of resident populations on the BNF. This monitoring began in 1989. Inventory information is available for streams throughout the subbasin and confirms the presence or absence of bull trout in various locations. The distribution and population status shown in Figure 4.13 is based on the current status of this sampling.

A summary of the most recent MFWP sampling efforts, as described in Clancy (2007), follows. During 2005 and 2006, MFWP personnel attempted to implant radio transmitters in fluvial bull trout in the East Fork Bitterroot River between Conner and Sula, Montana. Very few bull trout were captured during either sampling effort (Table 4.25). The catch-per-unit-effort indicates fewer fluvial bull trout in this reach than in 2000 (MFWP 2007). Radio transmitters were implanted in the two bull trout captured in 2005. While both made upstream movements and one migrated several miles upstream, neither entered a tributary stream. The lone fish captured in 2006 was released without planting a transmitter. In the East Fork Bitterroot River (stream mile 2.5), the number of large migratory bull trout has declined since 2000 (BNF 2007). At the same time in this reach, brown trout have substantially increased. This is particularly true in the portion of the river downstream of Sula.

In general, bull trout population estimates are more difficult to calculate due to the fewer number of bull trout in the monitoring-study sections of the river. However, during 2005 and 2006, bull trout population estimates were obtained in several streams. A common finding in comparisons of recent data with older data was that the number of bull trout, particularly in smaller sizes during 2006, was lower than past estimates. One site in particular, upper Warm Springs Creek (HUC 170102050505), had a much lower population than was estimated in the early 1990s. Appendix 4 summarizes bull trout population estimates based on this sampling.

Table 4.25. Number of fluvial bull trout captured in electrofishing in the East Fork Bitterroot River between Sula and Conner during spring of the years indicated.

Year	Miles	Number of Fluvial Bull Trout Captured
2000	15	10
2005	18	2
2006	9	1

From: Clancy (2007).

According to annual monitoring completed by the BNF since 1989, the resident bull trout populations across the forest have shown stable or inconclusive trends (BNF 2007). The populations typically show some natural fluctuations from year to year. In 2006 and 2007 the number of young bull trout in most of the core area populations was lower than past estimates (BNF 2007). As also noted by MFWP, the population in the Warm Springs Creek monitoring reach (at stream mile 7.4) was significantly lower than in recent years (BNF 2007). However, the bull trout populations in the Skalkaho Creek (at stream mile 16.8) and Daly Creek (at stream mile 0.7) monitoring reaches were within their long-term ranges in 2007 (BNF 2007). The BNF 2007 monitoring report concluded that it was unknown if the lower number of sampled bull trout was due to natural fluctuations in the populations or the beginning stages of a longer-term decline. Upper Rye Creek is one stream where the monitoring data indicate that bull trout have declined or possibly been extirpated since the 2000 fires. In contrast, bull trout population numbers have remained strong in the Skalkaho Creek drainage, despite research that shows there is little to no interchange with the Bitterroot River (BNF 2007).

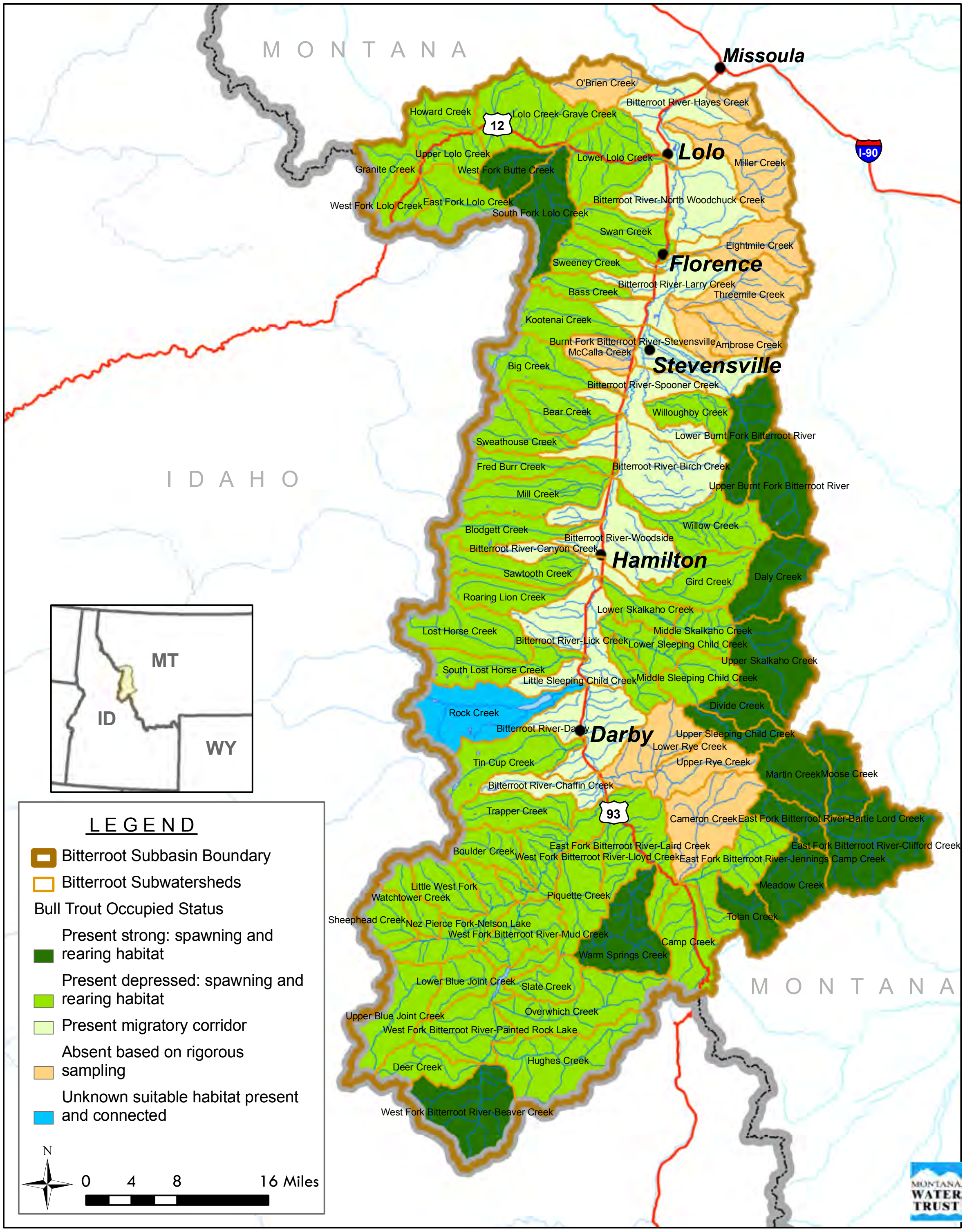


Figure 4.13. Distribution and population status of bull trout by subwatershed in the Bitterroot Subbasin. (Refer to Appendices 6 and 7 for status category descriptions.)
Data Sources: MFWP (2008a), BNF (2006), Clancy (2008), Knotek (2008), and Jakober (2008).

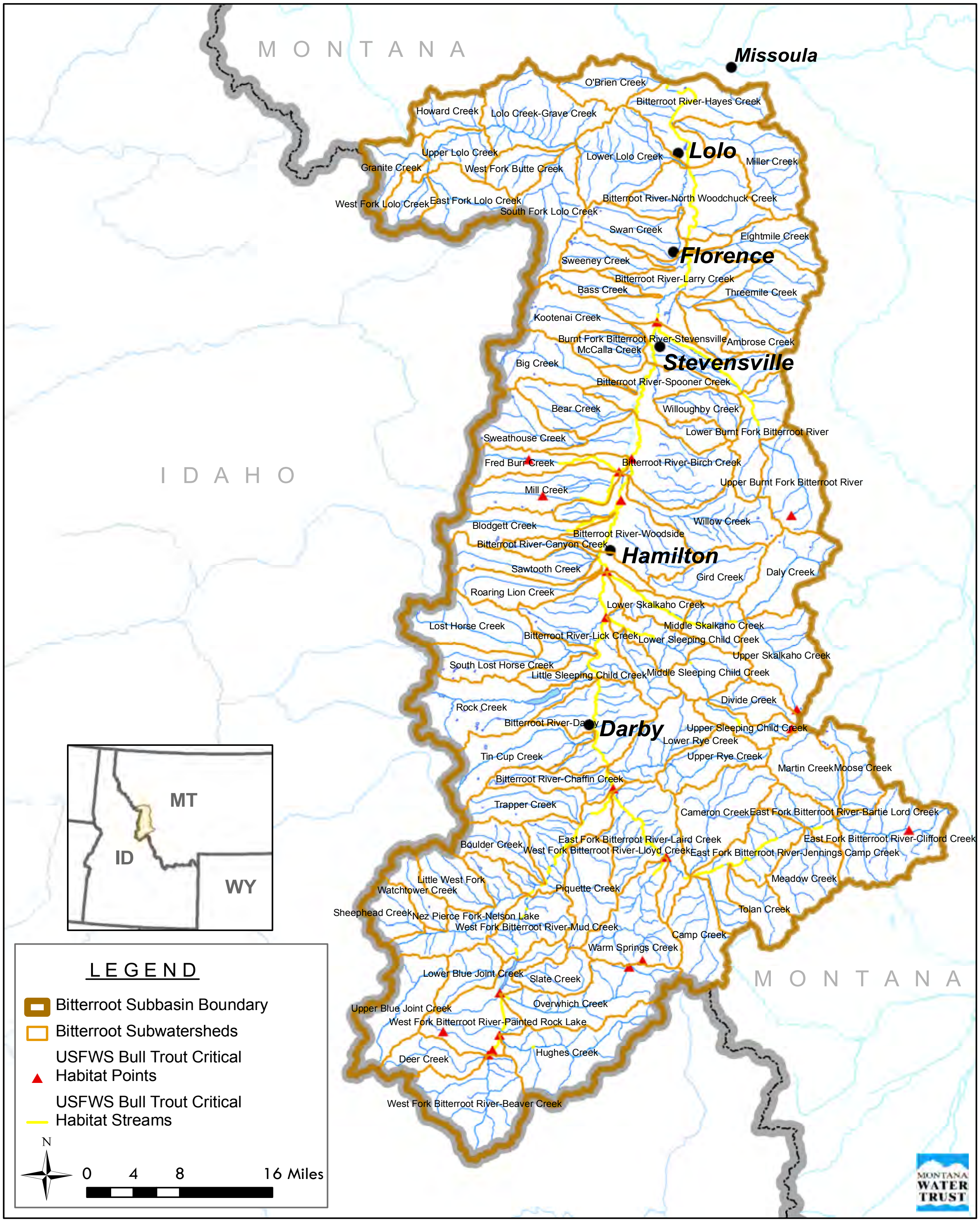


Figure 4.14. Bull trout critical habitat in the Bitterroot Subbasin.
Data Sources: U.S. Fish and Wildlife Service (2005).

Desired Future Condition

This section identifies the desired future condition for bull trout in the Bitterroot Subbasin as a theoretical reference condition that would ensure the long-term sustainability for bull trout in the subbasin. This is a key component of the USFWS ESA delisting evaluation and determinations would be made by the appropriate recovery team. Therefore, this section is adapted from the Bull Trout Draft Recovery Plan (2002). The specific goal of the bull trout recovery plan is to ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the Clark Fork River basin so that the species can be delisted. Specifically, the recovery subunit teams for the four Clark Fork River subunits (Upper Clark Fork, Lower Clark Fork, Flathead, and Priest) adopted the goal of a sustained net increase in bull trout abundance and increased distribution of some local populations within existing core areas in this recovery unit (as measured by standards accepted by the recovery subunit teams, often referred to collectively as the Clark Fork Recovery Unit Teams):

- Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Clark Fork Recovery Unit.
- Maintain stable or increasing trends in abundance of bull trout in each subunit of the Clark Fork Recovery Unit.
- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.
- Conserve genetic diversity and provide opportunity for genetic exchange.

The Upper Clark Fork, Lower Clark Fork, Flathead, and Priest Subunit Recovery Teams adopted the following objective for the Clark Fork Recovery Unit:

- A sustained net increase in bull trout abundance, and increased distribution of some local populations, within existing core areas in this recovery unit (as measured by standards that the Clark Fork Recovery Unit Teams develop).

To assess progress toward this objective, each recovery subunit team adopted recovery criteria for its respective subunit. Listed below are the proposed recovery criteria for bull trout in the Clark Fork Recovery Unit. The intent of recovery criteria is to maximize the likelihood of persistence. Such persistence will be achieved, in part, by seeking to perpetuate the current distribution and by maintaining or increasing abundance of all local bull trout populations that are currently identified in the Clark Fork Recovery Unit.

1. Distribution criteria will be met when the total number of identified local populations (currently numbering about 150) has been maintained or increased and when local populations remain broadly distributed in all existing core areas.

2. Abundance criteria will be met when, in all primary core areas, each of at least five local populations contain more than 100 adult bull trout. In the Flathead Lake Core Area, each of at least 10 local populations must contain more than 100 adult bull trout. In each of the primary core areas, the total adult bull trout abundance, distributed among local populations, must exceed 1,000 fish; total abundance must exceed 2,500 adult bull trout in Flathead Lake and Swan Lake. The abundance criteria for secondary core areas will be met when each of these core areas with the habitat capacity to do so supports at least one local population containing more

than 100 adult bull trout and when total adult abundance in the secondary core areas collectively exceeds 2,400 fish.

3. Trend criteria will be met when the overall bull trout population in the Clark Fork Recovery Unit is accepted, under contemporary standards of the time, to be stable or increasing, based on at least 10 years of monitoring data.

4. Connectivity criteria will be met when dam operational issues are satisfactorily addressed at Hungry Horse, Bigfork, and Kerr Dams (as identified through license conditions of the Federal Energy Regulatory Commission and the Biological Opinion of the U.S. Fish and Wildlife Service). In the Flathead Recovery Subunit, no major barriers currently require passage. Concerns related to water level manipulation and flow regulation through the operations of Kerr (Federal Energy Regulatory Commission license conditions) and Hungry Horse (USFWS Biological Opinion) Dams must be resolved, and conditions established by Federal Energy Regulatory Commission relicensing of Bigfork Dam must be met.

Table 4.26 presents relevant numerical standards. The standards for adult abundance are based in part on recent historical information about the size of the adult population as well as its potential given the extent of the interconnected watershed.

Table 4.26. Summary of bull trout recovery criteria for Bitterroot Core Area.

CORE AREAS	Existing number (estimated) of local populations	Existing number (estimated) of local populations with >100	Recovered Minimum Number Local Populations with > 100	Recovered Minimum Number Core Area Total Adult Abundance
Bitterroot River	9	2	5	1,000

Out-of-Subbasin Effects and Assumptions

Large hydroelectric dams erected on the mainstem Clark Fork River 50 to 100 years ago were the catalyst for much of the historical disruption of the migratory corridor for fluvial bull trout in the Clark Fork River basin (USFWS 2002). Further, the legacy of late 1800s and early 1900s mining in the upper Clark Fork eradicated all fish from substantial portions of the upper drainage. These out-of-subbasin effects remain significant threats to conservation and recovery of fluvial fish populations in the subbasin.

Presently three hydroelectric Dams (Cabinet Gorge, Noxon Rapids and Thompson Falls) prevent upstream movement of bull trout in the Clark Fork River basin (Milltown Dam upstream of the confluence of the Bitterroot and Clark Fork Rivers was removed in 2008). On-going research by Avista Corporation, U.S. Fish and Wildlife Service, Confederated Salish and Kootenai Tribes, and Montana Fish, Wildlife & Parks continues to capture fluvial bull trout migrating upstream and downstream at Thompson Falls with microsatellite DNA markers from Region 4, which includes the Bitterroot Subbasin (DeHaan and Hawkins 2008).

Bull Trout Limiting Factors

Guidance from the NWPCC defines limiting factors as those factors or conditions that have led to the decline of each focal species and/or that currently inhibit populations and ecological processes and functions relative to their potential (NWPCC 2001). The Aquatic Technical Subcommittee assessed all of the 6th-field HUCs in the subbasin by ranking a series of risks and threats to bull trout (described in section 4.3.3.1). Table 4.27 provides a summary of the percentage of hydrologic units by rank. The subcommittee further refined these results by selecting a group of limiting factors that could be linked to biological and habitat-related objectives for restoration and conservation prioritization. Of the population risk and habitat threats that ranked as high or extreme risk to bull trout populations, three biological factors and three habitat-related factors were selected as most representative of conservation and restoration focus for bull trout in the subbasin (Table 4.28).

Table 4.27. Summary of ranking of risk and threats to bull trout at the 6th-field HUCs level in the subbasin.

Risk or Threat	% of 6th-field hydrologic units ranking as high or extreme
Risk 1: Recruitment	7
Risk 2: Population Size	45
Risk 3: Growth and Survival	70
Risk 4: Isolation	62
Risk 5: Total Extinction Risk	18
Threat 1: Road Related	69
Threat 2: Non-native Species	36
Threat 3: Migration Barriers	22
Threat 4: Mining	1
Threat 5: Livestock Grazing	12
Threat 6: Mixed Ownership	35
Threat 7: Dewatering	34
Threat 8: Temperature	25

Table 4.28. Summary of primary biological and habitat related limiting factors to bull trout in the subbasin.

Bitterroot Subbasin Bull Trout Limiting Factors	
Biological	Growth and survival
	Isolation
	Non-native species
Habitat Related	Dewatering
	Temperature
	Habitat integrity (sediment)

The following paragraphs summarize the factors or conditions identified as being most limiting to bull trout restoration and conservation in the Bitterroot Subbasin.

Growth and Survival

Growth and survival is a deterministic population viability risk that considers both population size and habitat quality (e.g. fine sediments, stream temperature and habitat complexity) to evaluate the resiliency of the population to recover from catastrophic events (Rieman et al. 1993). This is a reflection of depleted populations size combined with degraded habitats and altered channel stability, both of which influence the survival and growth of bull trout populations. This risk combines a number of factors that have resulted in depleted populations size and habitat quality and connectivity.

Bull trout populations in the subbasin are depleted with few migratory fish remaining and only a handful of tributary populations connected to the mainstem river. This depleted population status and loss of connected habitats combined with widespread habitat degradation in the form of increased sedimentation, decreased channel stability, lack of complex habitats, elevated stream temperatures, and depleted stream flows create a suite of conditions that reduce the overall population viability for bull trout in the subbasin. For example, under current conditions, even in the absence of physical, biological, or other barriers to movement, the likelihood that existing populations will colonize other areas may be low. The predicted odds of bull trout presence were at least 64 percent higher when a strong adjacent mainstem population was present (Rich and McMahon 2003), and there are no strong mainstem populations present in the Bitterroot Subbasin. Elevated stream temperatures, reduced number of complex pools and off-channel habitat, and increased levels of fine sediment further compound restoration efforts. These degradations may reduce the potential for sub-populations to migrate from tributary streams and interchange with other subpopulations (Clancy 2008).

Isolation

The most likely serious threat to bull trout restoration is fragmentation of populations into isolated units. Fragmentation has resulted from a variety of factors, including physical barriers such as culverts and irrigation diversion structures, stream reaches with elevated stream temperatures that function as a barrier to bull trout movement, or the presence of introduced species that compete with bull trout for food and habitat and therefore function as a barrier. Remaining populations are at a higher risk of extinction because they are fragmented. Fragmentation exacerbates the effects of other risk factors such as agricultural and forestry practices on water quality and quantity, dewatering by irrigation diversions, and introduced species. These factors are also components of the 'growth and survival' risk (Rieman et al. 2003). When isolated populations become extinct, the probability of recolonization is low (MBTRT 2000).

The Montana Bull Trout Restoration plan also identifies isolation as a primary risk to bull trout recovery and states that restoration of bull trout will require restoration of historical connectivity within and among core areas and populations. Connectivity is achieved when fish can move between areas and interbreed. The more connectivity that can be restored within and among these areas, the greater the likelihood of long-term survival because a local population may go extinct but may be recolonized through occasional straying of migrants from other populations (MBTRT 2000).

Irrigation diversion structures are also a significant threat to the restoration of the migratory bull trout population in the subbasin. Diversions may make it impossible for fish to migrate upstream from the river into the tributaries to spawn. In addition, downstream migrants may be trapped by irrigation diversions and prevented from moving into the river. Most of the large tributary streams on both sides of the subbasin north of Darby are heavily diverted. There are also some diversions on the mainstem Bitterroot that may be barriers to fish passage (MBTRT 2000). In the Bitterroot Subbasin, five major diversions and numerous smaller canals remove substantial quantities of water from the river during the irrigation season (Spoon 1987).

Non-native Species

Competition with introduced salmonid species is another major limiting factor to bull trout conservation and restoration in the subbasin. Bull trout are subject to hybridization with brook trout (Leary et al. 1983) and interspecific competition from brook trout, lake trout, and brown trout. Brook trout and brown trout are the primary introduced salmonid species that directly or indirectly compete with bull trout for habitat and food in the Bitterroot Subbasin. Brown trout are common in the Bitterroot River and the lower end of tributary streams, and brook trout are common throughout many tributary streams (MBTSG 1995) (Tables 4.18 and 4.19).

Brook trout are capable of hybridizing with bull trout, but hybridization often produces sterile offspring. Approximately 75 percent of the identified bull trout occupied streams in the subbasin also contain brook trout, although not necessarily in the same stream reaches as the bull trout. Some genetic analysis has been done in the subbasin as a way to identify where and to what degree hybridization is occurring (Appendix 13). The degree of hybridization, other interactions, and distribution of the two species is probably influenced by habitat condition (Rieman and McIntyre 1993). Many studies have documented that bull trout are rare, if present at all, in streams supporting large numbers of brook trout (Buckman et al. 1992; Ziller 1992; Rich 1996). Rich (1996) found brook trout occupied more degraded stream reaches than bull trout. Leary et al. (1993b) documented a shift in community dominance from bull trout to brook trout in Lolo Creek and predicted the trend to continue until bull trout are displaced from the stream. Habitat degradation appears to give brook trout a competitive advantage over bull trout.

Streams that are known to contain bull trout-brook trout hybrids include: Bear Creek, Gold Creek, Slate Creek, Woods Creek, Nez Perce Fork, Tin Cup Creek, Trapper Creek, Watchtower Creek, and the South Fork of Lolo Creek (Leary 1991, 1993) (Appendix 13). Data from the South Fork of Lolo Creek and Tolan Creek indicate that brook trout may be expanding their range and numbers at a relatively rapid rate in some habitats. Bull trout rarely overlap with brown trout but are found concurrently with brook trout in many streams (Clancy pers. comm. 2008a). The impact that brook trout have on bull trout when they occur together is not clear. Some studies suggest that brook trout probably do influence bull trout populations and may facilitate if not cause local extinctions but that the threat probably varies strongly with environmental conditions (Rieman et al. 2005 and McMahon et al. 2007). Therefore, upstream displacement of bull trout by brown trout may be a more significant limiting factor for bull trout recovery in the Bitterroot Subbasin (Clancy pers. comm. 2008b).

Dewatering

Dewatering may be the primary habitat-related threat to bull trout in the Bitterroot Subbasin. Many of the tributaries that originate on the BNF are diverted for irrigation during the summer months and contribute little streamflow to the river during that time (Clancy 2007). Therefore, many tributaries and the mainstem of the Bitterroot River are chronically dewatered during the irrigation season. Dewatering of streams leads to other habitat and biological factors that limit bull trout restoration, such as higher mid-summer water temperatures, which favor brown and brook trout.

Streamflow characteristics vary along the Bitterroot River. The most critically dewatered reach is between Hamilton and Stevensville (Spoon 1987). To help alleviate mainstem dewatering, MFWP annually supervises the release of 15,000 acre-feet of water from Painted Rocks Reservoir on the West Fork of the Bitterroot River and 3,000 acre-feet of water from Lake Como. Table 4.29 lists the streams in the Bitterroot Subbasin that MFWP considers chronically dewatered.

Table 4.29. Streams in the Bitterroot Subbasin considered chronically[1] dewatered[2] by Montana Department of Fish, Wildlife and Parks.

Stream Name	Subwatershed HUC	Stream Mile Start	Stream Mile End
Tolan Creek	170102050501	0.00	1.00
Reimel Creek (East Fork Bitterroot River)	170102050405	0.00	1.00
Sweeney Creek	170102051504	0.00	1.00
Eightmile Creek	170102051505	0.00	3.00
Lolo Creek	170102051409	0.00	1.00
Lolo Creek	170102051409	0.00	3.05
Carlton Creek (Swan Creek)	170102051507	0.00	5.04
Bass Creek	170102051501	0.00	1.00
Burnt Fork	170102051304	0.00	5.00
O'Brien Creek	170102051602	0.00	1.50
Kootenai Creek	170102051302	0.46	2.06
Kootenai Creek	170102051302	0.00	0.40
Bitterroot River-Middle	170102051506	33.66	50.76
Big Creek	170102051201	0.00	3.00
Sweathouse Creek	170102051103	0.00	2.00
Bear Creek (North channel)	170102051104	0.00	4.00
Bear Creek	170102051104	0.00	3.86
Mill Creek	170102051101	2.67	5.64
Mill Creek	170102051101	0.00	0.50
Chaffin Creek (Bitterroot River—South)	170102050807	0.00	2.00
Blodgett Creek	170102051005	0.00	2.00
Skalkaho Creek	170102050901	0.00	4.00
Rock Creek	170102050805	0.00	4.07
Rock Creek	170102050805	7.33	8.23
Tin Cup Creek	170102050804	0.00	2.00
Lost Horse Creek	170102050602	0.00	4.00
Baker Creek (West Fork Bitterroot River)	170102050108	0.00	1.00

[1]*Chronic dewatering = streams where dewatering is a significant problem in virtually all years.*
[2]*Dewatered = a reduction in streamflow below the point where stream habitat is adequate for fish.*
From: MFWP (2006).

Temperature

Bull trout are particularly intolerant of warm water and are typically associated with the coldest stream reaches within basins they inhabit (Craig 2001; Selong et al. 2001). Causes for the low numbers of bull trout in most subbasin tributary streams probably include physical factors such as streamflow or water temperature. Data analyzed by BNF personnel indicate that air and water temperatures have been increasing over the past decade at many sites on the BNF (Figures 4.15 and 4.16) (BNF 2007; Clancy 2007). Since the BNF began temperature monitoring in 1993, stream temperatures have been increasing in the key bull trout streams on the Montana portion of the forest. The seven-day mean-maximum temperatures increased by about 1.5 degrees Celsius between 1993 and 2007 (BNF 2007). Degree days increased about 80 to 100 units between 1993 and 2007 (BNF 2007). Bull trout tend to be rare in streams that have maximum temperatures greater than 15 degrees Celsius for extended periods of time. If water temperatures continue to increase in future years, bull trout distribution is expected to shrink across the BNF, with the populations at the lowest elevations disappearing first (BNF 2007).

Rieman et al. (2007) have suggested that this trend exists across the entire area where bull trout are currently found and that the warming global climate is likely to have a significant effect on the species distribution. This trend may particularly impact fragmented populations where climate warming could lead to higher-elevation downstream limits capable of supporting bull trout, therefore increasing the fragmentation of remaining habitats and accelerating the decline of the species.

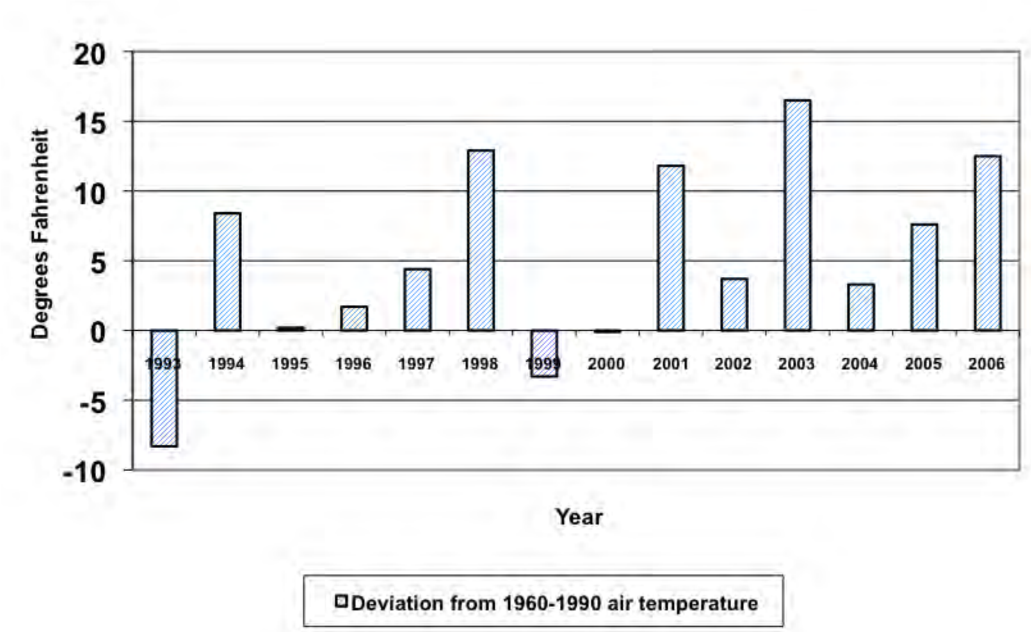


Figure 4.15. The deviation from past mean air temperatures in the Bitterroot Valley for the time period 1993-2006. Most years the deviation is warmer than in the previous time period 1960-1990.
Data Sources: Clancy (2007).

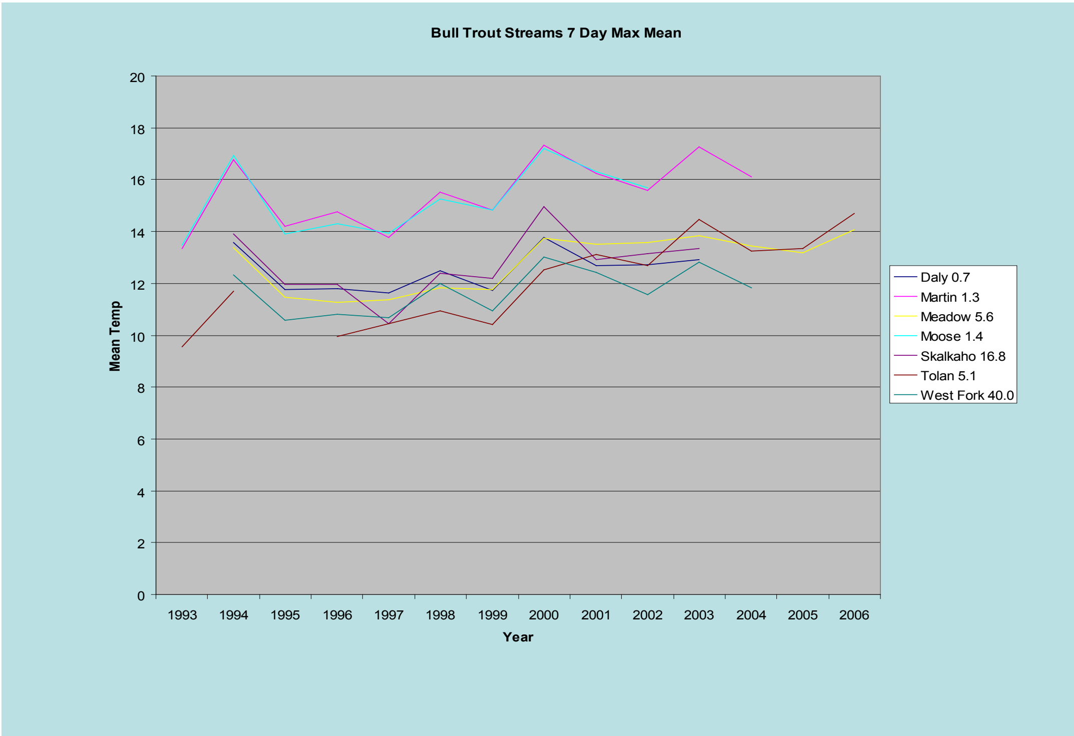


Figure 4.16. The 7-day maximum mean temperatures at select core area bull trout population streams of the Bitterroot National Forest between 1993 and 2006.
Data Sources: Clancy (2007) BNF (2007).

Habitat Integrity

Major impacts and land uses affecting bull trout through degraded habitat stem from past forest, grazing, and agricultural practices and roads, mining, and residential development. Table 2.16 lists all of the streams included on the Department of Environmental Quality's 303(d) list of streams with impaired water quality and identifies the causes of impairment.

A number of degraded habitat attributes are probably limiting bull trout in subbasin streams. Bull trout are threatened by activities that damage riparian areas and cause stream siltation. Logging, road construction, mining, and overgrazing may be harmful to spawning habitat (MBTSG 1995). Two subwatersheds with known major sedimentation impacts—Threemile and Rye Creek—are among the few subwatersheds where bull trout are now confirmed to be absent (Figure 4.12).

The Aquatic Technical Subcommittee identified increases in fine sediment as a particular habitat component historically and currently affecting bull trout habitat. Bull trout are more strongly tied to the stream bottom and substrate than other salmonids, and substrate composition has been repeatedly correlated with bull trout occurrence and abundance (Rieman and McIntyre 1993) as well as selection of spawning sites (Graham et al. 198). As described in MBTSG (1995), studies conducted on the BNF have found that bull trout numbers are negatively correlated with the amount of fine sediment found in the stream (Clancy 1993 and USDA Forest Service 1993). Weaver and Fraley (1991, 1993) found that as the percentage of the spawning substrate that is less than 0.25 inches in diameter increases, the survival-to-emergence success of bull trout and westslope cutthroat trout decreases. McNeil core samples taken on the BNF had a high average proportion of fine sediment (38 to 41 percent less than 0.25 inches) in developed drainages (Clancy 1991). Wolman pebble counts conducted in undeveloped watersheds on the BNF generally had less than 25 percent fine sediment less than 0.25 inches in diameter (Decker et al. 1993). Rich and McMahon (2003) found that bull trout occurrence was positively associated with channel width and large woody debris and negatively associated with channel gradient and the presence of brook trout. Bull trout occurred in nearly all streams greater than 3 meters wide and with abundant large woody debris (greater than 15 pieces per 100 meters).

4.3.3.3 Westslope Cutthroat Trout

Reasons for Selection as Focal Species

Globally, westslope cutthroat trout (*Oncorhynchus clarki lewisi*) have a G4T3 ranking, meaning the subspecies is either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors (MNHP 2008). A recent status report estimated that the subspecies currently occupies about 59 percent of its historical range, and only about 10 percent of that currently occupied range is populated by westslope cutthroat trout with no evidence of genetic introgression (Shepard et al. 2003).

The USFWS recently determined that westslope cutthroat trout do not warrant listing as threatened or endangered under the Endangered Species Act. In 2003, the agency reevaluated their finding and concluded again that the subspecies does not warrant listing under the Endangered Species Act. Region I of the Forest Service lists westslope cutthroat trout as a sensitive species. The Montana state ranking for the species is S2, which means the species is considered imperiled because of rarity or because of other factor(s), demonstrably making it very vulnerable to extinction throughout its range. MFWP and the Montana Chapter of the American Fisheries Society (AFS) have listed westslope cutthroat trout as a Class A State Species of Special Concern since 1972. Class A designation indicates limited numbers and/or limited habitats both in Montana and elsewhere in North America. MFWP's Comprehensive Fish and Wildlife Conservation Strategy identifies westslope cutthroat trout as a Tier 1 species, or species with the greatest conservation need (MWFP 2005).

Like bull trout, westslope cutthroat trout are often considered to be an indicator of the health of the aquatic ecosystem. They require high quality, cold water; clean gravel for spawning; and do best in complex habitats, much of which is created by large woody debris. Because of this and their state conservation and protection status, westslope cutthroat trout were selected as a focal species.

Environmental-Population Relationships

The following is summarized from the AFS summary of westslope cutthroat trout (AFS 2008). The westslope cutthroat trout is one of two subspecies of native cutthroat found in Montana. Spawning and rearing streams tend to be cold and nutrient poor. Westslope cutthroat trout seek out gravel substrate in riffles and pool crests for spawning. Cutthroat trout have long been regarded as sensitive to fine sediment (generally defined as 6.3 millimeters or less). Although studies have documented negative survival as fine sediment increases (Weaver and Fraley 1991), it is difficult to predict their response in the wild (McIntyre and Rieman 1995). This is due to the complexity of stream environments and the ability of fish to adapt somewhat to changes in microhabitat (Everest et al. 1987).

Westslope cutthroat trout also require cold water, although it has proven difficult to define exact temperature requirements or tolerances. Likewise, cutthroat trout tend to thrive in streams with more pool habitat and cover than streams with more uniform and simple habitats (Shepard et al. 1984). Juvenile cutthroat trout overwinter in the interstitial spaces of large stream substrates. To survive the winter, adult cutthroat trout need deep, slow-moving pools that do not fill with anchor ice (Brown and Mackay 1995).

Three distinct life history forms of westslope cutthroat trout have been recognized (Liknes and Graham 1988). The lacustrine-adfluvial form matures in lakes but returns to tributaries to spawn. The resulting young may reside in their natal tributaries for up to three years. The fluvial form has a similar life history, but moves between mainstem rivers and tributaries. Finally, the resident form consists of fish that spend their entire lives in tributary streams (MFWP 2008b).

Spawning typically occurs in low-gradient reaches of streams with gravel substrate ranging from 2 to 75 mm dimater, water depths near 0.7 ft (0.2 m) and mean velocities from 1 to 1.3 ft/sec (0.4 m/sec) (Liknes and Graham 1984, Shephard et al. 1984). Proximity to cover, such as overhanging stream banks or streambank vegetation, is also important. On the basis of information for other salmonid species, survival of developing westslope cutthroat trout embryos is inversely related to the amount of fine sediment in the substrate in which the fertilized eggs were deposited (Weaver and Fraley 1993 and Waters 1995). After they emerge from the spawning gravel, fry generally occupy shallow waters near stream banks and other low-velocity areas such as backwaters and side channels (McIntyre and Rieman 1995). They move into main-channel pools as they grow to fingerling size. Juveniles are most often found in stream pools and runs with summer water temperatures of 45 to 61 degrees Fahrenheit (7 to16 degrees Celsius) and a diversity of cover (Fraley and Graham 1981; McIntyre and Rieman 1995).

In streams, adult westslope cutthroat trout are strongly associated with pools and cover (Shepard et al. 1984; McIntyre and Rieman 1995). During winter, adults congregate in pools (Lewynsky 1986; Brown and Mackay 1995; McIntyre and Rieman 1995), while juveniles often use cover provided by boulders and other large instream structures (Wilson et al. 1987; Peters 1988; McIntyre and Rieman 1995). During summer in lakes and reservoirs (the primary habitat for the rearing and maturation of adfluvial fish), westslope cutthroat trout are often found at depths where temperatures are less than 61 degrees Fahrenheit (16 degrees Celcius) (McIntyre and Rieman 1995). Data on the distributions of various species of native and nonnative salmonids suggest cutthroat trout are typical in their tolerance of temperatures. Eaton et al. (1995) reported thermal tolerance limits for four species of salmonids at the 95th percentile of observed maximum water temperatures inhabited by each species. Tolerance limits for brook, cutthroat, rainbow, and brown trout were 72.1, 73.7, 75.2, and 75.4 degrees Fahrenheit, respectively.

Historically, habitats of westslope cutthroat trout ranged from cold headwater streams to warmer, mainstem rivers (Shepard *et al.* 1984; Behnke 1992). Today, remaining stocks of westslope cutthroat trout occur primarily in colder, headwater streams (Liknes and Graham 1988). Westslope cutthroat trout may exist in these streams not because the thermal conditions there are optimal for them, but because nonnative salmonid competitors like brook trout may not exploit cold, high-gradient waters (Griffith 1988; Fausch 1989).

Population Characterization

Historical Distribution

Westslope cutthroat trout inhabited all major drainages west of the Continental Divide and the South Saskatchewan and Missouri River drainages at least as far east as Fort Benton, Montana. Figure 4.17 shows the historical distribution of westslope cutthroat trout in Montana (MFWP 2007). It is assumed that westslope cutthroat trout historically occupied all accessible habitats in the Bitterroot Subbasin. Shephard et al. (2003) reported that of 2,345.6 available miles of habitat in the subbasin, an estimated 2,063.4 miles were historically (circa 1800) occupied by westslope cutthroat trout.

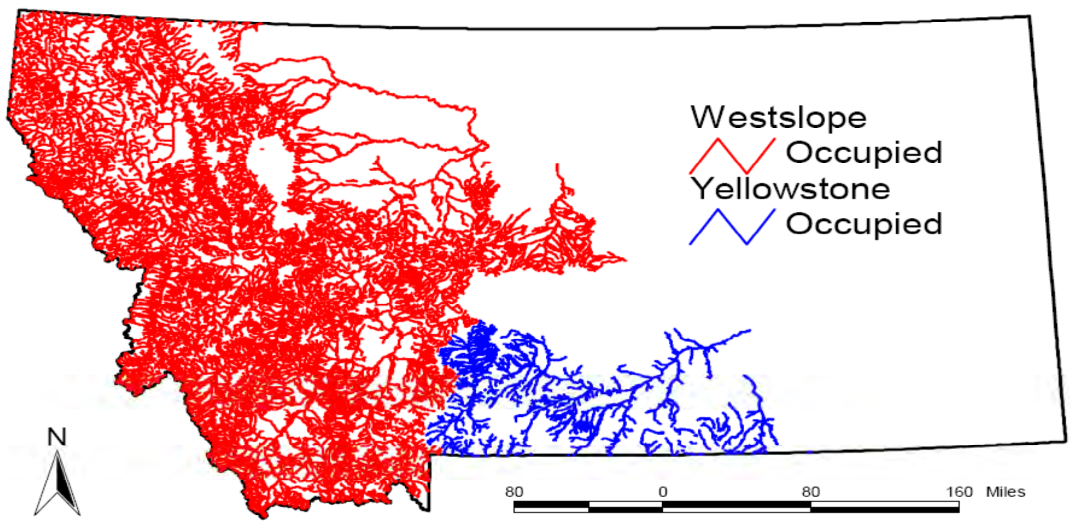


Figure 4.17. Historical distribution of westslope cutthroat trout (red) in Montana.
Data Sources: MFWP (2007).

Current Status and Distribution

Figure 4.18 shows the current distribution of westslope cutthroat trout in the subbasin. Recent sampling by MFWP and BNF indicate populations are widespread and stable in the Bitterroot Subbasin. In the mainstem Bitteroot River, westslope cutthroat tend to be the least numerous of the three species of trout common to the Bitterroot River (the other two species are rainbow trout and brown trout). Therefore, data for population estimates are not always possible to collect, particularly in the lower river where westslope cutthroat trout numbers are low and hybridization obscures their identity. In 2005 and 2006, population estimates were calculated for three sections of the river, and all indicate that populations are probably stable. Appendix 5 shows the recent population estimates for westslope cutthroat trout. The overall viability of westslope cutthroat trout in the subbasin is considered to be depressed, primarily because of the habitat fragmentation that occurs on private land between the Bitterroot River and its tributaries and the reduced numbers of migratory adult fish in the river (BNF 2007).

According to the BNF 2007 Annual Forest Plan Monitoring Report (BNF 2007), westslope cutthroat trout populations appear to be stable and relatively strong across the Forest. The report states that westslope cutthroat trout are the most abundant fish species, being present in nearly every fish-bearing stream and likely occupying greater than 90 percent of their historical habitat. In the subbasin, core populations for westslope cutthroat trout include: East Fork Bitterroot River and tributaries, including Moose Creek, Meadow Creek, and Tolan Creek; West Fork of the Bitterroot River and tributaries, including Blue Joint Creek, Slate Creek, Overwhich Creek and Deer Creek; Rye Creek; Skalkaho Creek; Nez Perce Fork; Roaring Lion Creek; and Sleeping Child Creek. Most of these populations are isolated in the headwater portions of the watersheds, although some fluvial-adfluvial life forms persist. Clancy (2008c) noted that the following subwatersheds in the subbasin have significant westslope cutthroat trout populations, some of which are hybrid populations: the upper reaches of Burnt Fork, Willow Creek, Gird Creek, Skalkaho Creek, Sleeping Child Creek, Rye Creek, Cameron Creek, Martin Creek, Moose Creek, the upper reaches of the East Fork Bitterroot River, Meadow Creek, Tolan Creek, Warm Springs Creek, Slate Creek, Overwhich Creek, Hughes Creek, the West Fork Bitterroot River above Painted Rocks Lake, Deer Creek, Blue Joint Creek, Nez Perce, Boulder Creek, Trapper Creek, Tin Cup Creek, and Rock Creek above Lake Como.

On BNF-administered lands, the trends in cutthroat populations vary by site, and it is not possible to characterize them on a widespread basis, partially due to impacts of the fires of 2000 (MFWP 2007). At most sites, population estimates fall within the range of past estimates. However some are of particular interest. For example, westslope cutthroat populations in both Sleeping Child and Skalkaho Creeks have been monitored annually since 1989. In both study reaches, the population has been stable overall; however, in Sleeping Child Creek debris flows after the 2000 fires caused significant declines in the fish population. The population has fully recovered, and the 2006 estimate was the highest ever recorded for larger sizes. On Skalkaho Creek (stream mile 16.8 study section), the population structure has shifted from smaller fish to larger fish, which may be due to catch-and-release-fishing regulations instituted in the early 1990s.

The genetic status of populations is shown in Figure 4.19. It is important to note that subwatersheds are identified by a single genetic status category. Therefore, if one stream within the subwatershed had a population testing as genetically pure, than the entire subwatershed would be assigned to that category ("no hybridization detected"). However, the general trend for most of the subwatersheds in this category is for populations in headwater areas to be genetically pure, with the degree of introgression increasing in a downstream direction as non-native species become more numerous. Genetically pure populations are often found above a natural or man-made barrier. Some verified genetically pure populations remain in the subbasin. These are considered strongholds or core populations for the species and are composed of populations of individuals that have no evidence of genetic introgression (hybridization) as determined by genetic testing (MFWP 2007). These populations could potentially serve as donors (either in the form of fish or gametes) for restoration efforts. Appendix 13 summarizes cutthroat trout genetics sampling conducted in the subbasin.

The monitoring completed by the BNF also indicates that 63 percent of the westslope cutthroat populations that have been tested on the Forest are genetically unaltered. In general, hybridized populations are more prevalent in the west-side canyon streams and the larger rivers (East Fork, West Fork, and mainstem Bitterroot), with genetically unaltered populations tending to occur on the east side of the valley and in headwaters on the south half of the Forest. Westslope cutthroat trout occur at reduced numbers in the Bitterroot River and in the private-land reaches of tributaries on the valley floor. However, the population of migratory westslope cutthroat trout has been increasing in the Bitterroot River and the East and West Forks since the mid 1990s. The implementation of catch-and-release regulations has likely been a factor contributing to the increase. The genetic make-up of the migratory westslope cutthroat trout populations in the rivers consists of a mix of pure and hybridized fish.

Understanding connections between Bitterroot River salmonids and their spawning areas is a priority for subbasin managers and for conservation and restoration planning. Radio transmitters were implanted in westslope cutthroat trout from the Bitterroot River between 1998 and 2003 (Clancy 2005). These fish were followed to identify spawning locations. Figure 4.20 shows the tributary streams documented to be used by fluvial westslope cutthroat trout in the subbasin.

Out-of-Subbasin Effects and Assumptions

Large hydroelectric dams erected on the mainstem Clark Fork River 50 to 100 years ago were the catalyst for much of the historical disruption of the migratory corridor for fluvial fish in the Clark Fork River basin (USFWS 2002). Further, the legacy of late 1800s and early 1900s mining in the upper Clark Fork eradicated all fish from substantial portions of the upper drainage. These out-of-subbasin effects remain significant threats to conservation and recovery of fluvial fish populations in the subbasin.

Presently three hydroelectric Dams (Cabinet Gorge, Noxon Rapids, and Thompson Falls) prevent upstream movement of westslope cutthroat trout in the Clark Fork River basin (Milltown Dam upstream of the confluence of the Bitterroot and Clark Fork Rivers was removed in 2008). Large, migratory fish are still captured in the lower reaches of the Bitterroot River. It is assumed they entered from the Clark Fork mainstem. Some migratory fish have also been captured in the vicinity of Lolo Creek, and this drainage may have historically been a spawning tributary for Clark Fork River cutthroat populations.

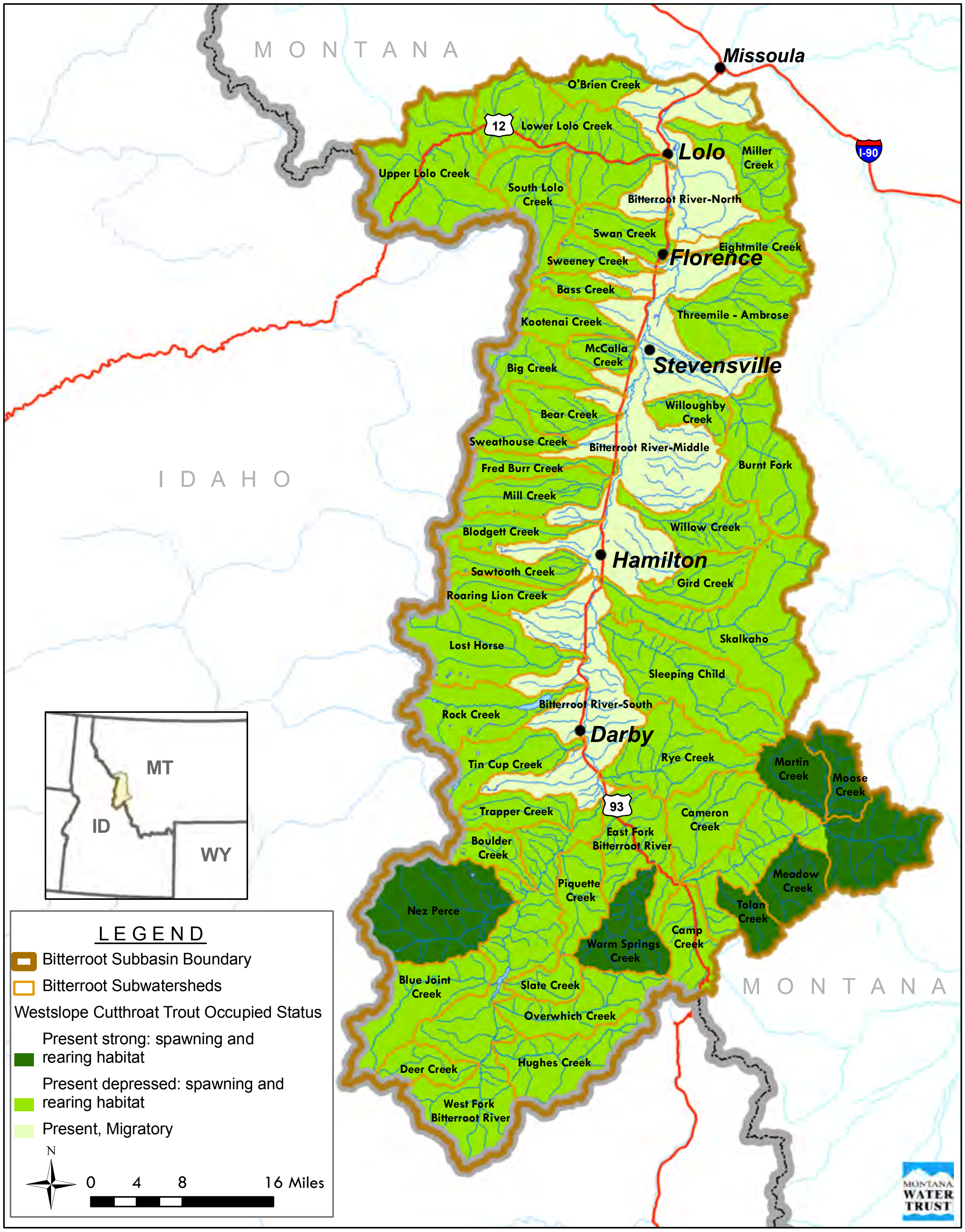


Figure 4.18. Distribution and population status of westslope cutthroat trout by subwatershed in the Bitterroot Subbasin. (See Appendices 6 and 7 for category descriptions.)
Data Sources: BNF (2006) and Jakober (2008).

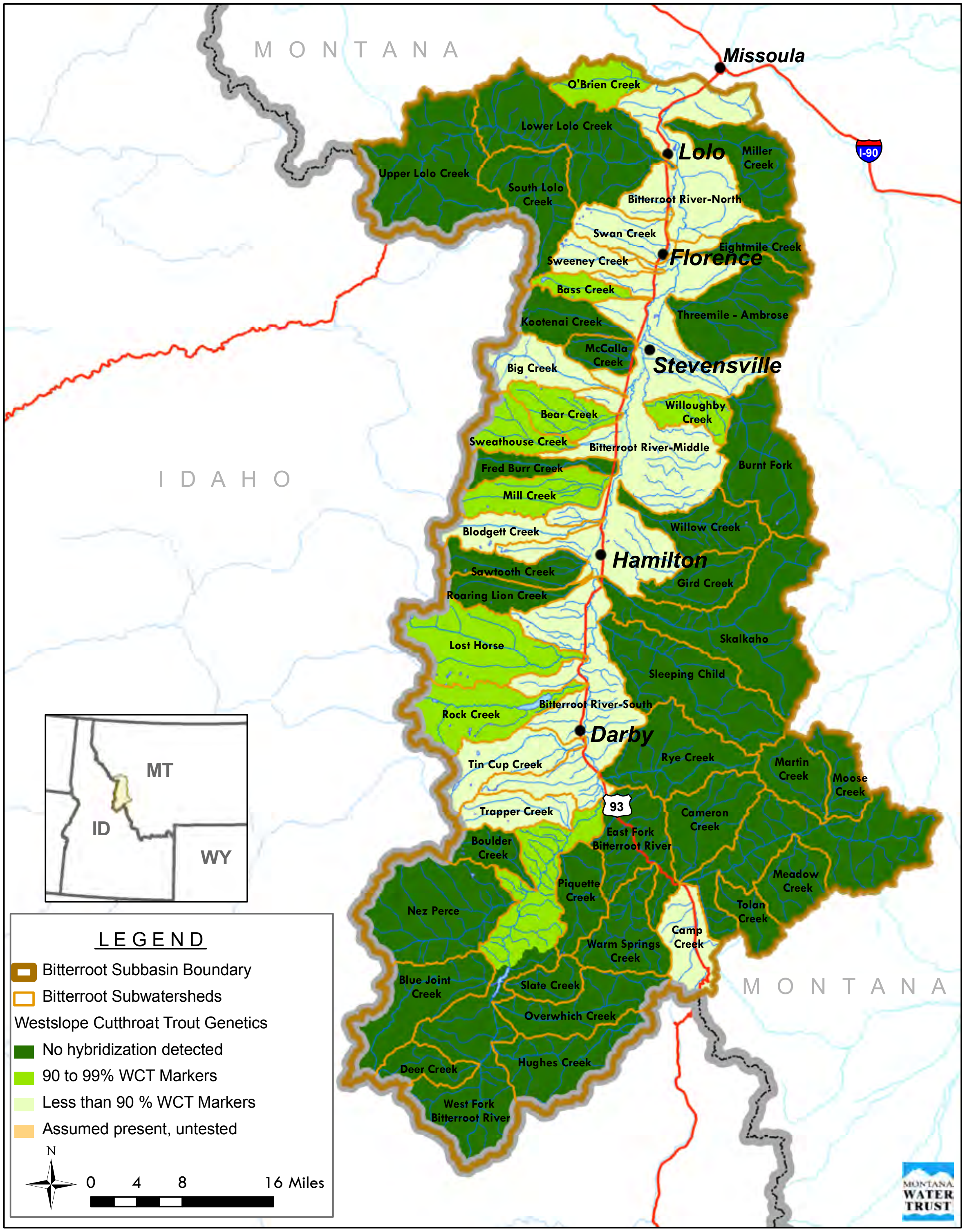


Figure 4.19. Distribution and genetics of westslope cutthroat trout in the Bitterroot Subbasin.
Data Sources: MFWP (2008b), BNF (2006), and Knotek and Leary (2008).

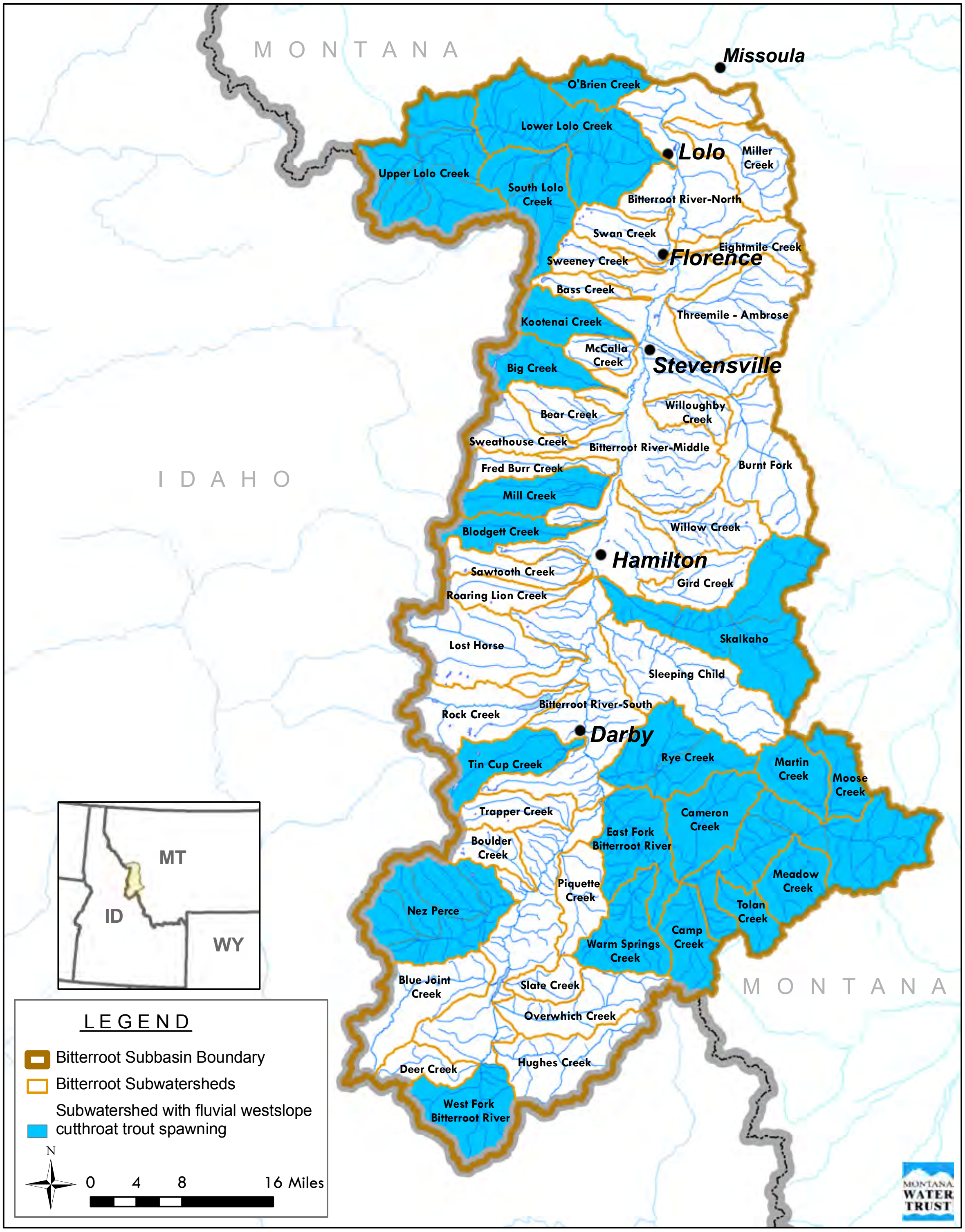


Figure 4.20. Streams in the Bitterroot Subbasin with documented fluvial westslope cutthroat trout spawning.
Data Sources: Clancy (2008) and Knotek (2008).

Westslope Cutthroat Trout Limiting Factors

Guidance from the NWPCC defines limiting factors as those factors or conditions that have led to the decline of each focal species and/or that currently inhibit populations and ecological processes and functions relative to their potential (NWPCC 2001). The Aquatic Technical Subcommittee assessed all of the 6th-field HUCs in the subbasin by ranking a series of risks and threats to westslope cutthroat trout (Section 4.3.3.1). Table 4.30 provides a summary of the percentage of hydrologic units by rank. The Aquatic Technical Subcommittee further refined these results by selecting a group of limiting factors that could be linked to biological and habitat-related objectives for restoration and conservation prioritization (Table 4.31). Of the population risk and habitat threats that ranked as high or extreme risk to westslope cutthroat trout populations, the subcommittee selected three biological factors and three habitat-related factors as most representative of conservation and restoration focus for westslope cutthroat trout in the subbasin.

Table 4.30. Summary of risks and threats ranking as high or extreme for westslope cutthroat trout in the Bitterroot Subbasin.

Risk or Threat	Percentage of 6th-field hydrologic units ranking as high or extreme
Risk 1: Recruitment	6
Risk 2: Population Size	0
Risk 3: Growth and Survival	10
Risk 4: Isolation	28
Risk 5: Total Extinct	36
Threat 1: Road Related	18
Threat 2: Non-native Species	34
Threat 3: Migration Barriers	23
Threat 4: Mining	1
Threat 5: Livestock Grazing	13
Threat 6: Mixed Ownership	38
Threat 7: Dewatering	36
Threat 8: Temperature	24

Table 4.31. Summary of primary limiting factors identified for westslope cutthroat trout in the Bitterroot Subbasin.

Bitterroot Subbasin Westslope Cutthroat Trout Limiting Factors	
Biological	Isolation
	Non-native Species
Habitat Related	Dewatering
	Temperature
	Habitat Integrity

The following paragraphs summarize the factors or conditions identified as being most limiting to westslope cutthroat trout restoration and conservation in the subbasin.

Isolation

Many of the remaining populations of westslope cutthroat trout in the subbasin are isolated to headwater portions of streams. These smaller, isolated populations are more susceptible to population-level risks due to isolation, small population size, and temporal environmental or demographic variability. However, their isolation makes them less susceptible to risks from genetic introgression, competition and predation by introduced fish species, risks of invasion and impacts of aquatic nuisance species, or the introduction of harmful diseases. Population isolation is the result of a number of factors, including road culverts, dams, irrigation diversion structures, non-native species, degraded habitat, dewatering, and elevated stream temperatures.

Irrigation canal entrainment can also result in the loss of connectivity between populations through the direct loss of fish from populations and because infrastructures can act as barriers to upstream and downstream fish passage. Bahn (2007) conducted a study to determine entrainment of juvenile and adult salmonids in irrigation diversions from Tin Cup and Lost Horse Creeks. She found that the species composition of entrained fish in Tin Cup Creek was predominantly westslope cutthroat trout and estimated entrainment rates of 2,995 for juvenile fish and 2,554 for adults per year for all diversions in the drainage. Harnisch (2007) estimated that between 67 and 70 percent of downstream-migrating westslope cutthroat trout and bull trout became entrained in unscreened irrigation canals as they attempted to emigrate from Skalkaho Creek to the Bitterroot River in 2006. Gale (2005) also conducted studies of fish entrainment into irrigation canals from Skalkaho Creek before and after installation of a fish screen and found that most age-0 (less than one-year old) westslope cutthroat trout entrained at screened canals were successfully bypassed and escaped, whereas those entrained at unscreened canals were lost to the population.

Non-Native Species

Hybridization with exotic trout has been identified as the greatest threat to the conservation of native westslope cutthroat trout (Allendorf and Leary 1988). Introduced rainbow trout and Yellowstone cutthroat trout will freely hybridize with westslope cutthroat trout and produce fertile offspring. This extensive hybridization will infuse exotic genes into the native populations, permanently altering their genetic composition and reducing individual survival and fertility (Leary et al. 1995). Rainbow and Yellowstone cutthroat trout have been widely introduced in the subbasin (Appendix 14 provides a stocking history).

Muhlfeld et al. (2009) indicates that hybrid westslope cutthroat trout/rainbow trout are less fit for long-term persistence than genetically unaltered westslope cutthroat trout. The authors found that the reproductive success of second generation hybrids is significantly less than that of fish comprised of 100 percent native cutthroat genes. This indicates that efforts to protect genetically unaltered cutthroat trout populations, especially those with genetic material that evolved locally should be a priority for conservation. Shepard et al (2003) concludes that genetic introgression and nonnative competition threats probably outweigh stochastic risks over the short-term for many existing westslope cutthroat trout populations and recommends isolating remaining non-introgressed westslope cutthroat trout populations as a prudent, short-term conservation strategy. Other studies have found that the trade-offs between isolating an existing pure population or allowing non-native species invasion were strongly influenced by size and quality of habitat of the stream to be isolated and characteristics of the population in question, including linkages within and among populations (Peterson et al. 2008).

Dewatering

Lack of connectivity between the river and spawning and rearing tributaries is a major problem for westslope cutthroat trout populations in the Bitterroot Subbasin (BNF 2007). One of the primary causes of lost connectivity is the dewatering of tributary streams due to irrigation withdrawals. Many of the tributaries that originate on the BNF are diverted for irrigation during the summer months and contribute little streamflow to the river during that time (Clancy 2007). Therefore, many tributaries and the mainstem of the Bitterroot River are chronically dewatered during the irrigation season. Dewatering of streams leads to other habitat and biological factors that limit westslope cutthroat trout restoration, such as higher mid-summer water temperatures that probably favor rainbow trout and brook trout.

Streamflow characteristics vary along the Bitterroot River, and the most critically dewatered reach is between Hamilton and Stevensville (Spoon 1987). To help alleviate mainstem dewatering, MFWP annually supervises the release of 15,000 acre-feet of water from Painted Rocks Reservoir on the West Fork of the Bitterroot River and 3,000 acre-feet of water from Lake Como. Table 4.29 lists the streams in the Bitterroot Subbasin that MFWP has identified as chronically dewatered.

Dewatering may be less of a threat to westslope cutthroat trout than it is to bull trout. Cutthroat trout spawn in the spring and therefore have the distinct advantage of entering the spawning tributaries when flows are high and connectivity is at its annual best. Bull trout, in contrast, enter spawning tributaries during the late summer and fall when flows are naturally low and when water is being removed from the tributary streams for summer irrigation. Connectivity for both species is considerably better in the East and West Forks than it is in the mainstem Bitterroot River (BNF 2007).

Temperature

Some of the leading causes for the decline of westslope cutthroat trout are habitat degradation and displacement by non-native rainbow and brook trout. Water temperature plays a key role in both situations. Temperature is considered a key element that influences the distribution of westslope cutthroat trout and likely influences the interactions between cutthroat trout and invasive species. Remaining populations of westslope cutthroat trout are primarily confined to cool, headwater stream reaches whereas non-native rainbow trout predominate in warmer, lower-elevation stream sections historically occupied by westslope cutthroat trout. Rainbow trout appear to have a higher upper-temperature tolerance and greater growth capacity at warmer temperatures, which may account for the species' displacement of westslope cutthroat trout at lower elevations and is an important consideration for restoration and conservation (Bear et al. 2007).

Data analyzed by BNF personnel indicate that air and water temperatures have been increasing over the past decade at many sites on the BNF (Figures 4.15 and 4.16) (BNF 2007; Clancy 2007). Since the Forest began temperature monitoring in 1993, stream temperatures have been increasing in the key bull trout streams on the Montana portion of the forest. The seven-day mean-maximum temperatures increased by about 1.5 degrees Celsius between 1993 and 2007 (BNF 2007). Degree days increased about 80 to 100 units between 1993 and 2007 (BNF 2007).

Habitat Integrity

The primary habitat degradation limiting factors for westslope cutthroat trout in subbasin streams probably include: riparian condition, channel stability, habitat diversity, and fine sediment. Habitats are degraded by a variety of past and present land uses, similar to those that have degraded bull trout streams: inappropriate grazing or logging, road-building, mining, and streamside development, including alteration of channels.

Fire is another factor that may, at least temporarily, limit westslope cutthroat trout populations. For example, changes associated with significant forest fires were observed in both Rye Creek and North Fork of Rye Creek. Both streams have long-term data that indicate changes over time, apparently resulting from the fire of 2000 when the drainage was severely burned. In Rye Creek water temperatures increased significantly after the fire (BNF 2006). Since the fires of 2000, the number of brook trout have increased in this stream reach, and the number of larger westslope cutthroat has declined. Bull trout have not been captured in this section since the fire (Clancy 2007).

Immediately after the 2000 fire debris flows of varying intensity occurred in North Rye Creek. They caused high mortality of fish within the study reach. In the past few years there have been no debris flows and the westslope cutthroat population has recovered. However, the brook trout population has never reached pre-fire numbers, and in 2006, no brook trout were captured in North Rye Creek (Clancy 2007).

4.4 Interpretation and Synthesis

4.4.1 Key Findings

This section summarizes the analysis of key terrestrial and aquatic habitats and species within the Bitterroot Subbasin. For terrestrial habitats, Conservation Target Habitats were identified as habitats whose integrity allows extrapolation of key terrestrial species' health and long-term viability. For aquatic habitats, two focal species were identified whose habitat requirements are closely linked to the ability of aquatic habitats to provide healthy and sustainable conditions to support aquatic species diversity.

For terrestrial habitats, a group of experts were used to identify limiting factors, based on the best available scientific data. These factors indicate the priorities for conservation and restoration necessary to ensure the long-term viability of target conservation species. For aquatic habitats, limiting factors were identified using a 6th-field HUC analysis of risks and threats to focal species' survival. These factors were prioritized to isolate the factors that should be addressed in subsequent restoration and conservation projects suggested by this plan.

The synthesis of this analysis reveals a body of largely anthropogenic factors that will require attention to engender greater ecosystem health and the survival and propagation of key aquatic and terrestrial species. This information in turn provides a foundation for the development of scientific hypotheses concerning ecological behavior and the ways that human intervention might prove beneficial (Section 4.4.2 and 4.4.3). Given the range of habitats, the number of key species impacted, and the size of the subbasin, this analysis is necessarily confined to broad evaluations of habitat quality. Despite this lack of specificity, understanding the ways in which human activity in the subbasin is contributing to limiting factors allows initiation of restoration, conservation, and educational programs on a scale that can potentially address these issues in a meaningful way.

4.4.2 Aquatic Working Hypotheses

The following working hypotheses reflect the best understanding of local experts on the factors limiting aquatic focal species population recovery in the Bitterroot Subbasin. Conserving and improving populations requires that these limiting factors be effectively addressed.

Bull Trout (BT) Hypothesis: At the subbasin scale, the long-term persistence and abundance of bull trout is limited by the loss of fluvial population components and genetic interchange.

Westslope Cutthroat Trout (WCT) Hypothesis: At the subbasin scale, the long-term persistence and abundance of westslope cutthroat trout is limited by genetic introgression with rainbow trout and the loss of fluvial population components and genetic interchange, which is the direct result of lost connectivity.

Public Tributary (T) Hypothesis: At the subbasin scale, the primary factors limiting focal species in tributaries on USFS-administered lands are barriers and sediment (road-related).

Private Tributary (PT) Hypothesis: At the subbasin scale, the primary factors limiting focal species on the private land portion of tributaries are dewatering, elevated stream temperature, and overall habitat integrity.

Mainstem (M) Hypothesis: At the subbasin scale, the primary factor limiting focal species in the mainstem is (elevated summer water) temperature.

4.4.3 Terrestrial Working Hypotheses

The following working hypotheses reflect the best understanding of local experts on the factors limiting the amount, quality, and productivity of target wildlife habitats in the Bitterroot Subbasin. Conserving and improving wildlife populations, especially populations of target wildlife species, will require that these limiting factors be effectively addressed.

Riparian Habitat (Mainstem): At the subbasin scale, the primary limiting factors for deciduous cottonwood forest and shrub riparian habitats along the Bitterroot River mainstem are altered channels and floodplain functionality, fragmentation caused by development, grazing regimes, and wildlife/human conflicts.

Riparian Habitat (Tributaries): At the subbasin scale, the primary limiting factors for shrub riparian and riparian conifer forest in the Bitterroot tributaries are altered channels and floodplain functionality, fragmentation caused by development, grazing regimes, and wildlife/human conflicts. Minor limiting factors include agricultural land conversion, and roads and timber management (for conifer riparian).

Wetland Habitat: At the subbasin scale, the primary limiting factors for wetlands are altered hydrology (drainage and diversion of water supply), altered channels, weeds and exotic species, and wildlife/human conflicts.

Grassland Habitat: At the subbasin scale, the primary limiting factors for native grasslands are agricultural land conversion, fragmentation caused by development, weeds and exotic species, and wildlife/human conflicts.

Sagebrush Habitat: At the subbasin scale, the primary limiting factors for native sagebrush habitat are agricultural land conversion, fragmentation caused by development, grazing regime, and weeds and exotic species.

Dry Forest (Dry Ponderosa pine): At the subbasin scale, the primary limiting factors for dry forest habitat in the Bitterroot are timber management, fire regime, and weeds and exotic species.

Mesic Forest (various subtypes): At the subbasin scale, the primary limiting factors for mesic forest habitat in the Bitterroot are fragmentation caused by roads, timber management, fire regime, and insects and disease.

4.5 Chapter 4 References

American Fisheries Society. 2008. Westslope cutthroat trout. Species information downloaded from Montana Chapter American Fisheries Society website at http://www.fisheries.org/units/AFSmontana/SSCpages/westslope_cutthroat_trout.htm.

Anonymous. 1929. The cannibal of Montana's streams. Montana Wild Life. Montana State Fish and Game Commission. 2:7.

Bahn, L. 2007. An assessment of losses of native fish to irrigation diversions on selected tributaries of the Bitterroot River, Montana. M. S. Thesis, Montana State University, Bozeman.

Bear, E., T. McMahon, A. Zale. 2007. Comparative thermal requirements of westslope cutthroat trout and rainbow trout: Implications for species interactions and development of thermal protection standards. Transactions of the American Fisheries Society. 136(4): 1113-1121.

Bitterroot National Forest (BNF). 2006. Forest plan monitoring and evaluation report. Fiscal Year 2006. Bitterroot National Forest, USDA Forest Service Northern Region. Hamilton, MT

Bitterroot National Forest (BNF). 2007. Forest plan monitoring and evaluation report. Fiscal Year 2007. Bitterroot National Forest, USDA Forest Service Northern Region. Hamilton, MT

Brown, R.S. and W.C. Mackay. 1995. Fall and winter movements of and habitat use by cutthroat trout in the Ram River, Alberta. Transactions of the American Fisheries Society 124:873-885.

Casey, Dan. 2000. Partners in flight draft bird conservation plan, Montana, American Bird Conservancy, c/o Montana Fish Wildlife and Parks, Kalispell, MT

Chalfant, S.A. 1974. Aboriginal territory of the Kalispell Indians. in E. O. Fuller, editor. Interior Salish and Eastern Washington Indians III. Garland Publishing Inc., New York and London.

Cilimburg, A. 2008. Montana Audubon Director of Bird Conservation. Missoula, MT. Personal communication.

Clancy, C. 2008a. Montana Department of Fish, Wildlife & Parks, Hamilton, Montana. Personal communication to Amy Sacry of Geum Environmental Consulting, Inc. regarding fish distribution and status in the Bitterroot Subbasin.

Clancy, C. 2008b. Montana Department of Fish, Wildlife & Parks, Hamilton, Montana. Personal communication to Tom Parker of Geum Environmental Consulting, Inc. regarding fish distribution and status in the Bitterroot Subbasin.

Clancy, C. 2008c. Montana Department of Fish, Wildlife & Parks, Hamilton, Montana. Personal communication to Sarah Flynn of Geum Environmental Consulting, Inc. regarding fish distribution and status in the Bitterroot Subbasin.

Clancy, C. 2007. Report to Dingle Johnson regarding statewide fisheries management status of fish in the Bitterroot River Drainage for fiscal years July 1 2005-June 30 2006 and July 1 2006-June 30, 2007. Federal Aid Project No: F-113-R1, R2, R3. Project Number 3220.

Clancy, C. 2005. Report to Dingle Johnson regarding statewide fisheries management status of fish in the Bitterroot River Drainage for fiscal years July 1 2003-June 30 2004 and July 1 2004-June 30, 2005. Federal Aid Project No: F-113-R1, R2, R3. Project Number 3220.

Clancy, C. 1993. Statewide fisheries investigations. Bitterroot Forest Inventory. Project F-46-R-4. Montana Fish, Wildlife & Parks, Helena.

Clancy, C. 1991. Statewide fisheries inventory: Bitterroot Forest inventory. Montana Fish, Wildlife & Parks, Job Completion Report, Project F-46-R-4-Ij, Helena, MT

CNK. 2006. Draft assessment of aquatic species Bitterroot, Lolo and Flathead National Forests.

Confederated Salish and Kootenai Tribes, Montana Department of Fish Wildlife & Parks. 2004. Flathead Subbasin Plan: Part I: Flathead Subbasin Assessment. A report prepared for the Northwest Power and Conservation Council, Portland, OR

Decker, G., R. Hammer, M. Beck, and M. Mais. 1993. Bitterroot watershed evaluation process. Bitterroot National Forest. Review Draft. Hamilton, MT

DeHaan, P. and D. Hawkins. 2008. Rapid response genetic identification of geographic origin of bull trout captured at Clark Fork River Dams. Annual report for calendar year 2008. Avista Reimbursable Agreement No. R-20413. U.S. Fish and Wildlife Service. Abernathy Fish Genetics Laboratory. Abernathy, WA

Everest, F.H., R.L. Beschta, J.C. Scrivener, K.V. Koski, J.R. Sedell and C.J. Cederholm. 1987. Fine sediment and salmonid production: A paradox. IN Streamside Management: Forestry and Fishery Interactions. University of Washington, Seattle, Washington. E.O. Salo and T.W. Cundy, tech Ed. pp. 98-142.

Evermann, B. W. 1892. Report of the Commissioner of Fish and Fisheries reflecting the establishment of fish-cultural stations in the Rocky Mountain Region and Gulf states. 52D Congress, Senate, Miscellaneous Document Number 65, U.S. Government Printing Office.

Gale, S. B. 2005. Entrainment losses of westslope cutthroat trout into screened and unscreened irrigation canals on Skalkaho Creek, Montana. M. S. Thesis, Montana State University, Bozeman.

Goslin, Deborah. 2008. USFWS biologist, Lee Metcalf National Wildlife Refuge, Stevensville, MT. Personal communication.

Gustafson, D. R. 2001. Westslope cutthroat hypothesis. Presentation to the American Fisheries Society Meeting, Bozeman, MT

Hackett, Harvey. 2008. Rancher (4th generation), Stevensville, Montana. Personal communication.

Harnisch, R. A. 2007. Fish screen efficiency and effects of screened and unscreened irrigation canals on the downstream movement of westslope cutthroat trout juveniles in Skalkaho Creek, Montana. Masters of Science Thesis, Montana State University, Bozeman, MT

Jakober, M. J. 2008. USDA Forest Service, Bitterroot National Forest, Conner, Montana. Personal communication to Amy Sacry of Geum Environmental Consulting, Inc. regarding fish distribution and status in the Bitterroot Subbasin.

Javorsky, L. 1994. The Bitterroot River floodplain: An historical analysis. Montana Department of Fish, Wildlife and Parks.

Knotek, L. 2008. Montana Department of Fish, Wildlife and Parks, Missoula, Montana. Personal communication to Amy Sacry of Geum Environmental Consulting, Inc. regarding fish distribution and status in the Bitterroot Subbasin.

Knotek, L. and M. Leary. 2008. Unpublished data. Montana Fish, Wildlife and Parks, Missoula, MT

Laymon, S. A. and M. D. Halterman. 1987. Can the western subspecies of the yellow-billed cuckoo be saved from extinction. Western Birds, No. 18.

Leary, R. 1991. Letter to Chris Clancy, Montana Fish, Wildlife, & Parks, December 10, 1991. University of Montana, Division of Biological Sciences, Missoula, MT

Leary, R. 1993a. Letter to Chris Clancy, Montana Fish, Wildlife, & Parks, September 15, 1993. University of Montana, Division of Biological Sciences, Missoula, MT

Leary, R. F., F. W. Allendorf, and K. L. Knudsen. 1983. Consistently high meristic counts in natural hybrids between brook trout and bull trout. Systematic Zoology. 32:369-376.

Leary, R. F.; F. W. Allendorf, and S. H. Forbes. 1993b. Conservation genetics of bull trout in the Columbia and Klamath River watersheds. Conservation Biology 7:856-865.

Liknes, G. A. and P. J. Graham. 1988. Westslope cutthroat trout in Montana: Life history, status and management. Status and Management of Interior Stocks of Cutthroat Trout. American Fisheries Society Symposium 4:53-60.

Lockman, Dave. 2008. USFS biologist, Bitterroot National Forest, Stevensville, MT. Personal communication.

Maxell, Bryce. 2004. Amphibian and aquatic reptile inventories conducted on and around Bitterroot National Forest 2000-2003, University of Montana, Wildlife Biology Program, Missoula, MT

McFarland, R. C. 2006. Montana statewide angling pressure 2005. Montana Department of Fish, Wildlife and Parks. Helena, MT

McIntyre, J. D. and B. E. Rieman. 1995. Westslope cutthroat trout. IN: Conservation assessment for inland cutthroat trout. General Technical Report RM-256. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. M.K. Young, tech. Ed. Pages 1-15.

McMahon, T. E., A. V. Zale, F. T. Barrows, J. H. Selong and R. J. Danehy. 2007. Temperature and competition between bull trout and brook trout: A test of the elevation refuge hypothesis. Transactions of the American Fisheries Society 136: 1313-1326.

Mitchell, L.G. 1970. Studies of Myxosporida of fishes of western Montana. Master's thesis, University of Montana, Missoula, Montana.

Parkin, D. and C. McConnaha. 2003. Qualitative habitat assessment (QHA) user's guide Version 1.0.

Montana Bull Trout Scientific Group. 1995. Bitterroot River drainage bull trout status report. Report prepared for the Montana Bull Trout Restoration Team by Montana Bull Trout Scientific Group. Montana Department of Fish, Wildlife, & Parks, Helena, MT. 31 pp.

Montana Bull Trout Restoration Team. 2000. Restoration plan for bull trout in the Clark Fork River basin and Kootenai River basin, Montana. Report prepared by Montana Bull Trout Restoration Team. Montana Department of Fish Wildlife & Parks, Helena. 116 pp.

Montana Department of Administration. 2008. Montana Cadastral Mapping Project. ftp://ftp.gis.mt.gov/cadastralframework. Accessed September 2008.

Montana Department of Fish Wildlife & Parks. 2008a. Print out of Microsoft Access database of fish sampling in the Bitterroot Valley. Hard copy provided by Chris Clancy Montana Fish, Wildlife and Parks, Hamilton.

Montana Department of Fish Wildlife & Parks. 2008b. Westslope Cutthroat trout restoration program: Past and present distribution, brood stock program, and conservation genetics committee report. Accessed at: http://fwp.mt.gov/wildthings/concern/westslope.html

Montana Department of Fish Wildlife & Parks. 2007. Memorandum of understanding and conservation agreement for westslope cutthroat trout and Yellowstone cutthroat trout in Montana. Helena. 34 pages.

Montana Department of Fish Wildlife & Parks. 2006. Dewatered streams of the Bitterroot Valley. Accessed December 2008 from NRIS Montana geographic information clearinghouse at: http://nris.mt.gov/gis/.

Montana Department of Fish Wildlife & Parks. 2005. Comprehensive fish and wildlife conservation strategy, Helena, MT. See internet: http://fwp.mt.gov/specieshabitat/strategy/fullplan.html

Montana Department of Fish Wildlife & Parks. 2004. Montana elk management plan, internet http://fwp.mt.gov/hunting/elkplan.html

Montana Department of Fish Wildlife & Parks. Various. Unpublished data collected prior to 1970 by the Montana department of Fish, Wildlife and Parks, Helena, Montana.

Montana Natural Heritage Program. 2008. Downloads from Montana Natural Heritage Program website on various species of concern and species distribution. Accessed at: http://nhp.nris.mt.gov/.

Montana Natural Heritage Program. 2007. Optimolocus. Spring 2007. The newsletter of the Montana Natural Heritage Program. See internet: http://mtnhp.org/newsletter/spring_07/2007_Spring_full.htm

Montana Natural Heritage Program and Montana Department of Fish Wildlife & Parks. 2008. Montana Animal Species of Concern. Helena, MT. 17 pp. Also see internet: http://nhp.nris.state.mt.us/SpeciesOfConcern/

Muhlfeld, C. 2009. Hybridization rapidly reduces fitness of native cutthroat trout in the wild, in press.

Natural Resource Information System. 2008. Natural Resources Information System Montana Fisheries information system. Various downloads on species status and distribution in the Bitterroot Subbasin. See internet: http://maps2.nris.state.mt.us/scripts/esrimap.dll?name=MFISH&Cmd=INST.

Northwest Power Planning Council (NWPCC). 2001. Technical guide for subbasin planners. Council Document 2001-20.

Ormiston, John. 2008. Retired USFS biologist, Missoula, MT. Personal communication.

Peterson, D., B. Rieman, J. Dunham, K. Fausch, and M. Young. 2008. Analysis of trade-offs between threats of invasion by nonnative brook trout (*Salvelinus fontinalis*) and intentional isolation for native westslope cutthroat trout (*Oncorhynchus clarkii lewisi*).
Canadian Journal of Fisheries and Aquatic Science. 65: 557-573.

Quigley, T.M. and H. Bigler-Cole. 1997. Highlighted scientific findings of the Interior Columbia Basin Environmental Management Program. PNW-GTR-404, USDA-Forest Service and Bureau of Land Management. Portland, OR

Raphael, Martin G., B. G.Marcot, R. S. Holthausen, M. S.Wisdom. 1998. ICBEMP: terrestrial species and habitats. Journal of Forestry. 96(10): 22-27.

Rich, C.F.1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, Western Montana. Master's Thesis. Montana State University, Bozeman MT

Rich, C.F. and T.E. McMahon. 2003. Local-habitat, watershed, and biotic features associated with bull trout occurrence in Montana streams. Transactions of the American Fisheries Society. 132: 1054-1064.

Rieman, B. E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce and D. Myers. 2007. Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River basin. Transactions of the American Fisheries Society 136: 1552-1565.

Rieman, B. E., J. T. Peterson, and D. L. Myers. 2005. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences 63: 63-78.

Rieman, B. E., D. Lee, J. McIntyre, K. Overton, and R. Thurow. 1993. Consideration of extinction risk for salmonids. Currents Fish Habitat Relationships Technical Bulletin: 14. USDA Forest Service Intermountain Research Station. Boise ID

Sime, Carolyn A., et.al. 2008. Montana gray wolf conservation and management 2007 Annual Report. Montana Fish Wildlife & Parks, Helena, Montana. Report accessed from: http://www.fwp.mt.gov/wildthings/wolf

Shepard, B. B., B. E. May, and W. Urie. 2003. Status of westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) in the United States. Montana Fish, Wildlife & Parks. Printed Agency Report. 94 pp. Helena.

Shepard, B. B., K. L. Pratt, and P. J. Graham. 1984. Life histories of westslope cutthroat trout and bull trout in the upper Flathead River Basin, Montana. Montana Department of Fish Wildlife & Parks, Helena.

Spoon, R.L. 1987. Evaluation of management of water releases for Painted Rocks Reservoir, Bitterroot River, Montana. Final Report. Montana Department of Fish Wildlife & Parks. Bonneville Power Administration, contract report. Project 83-463, contract number DE-A179-83BP13076.

Stagliano, D. M., George M. Stephens and W. R. Bosworth. 2007. Aquatic invertebrate species of concern on USFS Northern Region lands. Report to USDA Forest Service, Northern Region. Montana Natural Heritage Program, Helena, MT and Idaho Conservation Data Center, Boise, ID. 95 pp. plus appendices.

Storey, J. 2008. Montana State University biologist, Corvallis, MT. Personal communication.

USDA Forest Service. 2006. DRAFT Forest Plan monitoring and evaluation report. Fiscal Year 2006. Bitterroot National Forest, Hamilton, MT

USDA Forest Service. 1993. Forest Plan monitoring and evaluation report. Bitterroot National Forest. Fiscal Year 1992. Item 19- Cumulative offsite watershed effects, Hamilton, MT

USDA Forest Service, Bitterroot National Forest (BNF). 2007. Forest Plan monitoring evaluation report. Fiscal year 2007. U.S. Department of Agriculture Forest Service, Northern Region, Bitterroot National Forest. Hamilton, MT

USDA Forest Service, Bitterroot National Forest (BNF). 2006. Forest plan monitoring evaluation report. Fiscal year 2006. U.S. Department of Agriculture Forest Service, Northern Region, Bitterroot National Forest. Hamilton, MT

USDA Forest Service, Bitterroot National Forest (BNF). 2001. Wetlands in the Bitterroot Valley Complex, 2000 fire season, Bitterroot National Forest, Montana. Digital Geographic Information Systems (GIS) data. Hamilton, MT

U.S. Fish and Wildlife Service. 2008. Canada Lynx. Information accessed on internet at: http://www.fws.gov/mountain-prairie/species/mammals/lynx/)

U.S. Fish and Wildlife Service. 2007. National Wetlands Inventory website, Wetland and riparian mapping – Hamilton 100K Quadrangle. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/nwi/.

U.S. Fish and Wildlife Service. 2005. Endangered and threatened wildlife and plants; Designation of critical habitat for Klamath River and Columbia River populations of vull trout (*Salvelinus confluentus*). Vol 69, No. 193, United States Fish and Wildlife Service (FWS), 50 CFR Part 17, RIN 1018-AI52, 69 FR 59996.

U.S. Fish and Wildlife Service. 2002. Bull trout (*Salvelinus confluentus)* draft recovery plan. Region 1, US Fish and Wildlife Service, Portland, OR

U.S. Geological Survey (USGS) GAP Analysis Program. 2005. Land cover data for Montana. Published by National Biological Information Infrastructure.

Weaver, T. and J.J. Fraley. 1991. Flathead basin forest practices water quality and fisheries cooperative program: Fisheries habitat and fish populations. Flathead Basin Commission, Kalispell, MT

Weaver, T.M. and J.J. Fraley. 1993. A method to measure emergence success of westslope cutthroat trout fry from varying substrate compositions in a natural stream channel. North American Journal Fisheries Management. 13:817-822.

Whitney, A.N. 1955. Cataloging the waters of the project area: Bitterroot drainage electric fish census. Montana State Department of Fish and Game, Job Completion Report, F-12-R-1 Helena, MT