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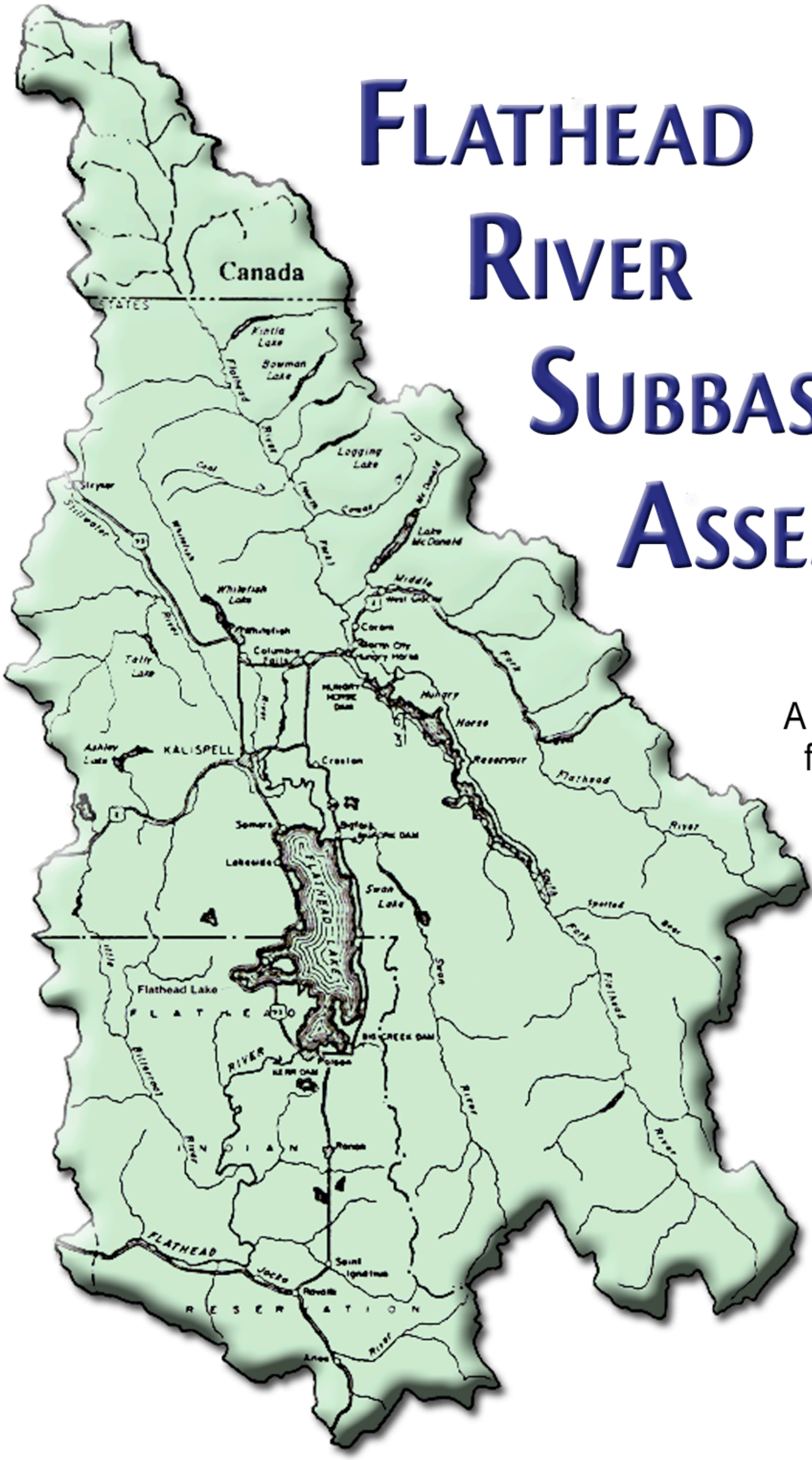
Flathead River Subbasin Assessment



A Report prepared for the Northwest Power and Conservation Council

A technical evaluation of the biological and physical characteristics of the Flathead Subbasin, including an assessment of biomes, fish and wildlife communities, focal and target species, and a ranking of 6th-code HUCs.

Reservation of Rights

Acknowledgements

This assessment, much of which is a compilation of existing information, draws heavily on the previous work of many agencies, groups, educational institutions, consulting firms, and individuals. Throughout we have used excerpts or condensed or adapted sections from other reports, studies, and plans. In each case we have acknowledged such use. The Flathead River Subbasin Plan Technical Team expresses its gratitude for the use of these materials. The Technical Team also thanks Chip McConnaha, Drew Parkin, and Betsy Torell for their assistance with QHA, Paul Anders for his work on LQHA, Mike Panian for developing the terrestrial spreadsheet tool (TBA), Bob Jamieson for his revisions of the assessment outline and early organizational work on TBA, and Susan Ball and Volker Mell for their GIS work. We are also grateful to Albert Chirico and Mike Panian other colleagues in the British Columbia ministries for their help and cooperation with this effort.

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Lead Agency: CSKT
Co-lead Agency: MFWP
Subbasin Coordinator: Lynn DuCharme, CSKT
Co-coordinator: Brian Marotz, MFWP

Technical Team

Lynn DuCharme	Confederated Salish and Kootenai Tribes
Brian Marotz	Montana Fish, Wildlife & Parks
Larry VanRinsum	Flathead County Conservation District
Leo Marnell	Glacier National Park
Albert Chirico	BC Ministry of Sustainable Resource Management
Mike Panian	BC Ministry of Sustainable Resource Management
Bob Jamieson	Private Consultant
Alan Wood	Montana Fish, Wildlife & Parks
Scott Relyea	Flathead Lake Biological Station, University of Montana
Seth Makepeace	Confederated Salish and Kootenai Tribes
Barry Hansen	Confederated Salish and Kootenai Tribes
Craig Barfoot	Confederated Salish and Kootenai Tribes
Art Soukkala	Confederated Salish and Kootenai Tribes
Steve Phillips	US Forest Service (USFS), Flathead National Forest
Fred Samson	USFS, Region One
Wade Fredenberg	US Fish and Wildlife Service
Bill Westover	BC Ministry of Land, Water, and Air Protection
Jeff Hutten	Montana Fish, Wildlife & Parks
Tom Weaver	Montana Fish, Wildlife & Parks
Dean Sirucek	US Forest Service (USFS), Flathead National Forest
Beth Gardner	US Forest Service (USFS), Flathead National Forest
Pat Van Eimeren	US Forest Service (USFS), Flathead National Forest
Herb Tepper	BC Ministry of Land, Water, and Air Protection
David Rockwell	CW Consulting

Document Prepared by David Rockwell
GIS work by Susan Ball and Volker Mell, CSKT

For information on this document, contact

Lynn DuCharme, Subbasin Coordinator
Confederated Salish and Kootenai Tribes
PO Box 278
Pablo, MT 59855
Phone: 406-675-2700 ext. 7279
email: lynnd@cskt.org

Brian Marotz, Subbasin Co-Coordinator
Montana Fish, Wildlife & Parks
490 North Meridian Rd
Kalispell, MT 59901
Phone: (406) 751-4546
bmarotz@state.mt.us

Montana Fish, Wildlife & Parks

Northwest Power and Conservation Council

INTRODUCTION

This assessment constitutes the technical evaluation of the biological and physical characteristics of the Flathead Subbasin, the first step in the development of a subbasin plan, which will be reviewed and eventually adopted as part of the Northwest Power and Conservation Council's Columbia River Basin Fish and Wildlife Program. The primary purpose of the plan will be 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 hydropower system.

The primary purpose of the assessment is to bring together and synthesize technical information so that it can be used to develop the biological objectives that form the foundation of the management plan. It begins with an overview of the subbasin environment. Chapter 2 examines in some detail the major biomes found in the subbasin—aquatic, riparian/wetland, grassland, coniferous forest. Each of these biomes is evaluated in terms of ecological function and process and how human activities have affected those functions and processes. For each biome we also describe the current condition and several reference conditions. Chapter 3 assesses fish and wildlife communities in the subbasin, Chapter 4 examines the status of individual focal and target species. In Chapter 5, we present the results of a detailed aquatic evaluation of each 6th-code HUC in the subbasin and a terrestrial assessment of various units within each of our targeted biomes. This resulted in a ranking of the restoration potential and protection value of each. Finally, in the last chapter we interpret and synthesize our results, setting the stage for development of specific objectives, which make up the bulk of the management plan. It is our hope that this approach, moving from the broad (biomes and communities) to the more specific (individual species and 6th-code HUCs), is a logical framework for developing objectives and strategies to protect, mitigate, and enhance the fish and wildlife of the Flathead Subbasin.

LINKS

For the PowerPoint introduction to the Kootenai and Flathead Subbasin Plans that the Subbasin Coordinators gave the Independent Scientific Review Panel, go to Appendix 96.

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1 Subbasin Overview

1.1 Subbasin Description

The Flathead Subbasin of northwestern Montana and the southeastern corner of British Columbia constitutes the northeastern-most drainage of the Columbia River (figure 1.1).

Headwater tributaries originate in Glacier National Park, the Bob Marshall Wilderness, and Canada. The river empties into the Clark Fork River at Paradise, Montana. East to west, the subbasin stretches roughly 90 miles, north to south just over 200 miles. It encompasses approximately 5.8 million acres.

The headwaters of the North Fork of the Flathead River are in British Columbia, where the river flows thirty-one miles through the province to the US-Canada border. In the US, the North Fork continues south, bounded on the east side by Glacier National Park and on the west by Flathead National Forest land.

The Middle Fork of the Flathead River has its headwaters in the Bob Marshall and Great Bear Wilderness areas. From its confluence with Bear Creek to where it joins with the North Fork Flathead River, the Middle Fork is bordered on the north by Glacier National Park and on the south by Flathead National Forest lands. Just ten miles south of the confluence of the North and Middle Forks, the South Fork Flathead River enters after leaving Hungry Horse Dam. The headwaters of the South Fork are in the Bob Marshall Wilderness. The North, Middle, and South Forks of the Flathead River have a combined drainage area of 4,464 square miles and an average annual discharge of 9,699 cubic feet per second, as measured at Columbia Falls (USGS 2002).

Between Columbia Falls and Kalispell, Montana, the mainstem of the Flathead River flows through the Kalispell Valley on its way to Flathead Lake. Two major tributaries—the Stillwater and Whitefish Rivers—enter it here. They drain the valley floor and mountain ranges of the northwestern part of the subbasin, where ownership is mostly private but includes both Flathead National Forest and State lands. The Whitefish River joins the Stillwater River about 3 miles before its confluence with the Flathead River, roughly 22 miles upstream of Flathead Lake.

Flathead Lake is the largest lake, in terms of surface area, of any natural freshwater lake in the western US, and is one of the 300 largest lakes in the world. It covers 126,000 acres, has a mean depth of 165 feet, and a maximum depth of 370 feet. The Flathead Indian Reservation, where the Confederated Salish and Kootenai Tribes (CSKT) are the primary landowner, encompasses the south half of the lake. The Swan River enters the lake just north of the Reservation boundary at the town of Big Fork. The Swan River flows generally north for 66 miles from its headwaters in the Swan and Mission Mountain ranges. The drainage includes private, State and Flathead National Forest lands.

LINKS

The Montana Natural Resource Information System contains additional, general information on the Flathead Subbasin.

Click Here

The Northwest Power and Conservation Council Flathead Subbasin website has general information on the subbasin and other links: http://nwppc.org/fw/subbasinplanning/flathead/default.asp

Click Here

Environmental information about the Flathead Watershed can be found on the EPA's Surf Your Watershed website: http://cfpub.epa.gov/surf/locate/index.cfm

Click Here

The lower mainstem of the Flathead River (known locally as the lower Flathead River) leaves Flathead Lake at Kerr Dam just south of Polson and flows south and west through the Flathead Indian Reservation for 72 miles (Kerr Dam, owned and operated by PPL Montana, is located 4 miles downstream of the original outlet of Flathead Lake). Below Flathead Lake, the river's primary tributaries are the Little Bitterroot and Jocko Rivers and Crow, Mission, and Camas Creeks. At its confluence with the Clark Fork, the lower Flathead River has an annual average discharge of 11,920 cubic feet per second (USGS 2002).

In terms of ecological classification systems, the US portion of the Flathead Subbasin lies within Northern Rockies Section of the Northern Rocky Mountains Steppe-Coniferous Forest-Alpine Meadow Province (M333) and includes the sections and subsections listed in table 1.1. In the British Columbia Ecoregion Classification system, the Canadian portion of the subbasin falls within the Border Range and Crown of the Continent ecosections, which is within the Northern Continental Divide ecoregion and the Southern Interior Mountains ecoprovince (table 1.2).

Included in the Flathead Subbasin's almost 10,000 square miles are virtually all of Flathead and Lake Counties and part of Missoula and Sanders Counties; the Flathead Indian Reservation; the west half of Glacier National Park; parts of four wilderness areas; millions of acres of forest land under federal, provincial, state, tribal, and industrial management; and thousands of acres of privately owned land.

Table 1.1. Ecological Units of the Flathead Subbasin (Nesser et al. 1997)

Section	Subsection	Code
Flathead Valley Section		**M333B**
	Salish Mountains Subsection	M333Bb
	Flathead River Valley Subsection	M333Bc
Northern Rockies Section		**M333C**
	Livingston Mountains Subsection	M333Ca
	Whitefish/Swan Mountains Subsection	M333Cb
	Mission/Swan Valley and Mountains Subsection	M333Cc
	Flathead Thrust Faulted Mountains Subsection	M333Cd

Table 1.2. Ecoprovince, ecoregion, and ecosections of the Canadian portion of the Flathead Subbasin (based upon the B.C. Ecoregion Classification System).

Province	Region	Section
Southern Interior Mountains		
	Northern Continental Divide	
		Border Range
		Crown of the Continent

For background on the ecosections found within the Canadian portion of the subbasin, go to: http://srmwww.gov.bc.ca/ecology/ecoregions/contents.htm

LINKS

The Environmental Statistic Group—Hydrologic Unit Project website has general information on the Flathead that includes: maps, flow connections, named places, elevation analysis, map line analysis, and more. Go to: http://www.esg.montana.edu/gl/huc/17.html

Click Here

For general watershed information on the Flathead, see also the Conservation Technology Information Center-Know Your Watershed website at: http://www.ctic.purdue.edu/KYW/

Click Here

For U. S. Geological Survey hydrologic information, go to: http://water.usgs.gov/wsc/acc/170102.html

Click Here

For background on the ecosections found within the Canadian portion of the subbasin, go to: http://srmwww.gov.bc.ca/ecology/ecoregions/contents.htm

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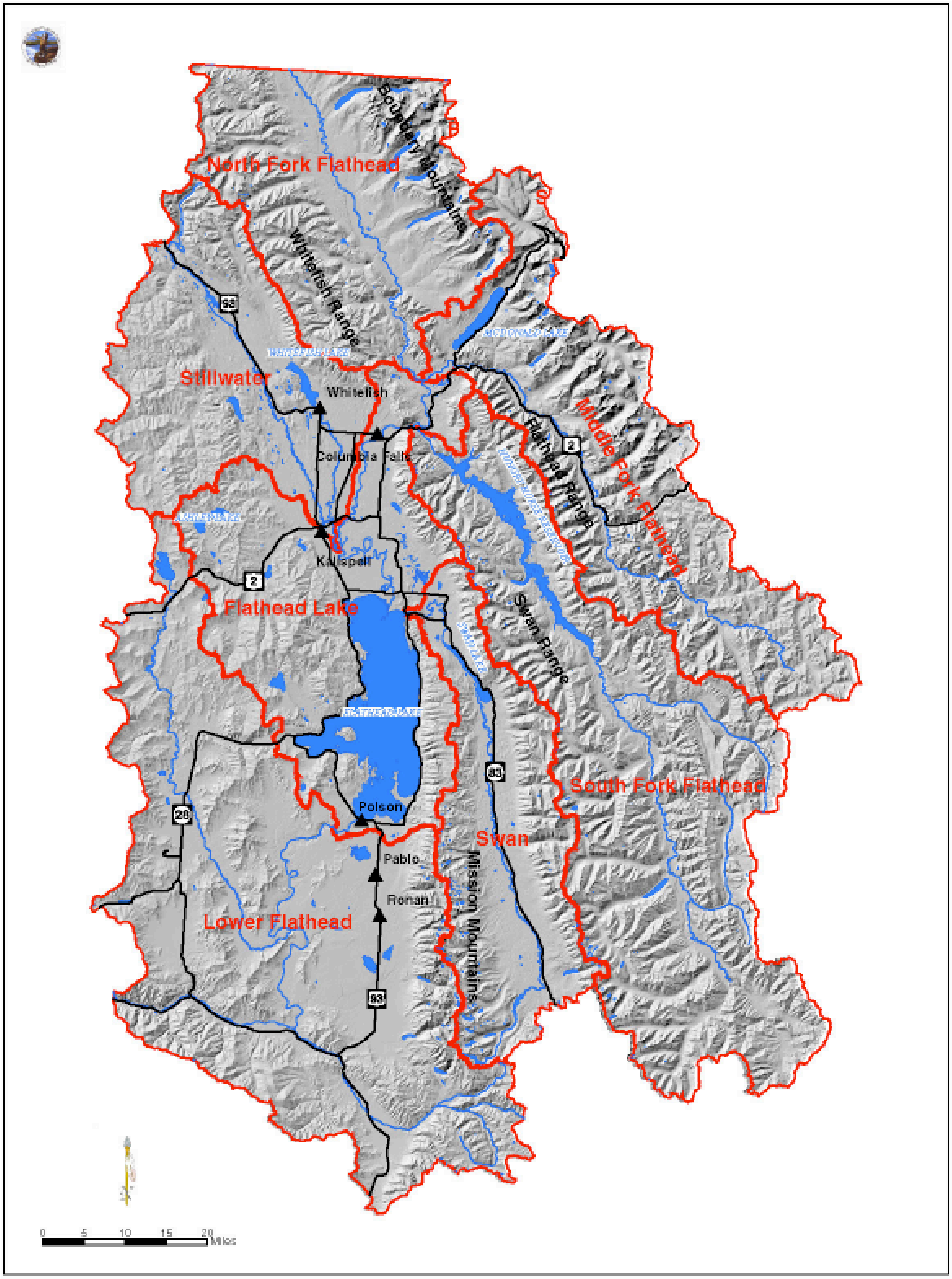

Figure 1.1. Flathead Subbasin, U.S. portion.

1.1.1 Land Status and Administrative Structure

Of the 5.8 million acres in the subbasin, 389,227 (7 percent) are in British Columbia (BC). Almost all of the land in the Canadian portion of the subbasin is provincial Crown land administered by the BC Ministry of Forests. The U.S. portion of the subbasin is 45 percent U.S. Forest Service, 12 percent National Park Service (Glacier National Park), 12 percent Confederated Salish and Kootenai Tribes, 4 percent State of Montana, 5 percent corporate timberland, and 21 percent other private (table 1.3, figure 1.2).

LINKS

Appendix 1 contains brief descriptions of land management agencies in the subbasin and their jurisdictional responsibilities with respect to fish and wildlife restoration and protection.

Click Here

Table 1.3. Acres and percent of area in various ownerships in the Flathead Subbasin.

Land Ownership	Acres	Percent
Corporate Timber land	273,890.21	5%
National Park Service	635,501.58	12%
Other Federal	26,908.52	0%
Private land	1,159,777.57	21%
State of Montana	242,912.21	4%
Tribal/BIA/Reservation	666,485.93	12%
U.S. Forest Service	2,418,370.67	45%

North Fork Flathead River, British Columbia: In BC, the only land that is not provincial Crown land is the Akamina Kishenena Provincial Park administered by the BC Ministry of Environment, Lands, and Parks and several parcels in private ownership (197 acres, 370 acres, and 2400 acres). The largest of the private parcels is the old Flathead townsite in the Upper Flathead, and is owned by Crestbrook Forest Industries. As might be expected from the landownership pattern, the Canadian portion of the Flathead is virtually uninhabited. Though loggers, fishermen, hunters, and recreationists visit the area, no one lives year round in the Canadian Flathead (Flathead Transboundary Network 1999).

North Fork Flathead River, Montana: In the United States, the western side of the river is predominantly National Forest land administered by the Flathead National Forest. The eastern side lies within Glacier National Park. Other ownerships include the Coal Creek State Forest and tracts of private land. The communities of Polebridge and Moose City lie within the watershed, while Columbia Falls and Hungry Horse are located immediately to the south.

Middle Fork Flathead River: The Middle Fork of the Flathead River forms the boundary between Glacier National Park and the Flathead National Forest. Approximately one half of the watershed is National Forest lands, with the remainder mostly within Glacier National Park. Relatively little land is in private ownership, although the communities of Essex and West Glacier are found here. Approximately two thirds of the National Forest lands are within the Great Bear and Bob Marshall Wilderness Areas.

South Fork of the Flathead River: This watershed encompasses a large area, bounded to the west by the crest of the Swan mountain range and by the Continental Divide to the east. The upper half, (approximately 64 percent), of the drainage lies within the Bob Marshall and Great Bear Wilderness Areas. There is no private land. The communities of Hungry Horse and Martin City lie near the mouth of the South Fork, north of the watershed.

Stillwater River: The Stillwater encompasses roughly one-half million acres of land 20 to 25 air miles south of the Canadian border. It includes the floor of the Flathead Valley north and northwest of Kalispell and all upland areas draining into the Stillwater River. About 40 percent of the area is National Forest land administered by the Flathead National Forest, while the far northwest portion lies within Kootenai National Forest. The Stillwater watershed includes the communities of Whitefish, Olney, and Stryker. Private lands are concentrated on the main valley floor and along the Stillwater River and the valley bottoms of many of the major drainages. Most of the upper Stillwater and Swift Creek drainages are in the Stillwater State Forest and are managed by Montana Department of Natural Resources and Conservation.

Swan River: Land ownership in the Swan is mixed. Approximately 60 percent is managed by the Flathead National Forest (a large part of this is designated or proposed wilderness), 20 percent by Plum Creek Timber Company, 10 by the Swan River State Forest, and 10 percent by other, mainly private, landowners. The communities of Bigfork, Ferndale, Swan Lake, Salmon Prairie, and Condon are located within the watershed.

Flathead Lake: The Flathead Lake watershed encompasses a large area extending from north of Hungry Horse to the Flathead Indian Reservation boundary. It is bounded on the east by the Mission and Swan Ranges and on the west by a low-lying watershed divide. It is dominated by private ownership. The communities of Kalispell, Columbia Falls, Coram, Hungry Horse, Marion, Lakeside, and Rawlins are included within this watershed. Much of the area is agricultural and residential lands surrounding these communities. Private, industrial timber lands dominate the southern portions of the watershed. National Forest lands are concentrated in the area west of Kalispell, in the Coram/Lake Five area, and in a fringe at the upper elevations of the watershed.

Flathead Reservation: The Confederated Salish and Kootenai Tribes are the primary landowner on the 1.2-million-acre Flathead Indian Reservation. The Reservation, established by the Hellgate Treaty in 1855, includes the south half of Flathead Lake and approximately 68 miles of the lower Flathead River, as well as its associated tributary streams. There are hundreds of allotments owned in whole or in part by individuals and the Tribes. The federal government holds title to tribally owned lands and allotments on behalf of the owners. The rest of the land is held in federal, State, or fee ownership. Ninety-five thousand acres of the Reservation are managed by the Tribes as the Mission Mountains Tribal Wilderness.

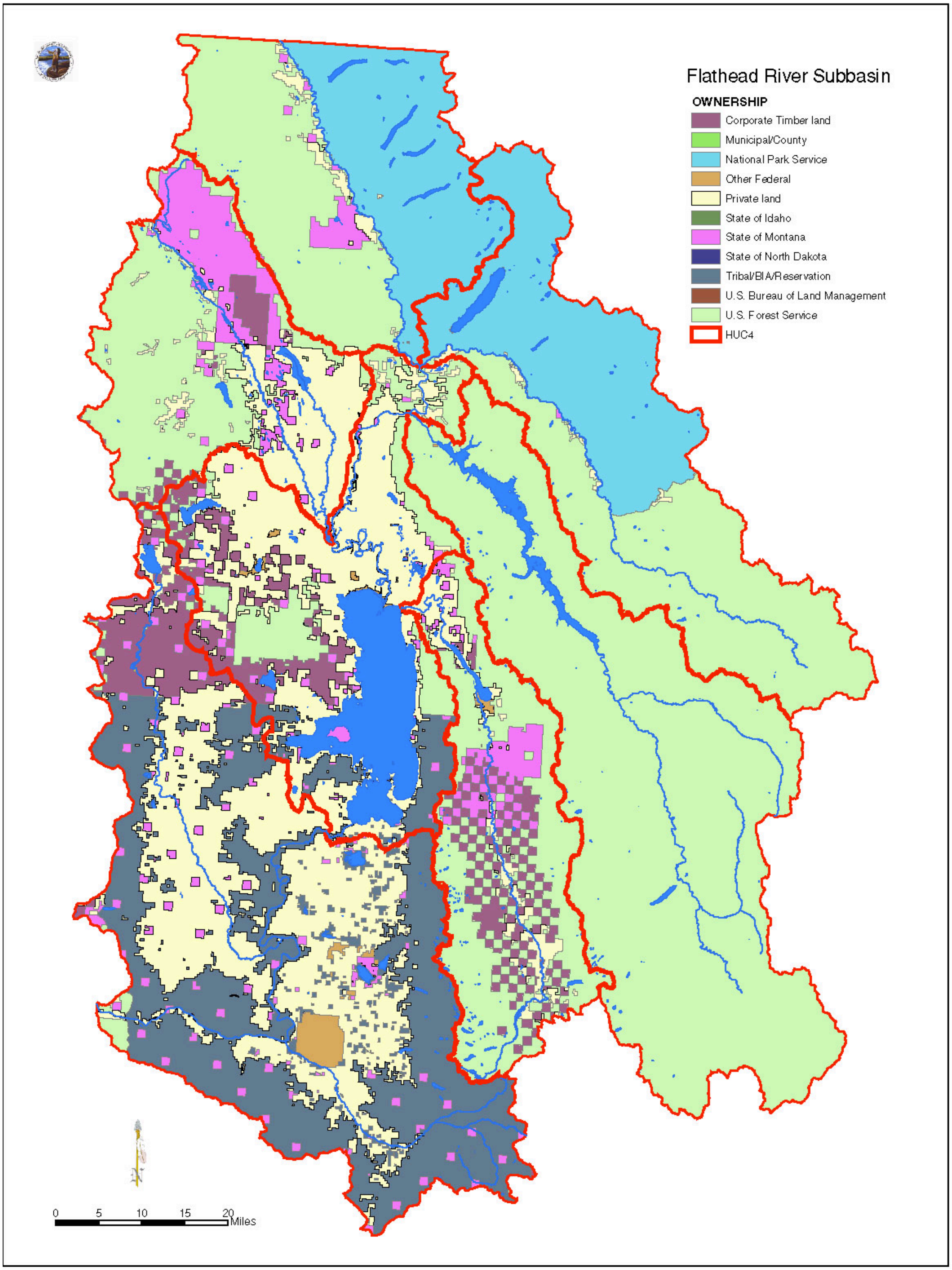

Figure 1.2. Landownership in the U.S. portion of the Flathead Subbasin.

1.1.2 Climate[1]

The climate of the subbasin is classified as modified maritime, which means it is strongly influenced by moist, pacific air masses. This is partly because major mountain ranges to the east of the Flathead are generally a barrier to the frigid arctic air that flows south along the east side of the Rockies out of Alberta during the winter. As a consequence, moist pacific air dominates in winter, often shrouding the area with low-lying, gray clouds and bringing mild temperatures. Kalispell, for example, has a mean January temperature of 20 °F. Periodically, continental air masses composed of arctic or polar air spill over the Continental Divide, bringing clear skies and frigid temperatures (-20 °F or colder) (NWS 2002).

Pacific air masses often dominate during the spring and early summer as well. They bring partly cloudy conditions, punctuated by rain and occasional warm, dry periods. By July, a high-pressure system often moves over the subbasin. Skies clear and temperatures range from the 70s to the high 90s with occasional, short, hotter periods. Afternoon thunderstorms are common throughout the summer. Severe thunderstorms can cause blowdowns and ignite forest fires. Fall repeats the unsettled weather pattern of spring; clear skies alternate with periodic cloudy weather.

Aside from these general patterns, local topography creates large differences in the subbasin's weather. For example, the headwaters of the North Fork of the Flathead in British Columbia, receive seventeen inches of precipitation a year. Polebridge, near the Canadian border, receives twenty-three inches a year, while West Glacier, just twenty miles southeast and 400 feet lower, receives thirty. The pattern reflects geography: the northern part of the drainage falls in the rain shadow of the Whitefish/Macdonald Range. Similar patterns exist south of Flathead Lake on the Flathead Indian Reservation where Camas Prairie, in the rain shadow of the Cabinet Mountains, is one of the driest areas in Montana, receiving just twelve inches of moisture a year. Twenty-five miles to the east, near the base of the Mission Mountains, over twenty inches a year falls.

Another major influence that topography has is the trend of increasing precipitation with elevation. While valley bottoms receive between 12 and 30 inches a year, the top of the Whitefish Range receives around 80, the Mission Range 100, and areas along the Continental Divide in Glacier Park 122.

Waterbodies are yet another local influence on the subbasin's climate. In addition to Flathead Lake, the valley contains hundreds of smaller lakes, rivers, streams, and sloughs. Until late in the winter, when a large portion of the lakes

[1] *The general climate inforamtion in this discussion comes from Finklin (1986), NWS (2002), National Climate Data Center, USDA (1986), and USFWS (2002), Rockwell (2002), and Long (2000).*

SNAPSHOT

The Flathead Subbasin is dominated by a mix of Pacific maritime and continental climatic conditions, which helps to enrich its biodiversity. Precipitation ranges from 18 to over 100 inches (460 to over 2,540 mm); most of the precipitation that arrives autumn, winter, and spring falls as snow; summers tend to be dry. The climate is classified as cool temperate with maritime influence. Temperature averages 36 to 45 °F. While maritime influences are present and winters are relatively mild, outbreaks of arctic air can occur frequently during winter. The growing season ranges from 45 to 120 days (McNab and Avers 1994).

LINKS

For monthly long-term climate summaries for Polebridge, Olney, Kalispell, Polson, St. Ignatius, and Hot Springs go to Appendix 2.

Click Here

and sloughs become frozen, this surface water tends to limit temperature extremes. The effect is most noticeable around Somers and Polson because of the influence of Flathead Lake, which because of its size, seldom freezes over.

There is evidence that the subbasin's climate is warming. This comes in part from changes in the number and size of small, alpine glaciers. In 1850, Glacier National Park had 150 active glaciers. Today, it has thirty seven, all of which are a fraction of the size they were in 1900.

LINKS

This NRCS site has additional climate information on the subbasin go to: http://www.wcc.nrcs.usda.gov/cgibin/state.pl?state=mt

Click Here

For climate data on B.C. locations, go to: http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html

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1.1.3 Geology and Geomorphology

Overview

The Flathead River Subbasin is situated along the west limb of the Rocky Mountains. Precambrian rocks of the Belt Supergroup form the bedrock under virtually the entire subbasin (figure 1.3). Belt rocks are exposed in the mountain ranges, as well as in many of the lower hills of the valleys. Major rock types include argillite, siltite, quartzite, and limestone. Almost all of the forested acres are underlain by these Precambrian rocks, which are fine grained, moderately metamorphosed sediments deposited over one billion years ago. For the most part, Belt sediments are highly stable and tend to have low erosion potential. They account for the generally high stability of the subbasin's watersheds (CSKT 2000). Igneous rocks also occur but only in a few areas. Belt rocks are characteristically deficient of nutrients (Stanford and Ellis 1988). Although there are limited areas of much younger and richer strata in headwater reaches of the three forks of the Flathead (Stanford and Hauer 1992), the subbasin's bedrock geology contributes little in the way of dissolved ions, nutrients, and suspended particulates to streams.

Over the last 100,000 years, advances and recessions of glaciers have extensively modified landscapes. The most recent glacial advance receded about 10,000 years ago and left unconsolidated surface sediments in many watersheds that include glacial tills, glacial stream deposits, and fine grained sediments deposited in Glacial Lake Missoula (CSKT 2000).

Regionally, a major portion of Flathead River valley is considered part of the southern end of the Rocky Mountain Trench, a 1,000-mile-long, asymmetric, fault bounded half-graben in which bedrock strikes northwest and dips northeast. The trench and other northwest-trending valleys were created during a regional southwest-directed extensional event that followed early Cenozoic eastward thrusting (Constenius 1996).

SNAPSHOT

The geology of the subbasin is predominantly Precambrian metasedimentary rocks of the Belt supergroup, with glacial deposits and valley fill. Landforms include glaciated mountains, glacial moraines, large glacial troughs, and glacial and lacustrine basins. Elevation ranges from 2,000 to 7,000 ft (610 to 2,135 m)

General Geomorphology and Geology

In British Columbia, a number of headwater streams issue from the Clark and Macdonald Ranges (elevations from 7,800 to 9,000 feet) and flow into the North Fork of the Flathead River (4,200 feet). The river is bordered by a series of benches and rolling hills that extend to the higher ranges. Clastic and carbonate sedimentary rocks that range in age from Precambrian to Late Cretaceous underlie this Canadian portion of the Subbasin. Small Upper Cretaceous intrusions are also found in the region. Tertiary sedimentary rocks are exposed in the valley and many of the major valleys contain considerable thicknesses of unconsolidated Quaternary cover (Flathead Transboundary Network 1999).

LINKS

For a brief geologic history of the subbasin, go to Appendix 4.

Click Here

Two major structural events influenced this northernmost part of the subbasin: the earliest corresponds to the uplift of the Rocky Mountains with simultaneous development of thrust faults and folds; the later is characterized by normal (gravity) movement. Faults include the west-dipping Flathead fault and a series of splay faults (Price 1965). The Flathead graben is bounded on the west by the east-dipping Shepp fault and on the east by the west-dipping Flathead fault. Movement in the graben has been highly asymmetrical, with much more offset on the Flathead fault (Grieve 1980).

Across the border in the Montana portion of the North Fork of the Flathead, the Clark Range gives way to the Livingston on the east side of the Flathead Valley. On the west side, the Macdonald Range becomes the Whitefish Range. The highest peaks bordering the valley reach almost 10,000 feet, most are between 7,200 and 9,500 feet. The valleys of the North and Middle Forks of the Flathead River trend northwest to southeast. Valley elevations range from about 3,200 to 4,200 feet. Both valleys have been downdropped on the east and are underlain by sedimentary rocks of the Kishenehn Formation consisting of lacustrine and fluvial sediments. In places, the rocks are covered by as much as 100 feet of glacial till of late Pleistocene age (Constenius 1981). Bogs filled with peats, organic muds, and volcanic ashes are common in depressions in the till (Carrara 1990).

On the east side of the North and Middle Fork valleys and trending northwest to southeast are two rugged mountain ranges that define Glacier National Park. The one on the west is the Livingston Range. It extends for 25 miles from the Canadian border south to the Lake McDonald region. To the east of the Livingston Range is the Lewis Range, which extends 53 miles from the border south through the park to Marias Pass. Large parts of both ranges lie above timberline (about 6,500 feet) and many of the peaks exceed 9,200 feet. A number contain small glaciers and snowfields. Relief is rugged, with valley floors as much as 4,900 feet below the surrounding peaks. The Continental Divide follows the crest of the Livingston Range in Canada, shifts to the crest of the Lewis Range in the US (Carrara 1990).

The Flathead Range, which also trends northwest to southeast, bounds the west side of the Middle Fork Valley. On the other side of the Flathead Range lies the South Fork Flathead River. Like the North and Middle Fork Valleys, it is underlain by sedimentary rocks of the Kishenehn Formation (Constenius 1981). Originating at the confluence of Danaher and Youngs creeks in the Bob Marshall Wilderness, the South Fork flows north for 57 miles into the 23,813-acre Hungry Horse reservoir. Completed in 1952, Hungry Horse Dam disconnects the South Fork Flathead River drainage from Flathead Lake. The Swan Range borders the South Fork valley on the west. The country is rugged; most of the peaks in the Flathead and Swan Ranges are between 7,000 and 9,000 feet. To the west of the Swan Range lies the Swan Valley drained by the Swan River.

During the Pleistocene, glaciers that filled the valleys of the North, Middle, and South Forks of the Flathead River converged northeast of the Flathead Valley and flowed around the north end of the Swan Range, overriding the southeastern end of the Whitefish Range and Teakettle Mountain (Alden 1953; Johns 1970; Carrara 1989). A glacier in the Swan River valley extended northwest from an ice cap centered in the mountains east of Flathead Lake and the Mission Range, joining the Flathead lobe in the southeastern Flathead Valley (Witkind and Weber 1982). That glacier left behind a blanket-like deposit of till at depth in the Swan Valley and a mantle of till across most of the bedrock in the foothills and mountains (Carrara 1990).

The upper Flathead or Kalispell Valley is an intermontane valley on the north end of Flathead Lake. The Swan and Mission Ranges border it on the east, the Whitefish Range on the north, and the Salish Mountains on the west. Drained by the mainstem of the Flathead River below the confluence of the South Fork Flathead River, the upper Flathead Valley also holds several major tributaries to the Flathead. They include the Stillwater and Whitefish Rivers in the northwest, the Swan River in the southeast, and Ashley Creek on the west. Elevations range between 7,500 feet on the crest of the Swan Range to 2,900 feet, approximately the summer pool elevation of Flathead Lake (Smith 2002).

Geomorphically, the Kalispell Valley consists of a low-relief floodplain along the Flathead River that broadens south of Kalispell. There are terraces along the main river valleys and rolling uplands above the terraces. Some of the uplands contain drumlinoid glacial landforms. The Swan range rises abruptly on the east side of the valley, but to the north and west, the transition to the Whitefish and Salish mountains is more gradual with lower slopes formed by an alluvial fan and glaciated surfaces (Smith 2002). The accumulation of more than 3,000 feet of sediments and sedimentary rocks beneath the Kalispell and Swan valleys (the source of which is Belt rock) suggest that at least part of this fill was deposited during the late Tertiary uplift of mountain ranges and subsidence of basins (Constenius 1996). Quaternary surficial deposits cover those sediments, as the upper Flathead River valley and virtually all the mountain ranges bordering it were covered by glacial ice during the latest Pleistocene time (~15,000 to 25,000 years ago); ice thicknesses in the valleys reached about 4,000 feet (Smith 2002).

The Swan River drainage is a north-south trending, glaciated basin between the Swan and Mission fault block mountain ranges. Waters drain through tributary canyons that cut through Belt Supergroup rock formations and morainal and alluvial deposits in the Swan Valley. The Swan River is a sinuous, locally anabranched stream that flows north into Swan Lake and then into Flathead Lake. Two major Pleistocene glacial advances that led to a period of fluvial transport, mass wasting, and alluvial thickening by in-filling from glacial outwash created the current geomorphic character of the Swan River and its tributaries (Kleinkopf et al. 1972).

The lower Flathead Valley, considered for the purpose of this plan, everything south of the north end of Flathead Lake except for the Swan Valley, is a broad area of low to moderate relief with large areas of it dotted with ponds, lakes, and reservoirs. It includes the Mission Valley, the Jocko Valley, the Little Bitterroot River Valley, Camas Prairie, and the valley containing the lower Flathead River west of Dixon. Nearly all the rocks cropping out in the lower Flathead Valley belong to Belt Supergroup. Lithologies include quartzite, siltite, argillite, and dolomite, all of which show some degree of metamorphism and are resistant to erosion (Makepeace 2000).

Two prominent sets of faults are mapped. One set is near Flathead Lake and extends southward to the Moiese Hills, trending nearly north and south. Faults belonging to this set are also mapped along the east side of Flathead Lake and in the Mission Range. The other set trends northwest-southeast and is in much of the rest of the valley. The two sets intersect in places and occasional faults follow other trends (Ostenna et al. 1995).

Glacial till, end moraines, outwash, and other glaciofluvial and flood deposits are all present, but not differentiated. Extensive lacustrine deposits from Glacial Lake Missoula, in places hundreds of feet thick, generally follow the Flathead River and extend up the White Earth Creek drainage, Mission Creek drainage, and the Jocko River valley (NRCS 1998). None of the Quaternary sediments are lithified, which contrasts with rocks of the Belt Supergroup, which are hard, and very resistant to erosion. This conspicuous difference in susceptibility to erosion accounts for the diversity of landscapes in this part of the subbasin (NRCS 1998).

The Mission Valley, a north-south trending valley, lies immediately south of Flathead Lake and is bordered on the east by the Mission Range and on the west by the Salish Mountains. The west half of the Mission Range, managed as wilderness by the Confederated Salish and Kootenai Tribes, rises 6,000 to 7,000 feet above the valley floor. Pablo Reservoir, Kicking Horse Reservoir, Ninepipe Reservoir, Lower Crow Reservoir, and Mission Reservoir are major water storage projects filled by streams issuing from the Mission Range. Elevations in this part of the subbasin range from over 9,000 feet along the crest of the Mission Range to 2,500 feet at the Flathead River's confluence with the Clark Fork.

The Mission Valley formed when bedrock downdropped relative to neighboring Salish and Mission mountain ranges. During the Pleistocene, glaciers partially filled the valley, leaving behind a blanket-like deposit of till at depth and a mantle of till across most of the bedrock in the foothills and mountains. Glacial Lake Missoula deposited silty, clayey, and gravely glaciolacustrine sediments south and west of the glacier terminous which was near Polson, and within and north of the present Flathead Lake as the glacier receded. It is worthy of note that the Mission Valley is the largest single basin of Glacial Lake Missoula and has an accumulation of glaciolacustrine sediments two to eight times thicker than any other in the Lake Missoula basin (Ostenna et al. 1995).

One of the more prominent features in the Mission Valley left behind by the glaciers is the Polson moraine. In the northern part of the Mission Valley, near the southern end of Flathead Lake, the Polson moraine forms a prominent hill just south of the town of Polson. It has a fairly smooth surface and is not marked by knobs and kettle holes. The rest of the Mission Valley is mantled by ground moraine deposited by various advances of the Flathead glacier. In places—north of the Polson moraine; north of the National Bison Range; along the western part of the valley in the general area of the Flathead River; and northwest of Ronan, glacial till is overlain by erosional remnants of silt deposited in glacial Lake Missoula (Slagle 1988).

Another prominent feature is a crescent-shaped rise in the southern part of valley extending from the foot of the Mission Mountains on the east to the Flathead River and the hills on the west, bounded on the north by Crow and Spring Creeks and on the south by Mission and Post Creeks. Once interpreted as a last-glacial terminal moraine, this feature is now thought to be an unsorted and unstratified sedimentary deposit that formed at the bottom of Glacial Lake Missoula (Smith 2000 and 2000a). The surface of this hill is characterized by a swell-and-swale topography containing thousands of undrained depressions or pingos that provide some of the most important wildlife habitat in the subbasin (Ostenna et al. 1995)

The Little Bitterroot River Valley in the northwestern part of the reservation is south-to-southeast-trending. The Salish Mountains to the east separate it from the

Mission valley. The Little Bitterroot Valley and Big Draw are the pre-glacial course of the Flathead River (Slagle 1988). Big Draw is a narrow west-trending valley extending from the Big Arm of Flathead Lake at Elmo on the east to its confluence with Sullivan Creek and the Little Bitterroot River valley near Niarada on the west. The Little Bitterroot River valley is underlain by lacustrine silt and clay deposited by Glacial Lake Missoula. The northern part of the valley, generally north and west of Niarada, contains volcanoclastic sediments that may be contemporaneous with the Tertiary volcanic rocks of the Hog Heaven Range (Slagle 1988).

LINKS

For more detailed descriptions of landforms go to Appendix 5.

Click Here

Camas Prairie basin is a small, nearly closed basin between Hot Springs and Perma that was once filled by Glacial Lake Missoula. The northern end is well known for its giant ripple marks caused by the spillage of tremendous volumes of water through mountain passes at the north and northeast margins of the basin (Pardee 1942) or as beach ridges formed by the lowering waters of Glacial Lake Missoula (Alden 1953).

The Jocko River valley extends from near the divide of the southern part of the Mission Range to its confluence with the lower Flathead River near Dixon. The lower Flathead River valley extends from near Dixon to about six miles west of Perma, where the river exits the reservation. Remnants of lacustrine silt are scattered throughout much of the valley. The most prominent occurrences are from the downstream part of lower Valley Creek to Dixon. Only small remnants of Lake Missoula silt remain in the lower Flathead River valley downstream from Dixon (Slagle 1988).

The Jocko Valley is a northwest-to-southeast trending valley at the very southern end of the Flathead Subbasin that formed when bedrock downdropped relative to neighboring mountain ranges. The Jocko River and its tributaries drain a portion of the southwestern part of the subbasin and joins the Flathead River at Dixon. Mission Creek, Crow Creek, and their tributaries are other drainages in the lower Flathead. White Earth Creek empties into the lower Flathead River from the west, about 15 miles downstream from Flathead Lake. Dayton Creek drains the northwest corner of the area into the Flathead Lake. The Little Bitterroot River is joined by several tributaries that drain small areas along the western edge of the area. It then empties into Flathead River about 4 miles southwest of the Round Butte community.

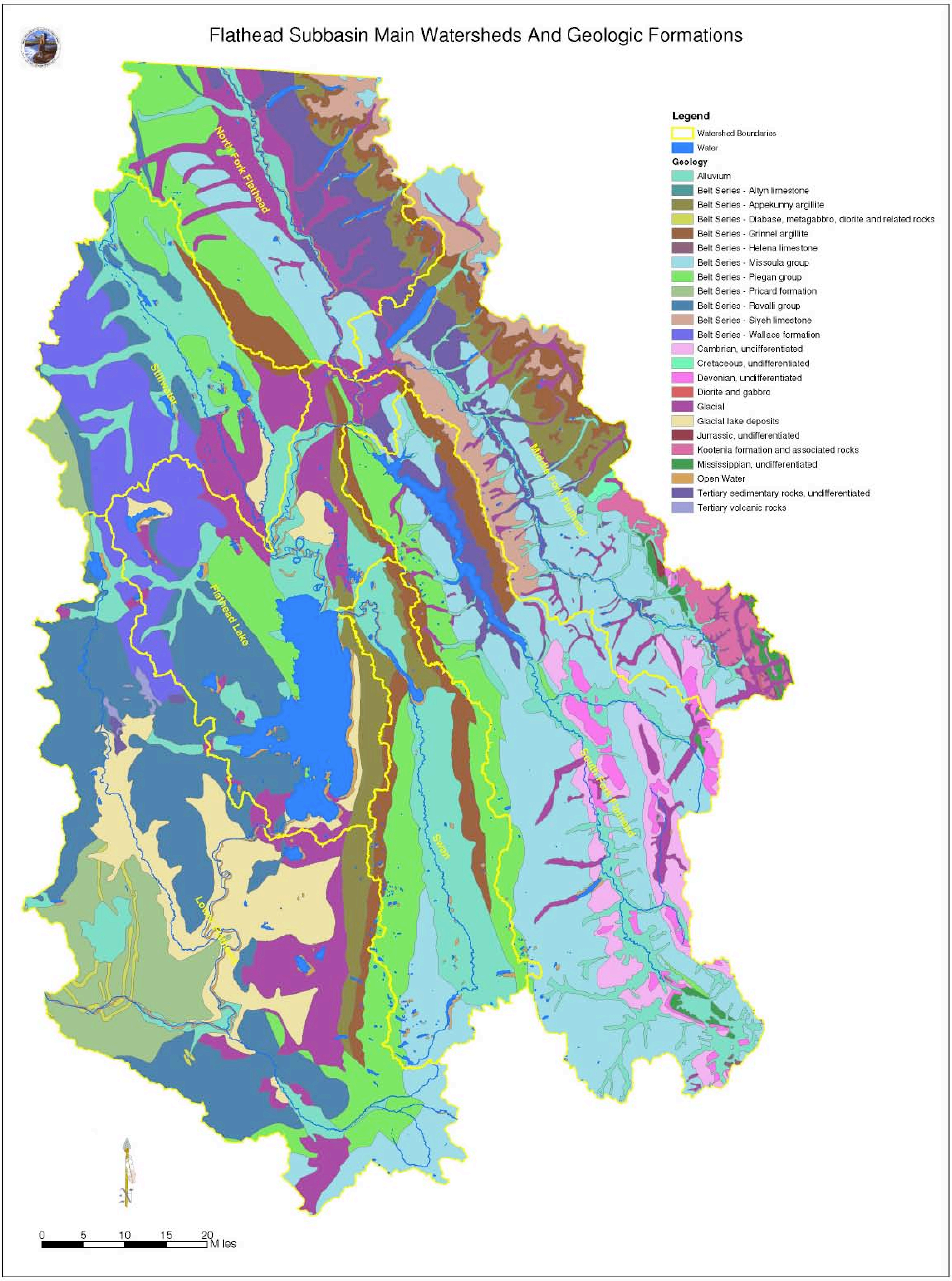

Figure 1.3. Geology of the Flathead Subbasin, U.S. Portion.

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1.1.4 Hydrology

Overview

In terms of volume, the Flathead River is Montana's fourth largest river (figure 1.4). It has a mean annual discharge of 8.8 million acre-feet. The flow rate averages just under 12,000 cubic feet per second (cfs) (USGS 2002). The subbasin encompasses seven, eight-digit USGS Hydrologic Unit Codes (HUCs) (table 1.4, figure 1.5). Table 1.5. gives basin area and discharge characteristics of the major streams in the subbasin.

Mountains in the subbasin receive about 80 percent of their precipitation as snow, and streams are classic examples of the spring snowmelt system described by Poff and Ward (1989). Spring runoff begins in April and peaks usually occur in late May or June. Approximately 65 percent of the annual inflows occur between May 15 and June 10 as a result of snowmelt from surrounding mountains (Stanford et al. 1994). In such a system, the hydrograph increases two-to-three orders of magnitude over winter base flow between April and June (Stanford 2000). Flood flow varies depending upon winter snowpack, vernal spring warming pattern and spring rainfall (Fagre et al. 1997). Not all snowmelt or rainfall becomes surface runoff; significant amounts infiltrate the ground to become groundwater that percolates downward in the soil and bedrock and resurfaces in wet areas, small ponds, fens and bogs, and perennial streams at various elevations below the point of infiltration. Slow release of groundwater provides the stream base flow starting in mid July to mid September (USFS 2000). Minimum flows generally occur during mid winter.

The basin is nearly completely underlain with Precambrian sedimentary rock, which is characteristically deficient of nutrients (Stanford and Ellis 1988), although there are limited areas of much younger and richer limestones and other Mesozoic strata in headwater reaches of the North, Middle, and South Forks of the Flathead (Stanford and Hauer 1992). As a result, subbasin waters are generally very low in dissolved ions, nutrients, and suspended particulates (Stanford and Ellis 1988). Exceptions include streams like the Little Bitterroot that drain lacustrine silt and clay deposits from Glacial Lake Missoula (NRCS 1998). Appendix 70 is a trilinear diagram showing that natural water chemistry is strongly a calcium bicarbonate water type—very well buffered and with very low acid content. The plot also shows that there is little change in basic water chemistry in a downstream direction, which is expected because of the bedrock geology in the subbasin (Makepeace, CSKT, pers. comm. 2003).

Headwater streams begin almost exclusively as springs below talus slopes or in deep groundwater flowing through cracked bedrock or limestone pathways (Stanford

SNAPSHOT

The Flathead River has a mean annual discharge of nine million acre-feet and a mean daily discharge at Perma, MT of just under 12,000 cubic feet per second. Mountains in the subbasin receive about 80% of their precipitation as snow. The melting of this snowpack during the spring and summer months produces a characteristic "snowmelt hydrograph." Peak runoff occurs between April and June.

LINKS

Appendix 70 is a trilinear diagram showing natural water chemistry in the subbasin.

Click Here

For a 6th-code HUC interactive hydrologic map of the Flathead Subbasin go to Appendix 71.

Click Here

and Ellis 2002). Streams flow across highly variable glacial landscapes through heavily timbered subalpine and slope forests. Gradients are often steep, and water temperatures cold all the way to the valley floors (Stanford and Ellis 2002).

The three forks of the Flathead together supply about 80 percent of the water carried within the system. At Flathead, British Columbia, the flow of the North Fork of the Flathead averages about 800 cfs (USGS 2002). Near Columbia Falls, flows on the North Fork are about 2,800 cfs, approximately the same as the flows on the Middle Fork at the two rivers' confluence. On both forks, peak spring runoff often exceeds 10 times the average flow (Zackheim 1983). The North and Middle forks experience an average elevation drop of 15 and 26 feet per mile, respectively. On the South Fork, the average annual discharge into Hungry Horse Reservoir is 2,300 cfs (Deleray et al. 1999). The North, Middle, and South Fork contribute 32 percent, 26 percent, and 25 percent of the inflow into Flathead Lake, respectively.

The mainstem of the Flathead River is slower and more meandering above Flathead Lake than any of the three forks. It drops just 6 feet per mile between Columbia Falls and Kalispell and just one foot per mile below Kalispell.

The Whitefish and Stillwater Rivers, which drain the Rocky Mountain Trench between Stryker and Rexford, merge just southeast of Kalispell and contribute about five percent of the flow of the upper Flathead. The Swan River provides just over one tenth of the water entering Flathead Lake. The largest tributary of the Flathead River below Flathead Lake is the Little Bitterroot River in terms of watershed area and the Jocko River in terms of flow volume (Makepeace, CSKT, pers. comm. 2003).

Flathead Lake has a surface area of roughly 197 square miles, a mean depth of 164 feet, and a maximum depth of 370 feet. It is the largest natural freshwater lake in the western U.S. The lake is classified as oligomesotrophic (Zackheim 1983). There are also other large lakes in the subbasin. They include those in Glacier National Park on the east side of the North Fork of the Flathead Valley, and Whitefish and Swan Lakes. The deepest are McDonald Lake on the Middle Fork and Tally Lake on the Stillwater River (with depths of 464 and 495 feet, respectively). All these lakes are oligotrophic or ultra-oligotrophic because of their depth and generally low nutrient dissolution from the catchment (Stanford and Ellis 2002)

The lower Flathead River is a low-gradient river. It averages a drop of 3.4 feet per mile. With the exception of the first 8.6 miles of the river, which flow through a steep canyon that has a drop of 7.9 feet per mile, the river is comparatively smooth-flowing and shallow, with riffles and pools blending. The gradient of the last 34 miles of river is less than 1.6 feet per mile (DosSantos et al. 1988). Approximately 94 percent of the river's 72 mile length fall within the Flathead Indian Reservation.

LINKS

General hydrologic information about the Flathead Watershed can be found on the EPA's Surf Your Watershed website: http://cfpub.epa.gov/surf/locate/index.cfm

Click Here

StreamNet maintains a website with hydrologic data for individual subbasins, including the Flathead: http://www.streamnet.org/subbasin/2001-subbasin-data.html

Click Here

Real time flow and elevation data for various control points in the Flathead Watershed can be downloaded at http://www.nwd-wc.usace.army.mil/nws/hh/basins/cgi-bin/flathead.pl

Click Here

For U. S. Geological Survey hydrologic information, go to: http://water.usgs.gov/wsc/acc/170102.html

Click Here

Table 1.4. The seven, eight-digit USGS Hydrologic Unit Codes (HUCs) in the Flathead Subbasin.

Hydrologic Code	Watershed Name
17010206	North Fork Flathead River
17010207	Middle Fork Flathead River
17010208	Flathead River to and including Flathead Lake
17010209	South Fork Flathead River
17010210	Stillwater River
17010211	Swan River
17010212	Flathead River below Flathead Lake

Table 1.5. Basin area and discharge characteristics of major streams in the Flathead

Tributary	Basin Area (mi^2)	Ave. Ann. Discharge (acre-feet $x10^6$)	Maximum Flow (cfs)	Minimum Flow (cfs)	Period of Record[a] (yrs)
South Fork	1,663	2.58	46,262	7[c]	53
North Fork	1,548	2.16	69,217	198	50
Middle Fork	1,128	2.13	139,846	173	42
Swan R.	726	0.84	8,899	193	29
Whitefish R.	338	0.24	4,344	40	29
Ashley Crk[b]	170	0.14	1,589	38	30
Flathead R. at Lk Outlet	7,093	8.29	82,636	5[c] / 3,200	74
Jocko R. near Dixon, MT	380	0.17			10
Flathead R. at Perma	8,795	8.56	48,000		19

Sources: USGS 2003, MT DEQ 1999, and Stanford et al. 1994.
[a] For calculation of average annual discharge.
[b] Data collected by Flathead Lake Biological Station.
[c] Due to dam closure.

Impoundments and Irrigation Projects

Hungry Horse Dam, completed in 1952, is located 8.4 km upstream from the confluence of the South Fork and the mainstem of the Flathead River. Hungry Horse Reservoir is 35 miles long and covers 23,782 acres at full pool. The dam, operated by the Bureau of Reclamation (BOR), provides flood control, electrical power production, and water storage capability for the Columbia River system. Annual operations for power and flood control result in a reservoir draft toward

LINKS

For current river levels, graphs of river flows and low-flow charts at 9 gaging stations in the Flathead Subbasin, go to: http://www.wrh.noaa.gov/Missoula/msorivers.html

Click Here

The following GIS maps are available at a HUC-6 scale from the USFS Region 1 Cohesive Strategy Team website: Flood Frequency, Hydrologic Integrity, Hydrologic Vulnerability, Erosion Hazard, Sediment Delivery Potential. Go to: http://www.fs.fed.us/r1/cohesive_strategy/index.htm

Click Here

For water information about the Flathead in B.C., go to: http://srmwww.gov.bc.ca/aib/

Click Here

For an electronic library of aquatic information for the B.C. portion of the subbasin, go to: http://srmwww.gov.bc.ca/appsdata/acat/html/deploy/acat_p_home.html

Click Here

LINKS

Appendix 76 is a GIS-generated summary of a number of key hydrologic and watershed attributes for all HUC-6 watersheds in the Flathead Subbasin.

Click Here

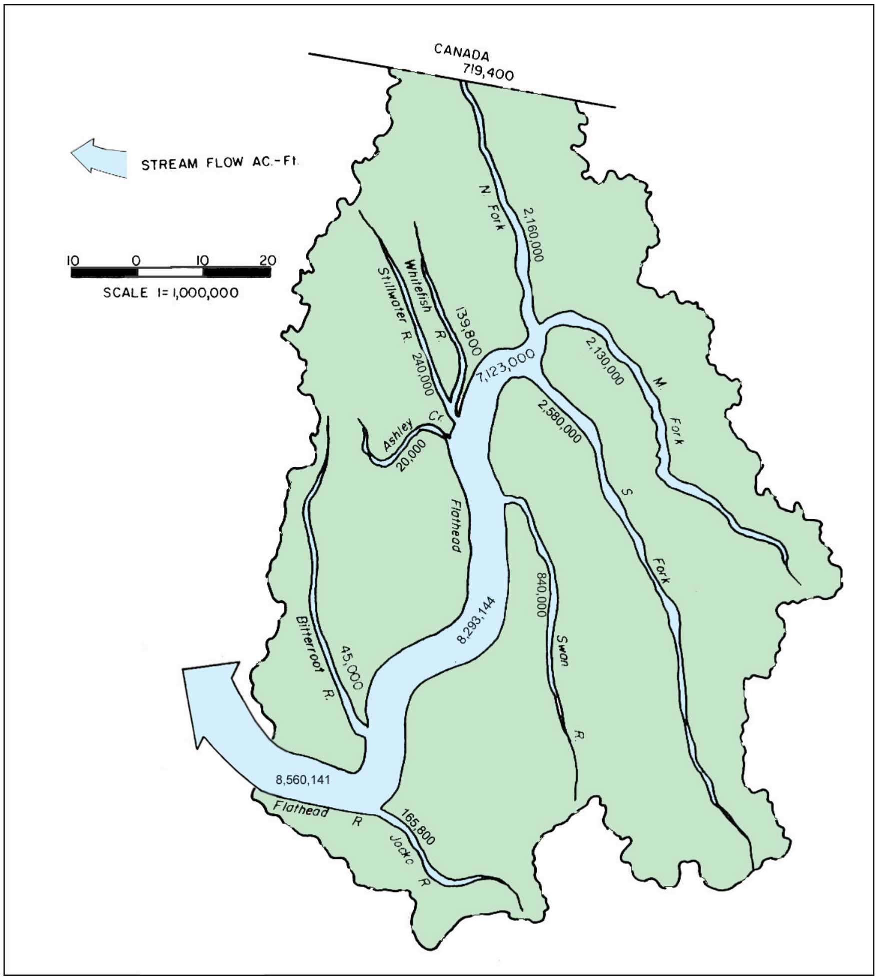

Figure 1.4. Annual Discharge of the Flathead River Subbasin in acre-feet

minimum pool by mid-April and refill toward full pool (elevation 3,560 feet) during July. The maximum reservoir drawdown on record was 188 feet. Hungry Horse Dam has a peak capacity of 320,000 kilowatts.

Kerr Dam, located 6.9 km downstream of the natural lake outlet, was built in 1938 and is currently operated by Pennsylvania Power and Light Montana (PPLM). The dam regulates the top three meters of water and is operated to provide flood control and power production. Its peak capacity is 180,000 kilowatts. The dam is now operated as a base-load facility. Presently, flood control and recreation require the lake level to be dropped to the low pool elevation of 2,883 feet by April 15, refilled to 2,890 feet by May 30, raised to full pool elevation of 2,893 feet by June 15, and held at full pool through Labor Day (Deleray et al. 1999).

Bigfork Dam is a small hydroelectric facility with a 4,000-kilowatt peak capacity. It is located on the Swan River less than 2 km from Flathead Lake.

On the Flathead Indian Reservation, the Flathead Agency Irrigation District (FAID) consists of an intricate network of natural channels, irrigation canals, and storage reservoirs that retain spring runoff and distribute the water to cultivated lands. Approximately 1,930 km of irrigation canals and 17 reservoirs exist under FAID. The larger FAID reservoirs include Pablo, Ninepipe, Crow, Kicking Horse, and Hubbard. Several natural lakes on the Flathead Indian Reservation have been adapted for controlled irrigation releases. An unquantified number of secretarial water rights also exist throughout the basin (Makepeace 2000).

LINKS

For watershed maps of the subbasin and a other information about Montana Rivers go to: http://www.nwifc.wa.gov/SAGE/metadata/aquatic/Montana/Montana Rivers Information System (MRIS).htm

Click Here

For flood frequency and basin characteristic data from the USGS go to: http://mt.water.usgs.gov/freq#TOC13

Click Here

For summaries of hydrologic data from any one of eleven USGS gauging stations in the subbasin, go to Appendix 61.

Click Here

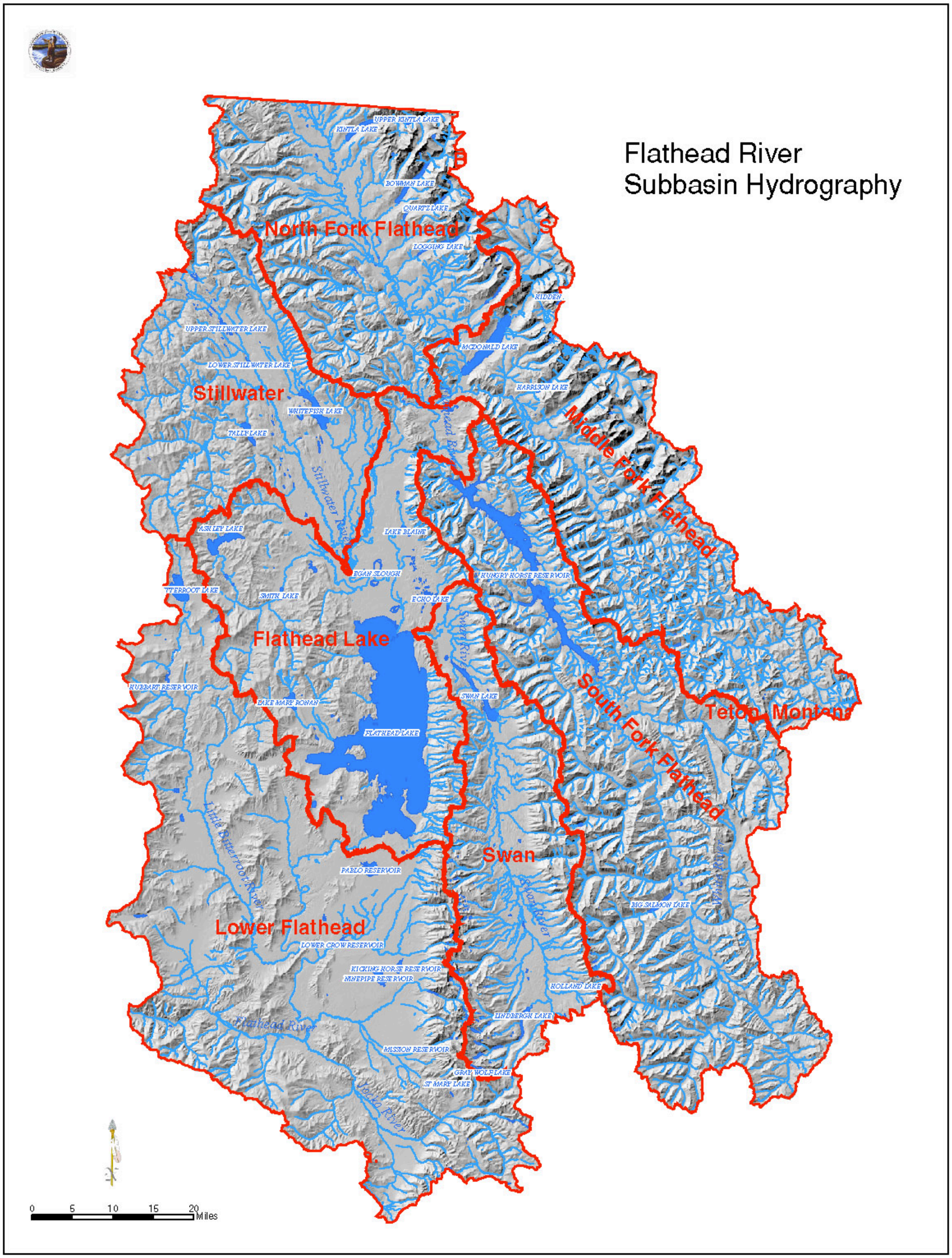

Figure 1.5. Hydrography of the U.S. portion of the Flathead Subbasin.

1.1.5 Soils and Landtypes

Overview

Soils formed from residual and colluvial materials eroded from Belt rocks or in materials deposited by glaciers, lakes, streams, and wind. Wind deposits include volcanic ash from Cascade Range volcanoes in Washington and Oregon (CSKT 2001).

Since glacial recession, geologic conditions have been relatively stable. This is suggested by the widespread distribution of 6,700-year-old Mt. Mazama volcanic ash in forested drainages, well developed soil profiles on many glacial features, stable stream channels, and stable slopes in forested watersheds. The volcanic ashes produce soils with very high soil-moisture holding capacity, high fertility, low strength, and high erodibility (CSKT 2000).

In many areas, soils formed in glacial till and are generally loamy, with moderate to high quantities of boulders, cobbles, and gravels. Although soils within the mountainous regions vary widely in character, most mountain and foothill soils are on steep slopes and are well drained with large amounts of broken rock. Rock outcrops are common (CSKT 2000, NRCS 1998).

Soils deposited by glaciers or flowing water cover about 40 percent of the National Forest lands. These are, for the most part, deep, well-drained, and productive soils. About 15 percent of the national forest lands have soils that developed in place through weathering of bedrock. They have a brown, ash-rich surface and a gravelly substrate. Breaklands with slopes exceeding 60 percent make up almost half of the National Forest lands in the subbasin. In most of the valleys, soils are deep, relatively productive, and gently sloping (CSKT 2000; Zackheim 1983).

Most of forest soils in the subbasin are somewhat resistant to erosion by water (Makepeace 2000), although there are exceptions. For example, in the North Fork of the Flathead where the vegetation has been removed from steeper slopes or when cut banks are exposed to erosion by streams, significant erosion and/or mass failure has occurred (USDI NPS 1992). Extensive lacustrine deposits on the White Earth Creek drainage, Mission Creek drainage, and the Jocko River valley are also susceptible to erosion (NRCS 1998).

SNAPSHOT

Soils are generally cool or cold. Most soils in the mountains are young to weakly developed with some having subsoil accumulations of clay. Some have a thin to thick deposit of volcanic ash at the surface. The basins and valleys have two general groups of soils: one has thick, dark topsoil, and the second includes young to weakly developed soils with little horizonation. In general, these soils are moderately deep to deep with silty, clayey, loamy, and sandy to gravelly textures, and most have been strongly influenced by volcanic ash, which increases their productivity (Quigley and Arbelbide 1997).

North, Middle, and South Forks of the Flathead River[2]

Soils in this part of the subbasin tend to be thin and incompletely developed because of the landscape has been disturbed relatively recently by glaciers. Major exceptions are the relatively productive alluvial soils developed from outwash

[2] *Adpated from USDI NPS 1992.*

deposits on the river floodplains and adjacent benches and terraces. Alluvial soils range from shallow, well-drained, relatively deep, coarse-textured alluvial sands, loams, and gravels to boulder-size rocks. These porous soils support grasses or deciduous plant communities, depending on their proximity to streams. A few floodplain areas have accumulations of silt or clay sediments. Soils in the bottomland and in deciduous stands tend to be deep and less acidic than soils in coniferous forests. The terrace grasslands are characterized by higher calcium content and low acidity levels.

Soils on the slopes above the river floodplains and terraces are generally derived from glacial-till deposits. These are usually moderately thick (20-40 inches), poorly consolidated, and have good surface layer drainage but poor subsurface drainage. The soils are gravelly/silty or gravelly/sandy loams with numerous rock fragments and a thin loess (windblown soil or debris) and humus cover. These soils generally support coniferous forests, tend to be acidic, and may have limited capacity to absorb water.

Soils on the mountain slopes in this part of the subbasin are generally rocky, thin, and nutrient poor. Because of precipitation and the low nutrient requirement of conifers, the soils support dense coniferous stands where drainage and depth are suitable.

Lower Flathead Valley[3]

Table 1.6 shows the most common soil groups and their approximate extent across the southern portion of the subbasin (lower Flathead Valley).

The most common forest soils south of the lake are weathering from quartzite and argillite bedrock (Belt Formations) on steep slopes. They tend to have sandy or loamy textures and a high amount of angular rock, and at the higher elevations, a surface layer of volcanic ash. Productivity is low to high depending on climate. Problems with road-building, slope stability, compaction or other concerns are less common on these soils than on most others in western Montana. Erosion and regeneration are a problem on some sites but can be managed to prevent serious impacts.

The second most common soil group south of the lake is glacial soils. Glacial soils are usually much more variable than bedrock soils and have unique management challenges. Productivity is often higher than other soils but road construction, erosion, compaction and other considerations usually present greater problems.

Soils with clayey subsoils are also common in this part of the subbasin below 4,500 feet but in some areas may occur up to 5,500 feet. Clayey soils have

[3] *Adapted from Dutton 1990a.*

Table 1.6. Soil Groups south of Flathead Lake.

Soil	Percent of the Area	Soil	Percent of the Area
Quartzite/argillite bedrock soils	40	Limestone soils	5
Glacial soils	20	Wet soils	2
Clayey soils	15	Granitic soils	<l
Shallow soils	5	Rhyolite soils	<l
Stream deposit soils	10	Other soils	2

weathered from a wide variety of geologic materials including Tertiary deposits, glacial lake deposits, glacial till, glacial drift, and some bedrock materials. Many of these soils do not have large amounts of clay but are dominated by mixtures of silt and clay layers. While among the most productive soils because of their much higher water and nutrient-holding capacities, they can present problems because they are susceptible to erosion and compaction.

LINKS

For more detailed information on landtype associations and soils, go to Appendix 6.

Click Here

1.1.6 Vegetation

Vegetation of the Flathead Subbasin is typical of the Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow Province (Bailey et al. 1994). Engelmann spruce and subalpine fir occur in subalpine areas and give way to forests of western redcedar, Douglas-fir, western white pine, western larch, grand fir, and western ponderosa pine at lower elevations (figure 1.6). In the southern part of the subbasin, grasslands dominated by wheatgrasses, fescues, and introduced bluegrasses occur in valley bottoms. River floodplains support ponderosa pine, Rocky Mountain juniper, Douglas-fir, black cottonwood, aspen, paper birch, willow, chokecherry, serviceberry, alder, dogwood, rose, and snowberry. Willows, alder, aspen, dogwood, cattails, meadow grasses, and sedges dominate wetlands.

Montana Natural Heritage Program plant species of concern that occur in Flathead, Lake, and Sanders County and USFWS listed species are listed in Appendix 8 (see Links column).

LINKS

A list of the natural vegetation communities occurring within the subbasin is included as Appendix 7.

Click Here

USFWS Listed and Candidate plant Species and Montana Natural Heritage Program plant species of concern that occur in Flathead, Lake, and Sanders County are listed in Appendix 8.

Click Here

Grasslands

Most of the grasslands in the Flathead occur in the lower Flathead Valley on the Flathead Indian Reservation. Historically, these areas were palouse prairie—a community of bunchgrasses dominated by bluebunch wheatgrass (*Agropyron spicatum*), rough fescue (*Festuca scabrella*) and Idaho fescue (*Festuca idahoensis*). In the Mission Valley, palouse prairie grassland habitats are interspersed with wetlands, which significantly enhances their value to wildlife. Small prairies and

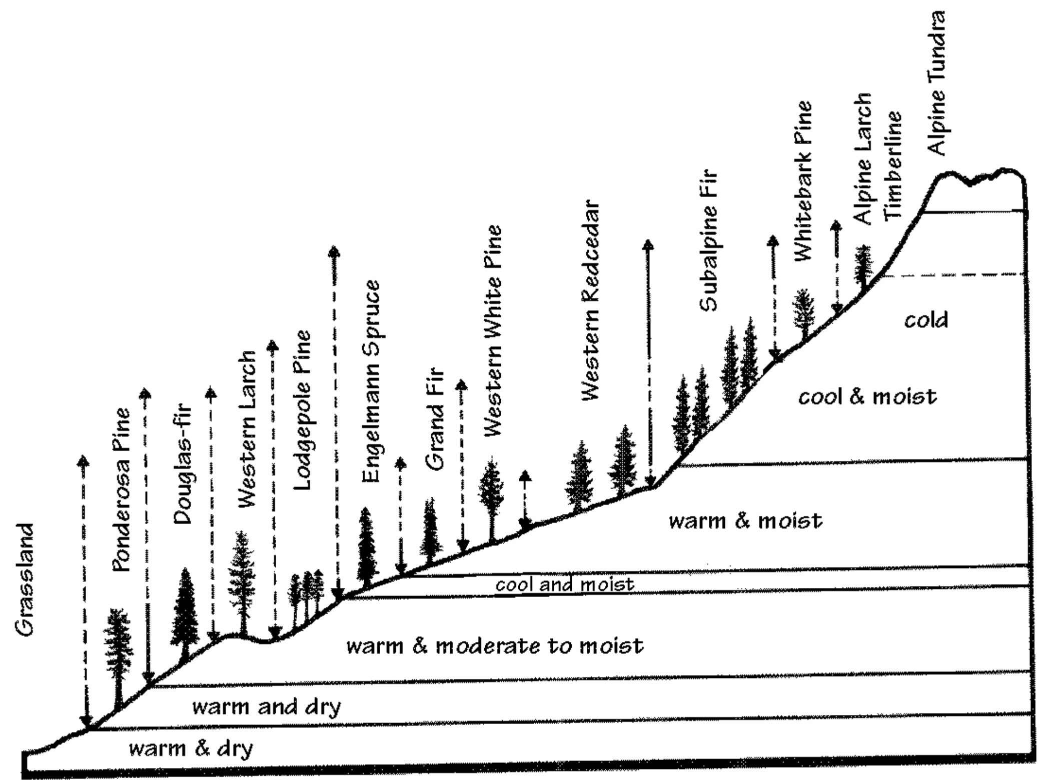

Figure 1.6. A generalized distribution of forest trees within the Flathead Subbasin (after Pfister et al. 1977). The arrows show the relative elevational range of each species; the solid portion of each arrow indicates where a species is the potential climax and the dashed portion shows where it is seral.

meadows of foothills grasslands occur in the North Fork of the Flathead in and near Glacier National Park and in areas of the South Fork of the Flathead and Swan valleys. Sagebrush, ponderosa pine, Douglas-fir, lodgepole pine, and other woody species have encroached on these areas as a result of the fire exclusion policies of the last 50 to 100 years. On the Flathead Reservation, many grassland areas have been converted to nonnative prairie, cropland, and pasture. Where native grasslands remain, they have been degraded by weed invasions and damaged by overgrazing.

Riparian and Wetland Areas

Riparian habitats in the subbasin are found at lower elevations, valley bottoms and lower slope positions near streams, lakes, ponds, and seeps. In forested areas, riparian overstories are primarily shade-intolerant western larch, Douglas-fir, western white pine, lodgepole pine, ponderosa pine and moderately shade-tolerant Engelmann spruce. Stands also include, and occasionally are dominated by, shade-tolerant western redcedar, western hemlock, subalpine fir, and grand fir. In grassland areas and lower elevation valleys, riparian areas support ponderosa pine, Rocky Mountain juniper, Douglas-fir, black cottonwood, aspen, and birch. For specific descriptions of riparian types found within forested portions of the subbasin, see Sirucek and Bachurski (1995).

The Flathead drainage supports one of the greatest and most diverse concentrations of wetlands in the Rocky Mountains, including peatlands, oxbow ponds, springs and seeps, complexes of pothole ponds, vernal pools, prairie potholes and pingos, and beaver ponds (Greenlee 1998).

LINKS

Appendix 9 includes general descriptions of major wetland types found in the upper Flathead.

Click Here

The habitat integrity and availability of riparian deciduous forest and riparian shrublands have been compromised in many parts of the subbasin, and threats continue (CSKT 2001). Generally, degradation has resulted either from the interruption or alteration of natural flood processes or the direct removal of vegetation through grazing, clearing, or logging. Changes in flow regimes can have profound effects on the mix of seral stages present along river reaches, as cottonwoods require flooding and silt deposition for germination (CSKT 2001). In many cases where the seasonal pattern of high flows has been removed or stabilized, there is a threat of inadequate recruitment to replace older trees as they die. In the most extreme examples of flow alteration—dewatering on the one hand and inundation through damming on the other—all riparian habitat values can be lost. Activities with the most direct effects on riparian habitats include flood control and channelization, dam construction and operation, logging, water diversion, clearing for agriculture, grazing, residential development, and recreational use (CSKT 2001).

Prairie wetland habitats occur in the Mission Valley, and significant conversion of these habitats has occurred there. Pingo habitats have also been impacted by the loss of surrounding uplands from conversion to croplands, degradation of uplands due to overgrazing, subdivision, contaminated runoff from agriculture, selenium contamination (from leaching due to irrigation or saline seeps), invasion by non-native plants (purple loosestrife), road building and filling. Wildlife values of many wetlands in the subbasin have also been reduced due to fragmentation, isolation, non-native plants, and high disturbance levels from subdivision and resultant high homesite densities (CSKT 2001).

Coniferous Forest

Table 1.7[4] shows habitat groups found in the Flathead Subbasin. Habitat groups are groupings of habitat types, which are based on the idea that on a given site, the same successional patterns will repeat after disturbances and that the climax plants and trees are a meaningful index of soils, topography, precipitation, and other factors affecting the growth of trees and other organisms there. So a habitat group is a set of habitats with similar species composition, successional pathways, and that are expected to respond similarly to disturbances. Appendix 10 (see Links column) lists the habitat types that occur within each habitat group. The use of habitat groups allows repeatable landscape patterns to be related to predictable ecological processes and makes it possible to project future landscape conditions. For mapping purposes we have further lumped these eleven habitat groups into six Potential Vegetation Groups (PVGs) (table 1.8). The table also shows how PVGs correspond to the PVGs used in the Upper Columbia River Basin EIS. Figure 1.7 shows the distribution of vegetation cover types in the Flathead Subbasin.

LINKS

Appendix 10 lists the habitat types that occur within each habitat group in the subbasin.

Click Here

Appendix 11 provides detailed descriptions of each habitat group.

Click Here

The following descriptions of habitat groups (HG) in the Flathead Subbasin are excerpted from the Flathead National Forest Biophysical Classification FNF (USFS 1995). Appendix 11 (see Links column) provides detailed descriptions of each habitat group.

Warm Dry PVG

HG 1 – Warm and Dry: This habitat type group is characterized in naturally functioning ecosystems by dry and open-grown parklike stands of *Pinus ponderosa* or *Pseudotsuga menziesii* with bunch grass understories. Most of the sites occur on hot and dry landscapes at lower elevations and on west and south aspects. A natural fire free interval of 5 to 25 years on these sites maintained grassy and open parklike stands dominated by large and old *Pinus ponderosa* and some *Pseudotsuga menziesii* (Fischer and Bradley 1987). These were low severity underburning fires. Stand replacement fires were probably rare.

HG 2 – Moderately Warm and Dry: These habitat types are characterized in naturally functioning ecosystems by open-grown stands of *Pinus ponderosa* or *Pseudotsuga menziesii* with grass and brush understories. Most of the sites normally occur at lower elevations on many aspects, but are also found at higher elevation

[4] The guiding documents used in the development of the groupings are Forest Habitat Types of Montana (Pfister et al. 1977) and Forest Habitat of Northern Idaho: A Second Approximation (Cooper 1987).

Table 1.7. Habitat Groups in the Flathead Subbasin.

Habitat Group	Climate Modifier (Regional Grouping)
HG 1	Warm and Dry
HG 2	Moderately Warm and Dry
HG 3	Moderately Warm and Moderately Dry
HG 4	Moderately Warm and Moist
HG 5	Moderately Cool and Moist
HG 6	Moderately Cool and Wet
HG 7	Cool and Moist
HG 8	Cool and Wet
HG 9	Cool and Moderately Dry
HG 10	Cold and Moderately Dry
HG 11	Cold

Table 1.8. Potential Vegetation Groups.

<table>
<tr><th>Habitat Groups</th><th>Flathead Subbasin Plan PVGs</th><th>Upper Columbia River Basin PVGs</th></tr>
<tr><td>1, 2, 3</td><td>Warm Dry</td><td>Dry Forest</td></tr>
<tr><td>4, 5</td><td>Warm Moist</td><td rowspan="3">Moist Forest</td></tr>
<tr><td>7</td><td>Cool Moist</td></tr>
<tr><td>9</td><td>Cold Moist</td></tr>
<tr><td>10, 11</td><td>Cold</td><td>Cold Forest</td></tr>
</table>

on more southerly and westerly aspects. The natural fire-free interval for underburning was 5 to 50 years (Fischer and Bradley 1987). These mostly low and moderate severity fires maintained most commonly open parklike stands dominated by *Pinus ponderosa*. In some cases, stand composition was high in *Pseudotsuga menziesii* and *Larix occidentalis*. Little information is available for stand replacement fires, but these severe intensity fires occurred only after a fire free interval probably exceeding 500 years on the drier types and 50-200 years on the more moist types (Smith 1995).

HG 3 – Moderately Warm and Moderately Dry: This contains a highly variable group of habitat types. The group marks a transition between the dry and more moist types. It includes types characteristic of each. These habitat types were characterized in naturally functioning ecosystems by mixed species stands of *Pinus ponderosa, Pseudotsuga menziesii, Lark occidentalis, Pinus contorta*, and *Abies grandis*. Understories in absence of fire or other disturbance are composed primarily of dense *Pseudotsuga menziesii* or *Abies grandis* thickets, though other tree species may be present. The natural fire free interval for underburning was 15 to 50 years. Mixed intensity of moderate and severe fires commonly created mosaics of even-aged stands with survivor individual and groups of trees (Smith 1995). Also common are open parklike stands dominated by *Pinus ponderosa, Larix occidentalis* and *Pseudotsuga menziesii*.

Warm Moist PVG

HG 4 – Moderately Warm and Moist: These are warm and moist habitats occurring *along* the lower slopes and valley bottoms. The group is highly diverse and nearly all the conifer species in the area *can* occur on these types. Understory vegetation may be dominated by a wide variety of species. Fire free interval is wide from 50 years on the drier types to over 200 years on the more moist types. Typical fires are minor ground fires that create a mosaic within the stand. On the other extreme with drying, a complete stand replacement fire will occur. Many times this is the result of a fire burning from an adjacent and drier type. Fire exclusion on these sites has changed them very little except to reduce the number of acres in early succession types.

HG 5 – Moderately Cool and Moist: These are moderately cool and moist sites. They contain many species, including *Thuja plicata, Tsuga heterophylla, Pseudotsuga menziesii, Picea engelmannii, Abies grandis, Pinus contorta, Tsuga mertensiana, Larix occidentalis* and *Pinus monticola*. Very high basal areas can be achieved on these types. Fire frequency can be low due to the maritime influence on these sites. Fire severity can be highly variable due the most common moist conditions, but is severe during periods of drought. Fire free intervals range from 50 to greater than 200 years (Fischer and Bradley 1987). Many species do well on these sites and may thrive for centuries without disturbance. *Thuja plicata* is the most notable example.

Cool Moist PVG

HG 7 – Cool and Moist: These types are characterized by cool and moist site conditions. Species diversity can be high with *Larix occidentalis, Pseudotsuga menziesii, Pinus monticola, Picea engelmannii, Pinus contorta, Abies lasiocarpa and Abies grandis.* Other sites are dominated by *Pinus contorta* after stand-replacement burns. These sites are probably too cool for *Tsuga heterophylla* and *Thuja plicata*. Fire history information is scarce. Fire intervals are estimated at greater than 120 years for most sites (Fischer and Bradley 1987).

Cold Moist PVG

HG 9 – Cool and Moderately Dry: These are the cooler *Abies lasiocarpa* habitat types within the area. The fire-free interval of these types is 50 - 130 years (Fischer 1987). The periodic fire disturbances and high amount of low to moderate fire intensity, favors species such as *Pinus contorta, Pseudotsuga menziesii* and *Larix occidentalis*. Other species on these sites are commonly *Abies lasiocarpa, Picea* and *Pinus albicaulis*. Stands dominated by *Pinus contorta* that are over 80 years of age tend to build fuels to become a part of large stand replacement events encompassing thousands of acres (Fischer and Bradley 1987). These sites, especially in the *Vaccinium caespitosum* and *scorparium* types, are quite frosty.

Cold PVG

HG 10 – Cold and Moderately Dry: These types are upper elevation cold dry sites. Many are above the cold limits of conifers such as *Pseudotsuga menziesii*, *Larix occidentalis*, and *Pinus monticola*. Common species are *Pinus albicaulis*. *Pinus contorta, Tsuga mertensiana, Abies lasiocarpa,* and *Larix lyalii*. The fire-free interval varies considerably from 35 to over 300 years. Stand replacement fires occur after intervals of more than 200 years (Fischer and Bradley 1987). Most fires are of low severity because of discontinuous fuels (Arno 1989).

HG 11 – Cold Dry: These types are high elevation cold sites. They are near timberline and above the cold limits of species such as–*Pseudotsuga menziesii* and western larch. Common species are *Pinus albicaulis, Tsuga mertensiana, Abies lasiocarpa* and *Larix lyallii*. The fire free interval varies considerably from 35 to over 300 years. Stand replacement fires occur after intervals of more than 200 years (Fisher and Bradley 1987).

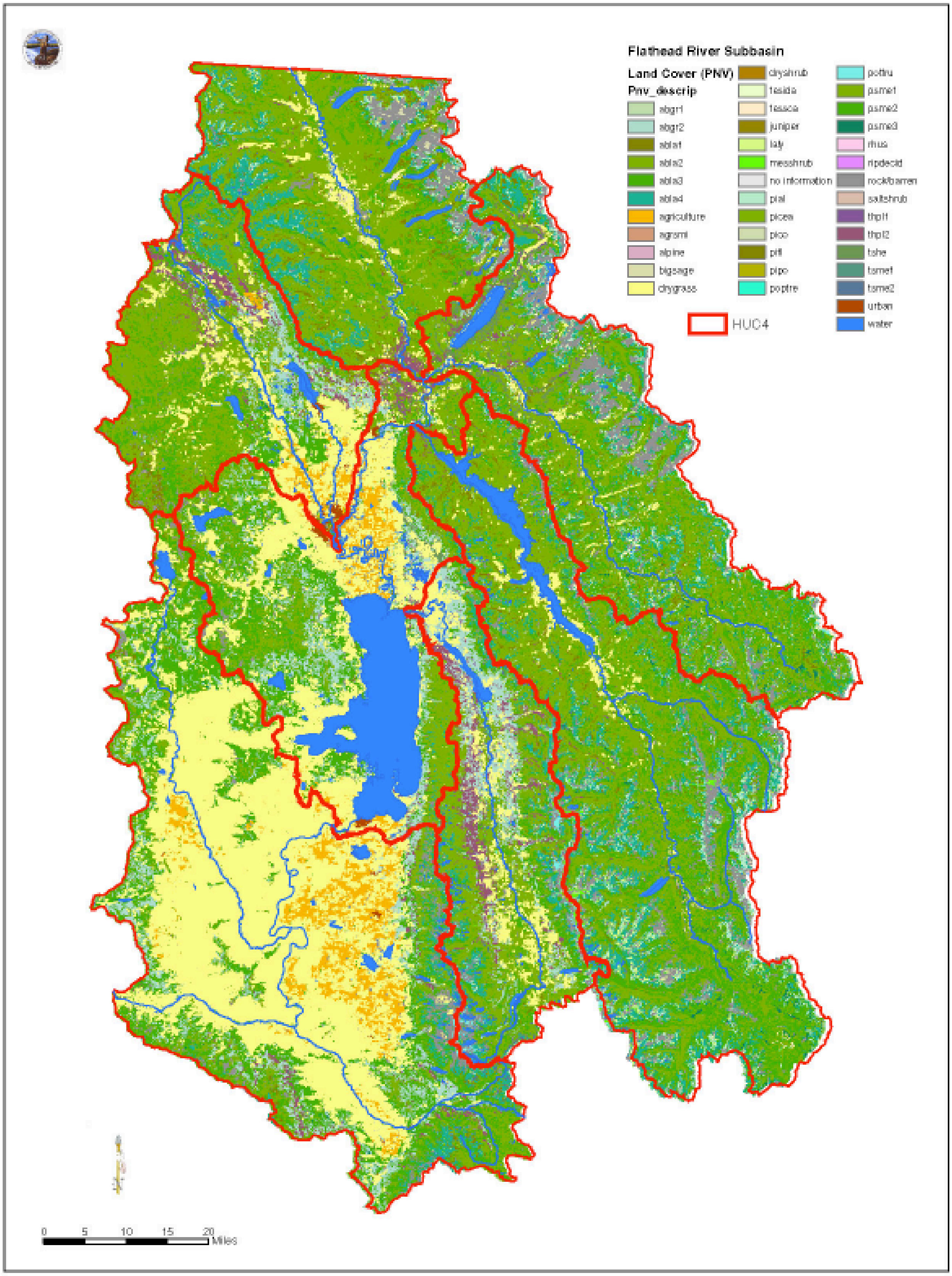

Figure 1.7. Land cover types of the U.S. portion of the Flathead Subbasin.

1.2 The Subbasin in the Regional Context

1.2.1 Size, Placement, and Unique Qualities.

The Flathead Subbasin, located in northwestern Montana and the southeastern corner of British Columbia, constitutes the northeastern-most drainage of the Columbia River (figure 1.8). At 5.8 million acres, the Flathead Subbasin is one of the largest subbasins in the Columbia. It is distinguished by a number of unique features:

- Because the Flathead Basin is midway in the north-south gradient of the Rocky Mountains and because it is variably dominated by Pacific maritime and continental climatic conditions, it has been termed a "continental biodiversity node," in other words, a natural mixing zone for biota (Stanford 2000).

- The Flathead River Subbasin supports one of the greatest and most diverse concentrations of wetlands in the Rocky Mountains, including peatlands, oxbow ponds, springs and seeps, complexes of pothole ponds, vernal pools and beaver ponds (Greenlee 1998).

- The North Fork of the Flathead River is home to the highest diversity of aquatic invertebrate species in the Rocky Mountains from New Mexico to the Yukon (Long 2000). The rest of the subbasin also hosts a diverse aquatic insect community. For example, 70 percent of the stoneflies known to occur in the entire Rocky Mountain area from Alaska to Mexico occur in the Flathead River Subbasin (Stanford and Ellis 2002).

- The portion of the North Fork of the Flathead in Canada remains the largest unsettled drainage in southern Canada outside of a park (Long 2000).

- The Canadian and U.S. portions of the North Fork of the Flathead River Drainage support the highest density of inland grizzlies in North America (Weaver 2001).

- The North Fork of the Flathead still hosts virtually a full constellation of native wildlife; almost all the species that were there 400 years ago still roam there (Long 2000). That includes carnivores, which makes

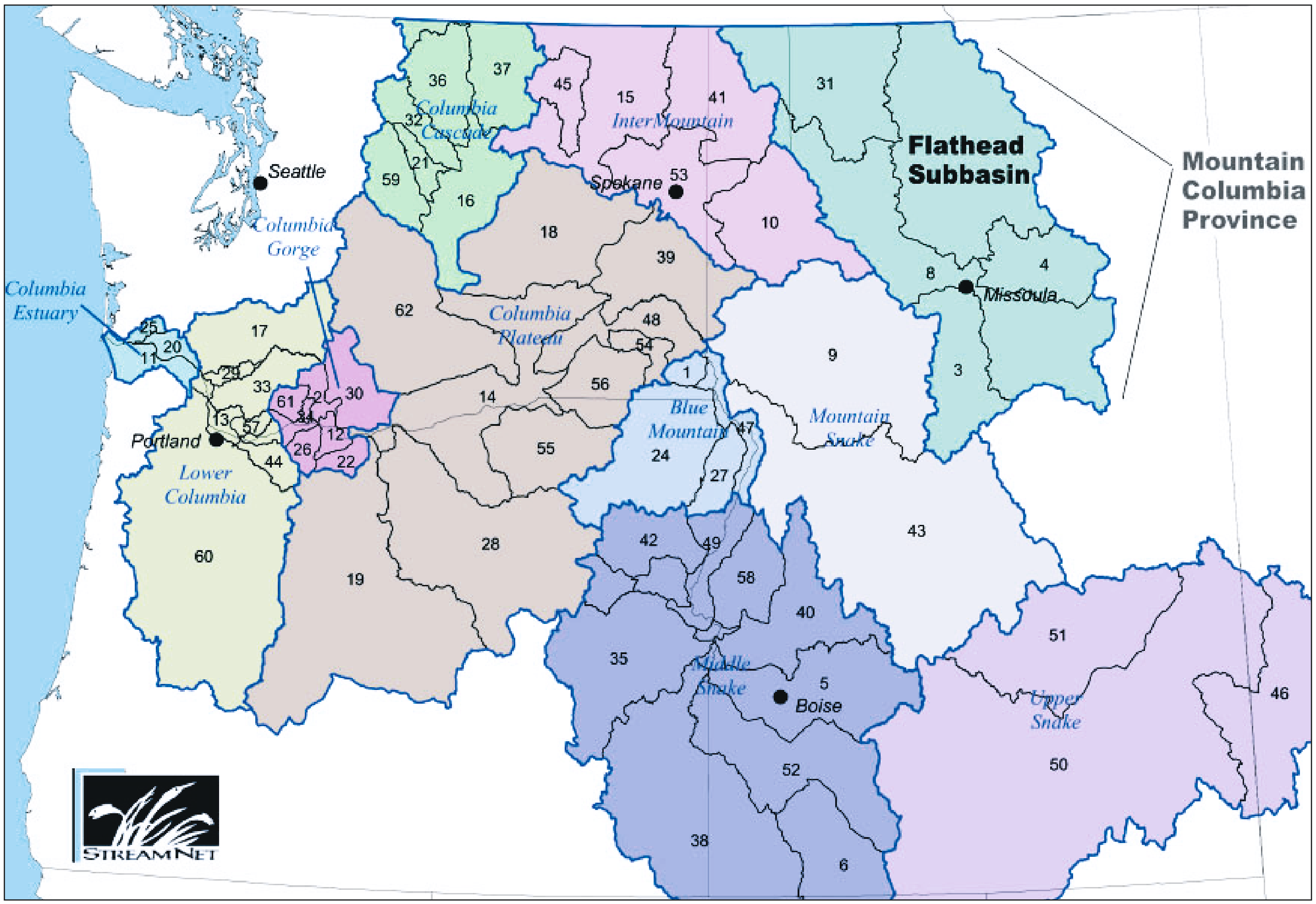

Figure 1.8. The Flathead Subbasin is the northeastern-most drainage of the Columbia River.

the valley unique. According to Weaver (2001), the assemblage appears unmatched in north America for its variety, completeness, use of valley bottomlands, and density of species which are rare elsewhere. Weaver goes on to state that because of these unique characteristics and the valley's strategic position as a linkage between national parks in both Canada and U.S., the North Fork of the Flathead "may be the single most important basin for carnivores in the Rocky Mountains."

- Prior to construction of Kerr and Hungry Horse Dams, the Flathead Subbasin may have supported the largest migratory bull trout assemblage in the world (Montana Bull Trout Scientific Group 1995).

- Among watersheds in the Columbia River Basin where Interior Columbia Basin Ecosystem Management Project (ICBEMP) data are available, the Flathead Subbasin has the third highest number of HUCs with westslope cutthroat trout stocks that are considered strong or predicted strong (USFWS 1999).

- Flathead Lake is one of the 300 largest lakes in the world and is one of the least culturally eutrophied large lakes in the northern hemisphere (Stanford and Ellis 2002).

1.2.2 Relationship of the Subbasin to ESA Planning Units

Bull Trout

For listing purposes, the USFWS divided the range of bull trout into distinct population segments. The agency identified 27 recovery units, and the Flathead Subbasin falls within the Clark Fork River Recovery Unit. It in turn encompasses four subunits—the Upper Clark Fork, Lower Clark Fork (which includes the lower Flathead and its tributaries), Flathead (which includes the rest of the Flathead Subbasin), and Priest. The following parts of the Clark Fork River Recovery Unit encompass the portions of the Flathead Subbasin that have been designated as primary core areas: lower Clark Fork River (which encompasses the lower Flathead River and its tributaries), Flathead Lake, Swan Lake, and Hungry Horse Reservoir. In addition, twenty-two lakes in the Flathead Recovery Subunit have been designated as secondary core areas for the purposes of recovery.

Grizzly Bear

The Grizzly Bear Recovery Plan focuses on the six areas in Idaho, Montana, Washington, and Wyoming that have habitat suitable for self-sustaining grizzly populations. The Flathead Subbasin is within the Northern Continental Divide Recovery Zone.

Bald Eagle

The Bald Eagle Recovery Plan established seven bald eagle recovery zones in Montana. The Flathead Subbasin is in Zone 7, the Upper Columbia Basin.

LINKS

For USFWS recovery plans, go to: http://montanafieldoffice.fws.gov/Endangered_Species/Recovery_and_Mgmt_Plans.html

Click Here

Northern Rocky Mountain Wolf

The Northern Rocky Mountain Wolf Recovery Plan established three recovery zones in Montana, Idaho, and Wyoming. The Flathead Subbasin is in the Northwest Montana Recovery Area.

Lynx

For purposes of their Canada Lynx Conservation Assessment and Strategy analysis and development of conservation measures, the Lynx Biology Team identified five lynx geographic areas (Ruediger et al. 2000). The Flathead Subbasin is within the Northern Rocky Mountains Lynx Geographic Area. Lynx geographic areas were not identified to represent distinct lynx populations, or isolated subpopulations, or even currently occupied habitat. Rather, each has uniquely different forest ecosystems and management histories.

1.2.3 External Environmental Conditions Impacting the Subbasin

The primary external factors impacting the Flathead Subbasin fish and wildlife resources come from the mainstem Columbia River federal hydropower operations, which profoundly influence dam operations as far upstream as headwater reservoirs. Dam operations affect environmental conditions in the reservoirs upstream and rivers downstream of Hungry Horse and Kerr dams. The abundance, productivity and diversity of fish and wildlife species inhabiting the subbasin are dependent on their immediate environment that ebbs and flows with river management. Mainstem Columbia River operations affect native fish and wildlife in the following ways:

- Unnaturally high flows during summer and winter negatively impact resident fish.
- Summer flow augmentation causes reservoirs to be drafted during the biologically productive summer months. This impacts productivity in the reservoirs.
- Drafting the reservoirs too hard prior to receiving the January 1 inflow forecast places the reservoirs at a disadvantage for reservoir refill. This is especially important during less-than-average water years.
- Flow fluctuations caused by power, flood control or fish flows create a wide varial zone in the river, which becomes biologically unproductive.
- The planned reservoir-refill date in the NOAA Fisheries BiOp of June 30, will cause the dam to spill in roughly the highest 30 percent of water years. This is because inflows remain above turbine capacity into July on high years. That means the reservoirs fill and have no remaining capacity to control spill, which causes gas super saturation problems.
- Flow fluctuations caused by power, flood control or fish flows cause sediments to build up in river cobbles. Before dams were built, these sediments normally deposited themselves in floodplain zones that provided the seedbeds necessary for establishment of willow, cottonwood, and other riparian plant communities. Young cottonwood stands are needed to replace mature stands that are being lost to natural stand aging as well as adverse human activities such as hardwood logging and land clearing.

LINKS

Appendix 12 has more complete information on the impacts to aquatic environments in the subbasin from mainstem hydropower operations.

Click Here

LINKS

For a list of publications on climate change in the Pacific Northwest and the implications for fish and wildlife and other natural resources, go to: http://www.cses.washington.edu/db/pubs/author20.shtml

Click Here

1.2.4 Macroclimate Trends

The glaciers in Glacier National Park show evidence of global warming, which is caused by increasing levels of carbon dioxide and other greenhouse gases in the atmosphere. Glacier National Park researchers now estimate that the largest glaciers in the park cover, on average, less than a third of their previous area. In addition, the current ice surfaces of the remaining glaciers are hundreds of feet lower than they were in the early 1900s. At the current rate, those researchers say all the park's glaciers will be gone by 2030 (Rockwell 2002). It is impossible to predict all the consequences, but we do know that unglaciated basins contribute much less water to streams than glaciated basins because glaciers buffer the timing and extent of runoff. As glaciers shrink and disappear, scientists expect stream flows park-wide to drop. Many streams will have little or no baseflow in late summer.

Models developed by researchers at NASA and elsewhere are predicting that the park and surrounding areas will see a 30 percent increase in precipitation and a 0.5 °C increase in annual temperature within fifty years (Fagre 2000). This, according to the park's own models, will expand the ranges of western redcedar and western hemlock in west-side valley bottoms. At higher elevations, the changed climate will cause treeline to move up-slope. Throughout the rest of the park, forest productivity is expected to increase. That will bump-up fuel loads significantly, which could mean larger, more intense and frequent wildfires. Because evapotranspiration is expected to go up, and snowpacks are expected to melt earlier in the year, the anticipated increase in precipitation won't prevent the forest from depleting soil moisture. Low soil moistures will mean lower streamflows (on top of already low flows caused by the shrinking glaciers). Couple these changes with an increase in stream temperatures caused by the higher air temperatures, and it appears likely that under this scenario, the subbasin's aquatic organisms, dependent on abundant cold water, will be further stressed (Fagre 2000).

LINKS

For the US National Assessment of the Potential Consequences of Climate Variability and Change report for the Pacific Northwest Region, go to http://www.usgcrp.gov/usgcrp/nacc/pnw.htm

Click Here

For the Executive Summary of Impacts of Climate Change on the Pacific Northwest from the above report, go to Appendix 93.

Click Here

For information climate change-landscape interactions currently being conducted in Montana's Glacier National Park, go to: www.nrmsc.usgs.gov/research/global.htm

Click Here

For climate change information from the University of Washington's Program on climate change, go to: http://depts.washington.edu/uwpcc/index.html

Click Here

Or go to:http://www.jisao.washington.edu/PNWimpacts/

Click Here

1.3 Fish, Wildlife, and Plant Species

1.3.1 Vertebrate Species

Forty-six species of fish (including hybrids) occur in the Flathead Subbasin, 23 of which are native (Hutten 2003). The Flathead Subbasin is also home to 374 terrestrial wildlife species. The list includes 11 amphibians, 11 reptiles, 281 birds, and 71 mammals. These are listed in Appendix 13 (see Links column).

LINKS

Appendix 13 lists aquatic and terrestrial vertebrate species occurrences for the Flathead Subbasin.

Click Here

1.3.2 Species at Risk

The Federal government has classified eight species of plant and animals that occur within the Flathead Subbasin as threatened or endangered under the Endangered Species Act (table 1.9). The peregrine falcon was formerly endangered but was delisted in 1999 and is now considered recovered subject to five years of monitoring. Appendix 14 lists animal species considered sensitive by the Confederated Salish and Kootenai Tribes and plant and animal species of concern as reported by the Montana Natural Heritage Program.

For a list of terrestrial species considered sensitive by the Confederated Salish and Kootenai Tribes and the Heritage Program ranks for plant and animal species of concern within the subbasin go to Appendix 14.

Click Here

Table 1.9. Threatened and endangered species in the Flathead Subbasin (Source: USFWS website (2003)).

Species Category	Common Name	Scientific Name	Status	Year Listed
Mammal	Gray Wolf	Canis lupis	Threatened	2003
	Grizzly Bear	Ursus arctos horribilis	Threatened	1967
	Canada Lynx	Lynx canadensis	Threatened	2000
Bird	Bald Eagle	Haliaeetus leucocephalus	Threatened	1967
	Whooping Crane	Grus americana	Endangered	1967
Fish	Bull Trout	Salvelinus confluentus	Threatened	1998
Flowering Plant	Water Howellia	Howellia aquatilis	Threatened	1994
	Spalding's Cathfly	Silene spaldingii	Threatened	2001

Appendix 15 lists B.C. red- and blue-listed species.

Click Here

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild Canadian species, subspecies and separate populations suspected of being at risk. These are listed in Appendix 16 (see Links column).

Appendix 16 lists species within the Flathead and Kootenai Subbasins (U.S. and Canada) that are at risk.

Click Here

The B.C. Conservation Data Centre lists terrestrial species and plant communities at the Provincial scale (for British Columbia) as rare and endangered (red-listed), vulnerable (blue-listed) or species of regional management concern (yellow-listed). Red- and blue-listed vertebrate and vascular plant species in the Cranbrook Forest District and the Southern Rocky Mountain Management Plan Area, which includes the Canadian portion of the North Fork of the Flathead, are listed in Appendix 15.

LINKS

For Montana's Natural Heritage Program, which has information on species at risk, go to http:// nhp.nris.state.mt.us/

Click Here

For the Conservation Data Centre for B.C., go to http:// srmwww.gov.bc.ca/cdc/

Click Here

1.3.3 Aquatic Focal Species and Terrestrial Target Species

Members of the Flathead Subbasin Technical Team have selected bull trout and westslope cutthroat trout as the aquatic focal species for the Flathead Subbasin Plan. The Team selected these two species based upon their population status and their ecological and cultural significance.

For the terrestrial environment, the Technical Team has taken a multi-species approach as opposed to identifying individual focal species. The team has identified the following terrestrial species, which we are calling target species (table 1.10). These were chosen because: (1) they have been designated as a Federal endangered or threatened species or have been otherwise designated a priority species for conservation action; (2) they play an important ecological role in the subbasin (for example as a functional specialist[5] or as a critical functional link species[6]); or (3) they possess economic or cultural significance to the people of the Flathead Subbasin.

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[5] *Functional specialist — Species that have only one or a very few number of key ecological functions. An example is turkey vulture, which is a carrion-feeder functional specialist. Functional specialist species could be highly vulnerable to changes in their environment (such as loss of carrion causing declines or loss of carrion-feeder functional specialists) and thus might be good candidates for focal species. Few studies have been conducted to quantify the degree of their vulnerability. Note that functional specialists may not necessarily be (and often are not) also critical functional link species (functional keystone species), and vice versa.*

[6] *Critical functional link species — Species that are the only ones that perform a specific ecological function in a community. Their removal would signal loss of that function in that community. Thus, critical functional link species are critical to maintaining the full functionality of a system. The function associated with a critical functional link species is termed a "critical function." Reduction or extirpation of populations of functional keystone species and critical functional links may have a ripple effect in their ecosystem, causing unexpected or undue changes in biodiversity, biotic processes, and the functional web of a community. A limitation of the concept is that little research has been done on the quantitative effects, on other species or ecosystems, of reduction or loss of critical functional link species.*

Table 1.10. Terrestrial target species.

MAMMALS	IBIS STATUS	BIRDS (CONT.)	IBIS STATUS	BIRDS (CONT.)	IBIS STATUS
American Beaver	*CFLS*	Black Swift	*FS*	Merlin	*FS*
American Pika	*CFLS*	Black Tern	*CFLS*	Northern Goshawk	
Big Brown Bat	*CFLS*	Black-backed Woodpecker		Northern Pygmy-owl	*FS*
Black Bear	*CFLS*	Black-chinned Hummingbird	*CFLS*	Olive-sided Flycatcher	
Bushy-tailed Woodrat	*CFLS*	Boreal Owl	*FS*	Peregrine Falcon	*FS*
Deer Mouse	*CFLS*	Brewer s Sparrow		Pileated Woodpecker	
Fisher	*CFLS*	Brown Creeper		Red-eyed Vireo	
Golden-mantled Grnd Squirrel	*CFLS*	Brown-headed Cowbird	*CFLS*	Red-naped Sapsucker	
Grizzly Bear	*CFLS*	Calliope Hummingbird		Ruffed Grouse	
Lynx	*FS*	Canada Goose	*CFLS*	Rufous Hummingbird	*CFLS*
Mink	*CFLS*	Columbian Sharp-tailed Grouse		Snowy Owl	*FS*
Montane Vole	*CFLS*	Common Loon		Three-toed Woodpecker	
Moose	*CFLS*	Common Nighthawk	*FS*	Trumpeter Swan	
Mule Deer	*CFLS*	Cordilleran Flycatcher		Tundra Swan	*CFLS*
Northern Bog Lemming	*FS*	Flammulated Owl		Turkey Vulture	*FS*
Northern Pocket Gopher	*CFLS*	Grasshopper Sparrow		Vaux s swift	
Nuttall's Cottontail	*CFLS*	Great Blue Heron	*CFLS*	Veery	
Raccoon	*CFLS*	Great Horned Owl	*CFLS*	Williamson's Sapsucker	*CFLS*
Red Squirrel	*CFLS*	Gyrfalcon	*FS*	Willow Flycatcher	
River Otter		Hammond s Flycatcher		Winter Wren	
Rocky Mountain Elk	*CFLS*	Harlequin Duck	*FS*	**AMPHIBIANS**	
Snowshoe Hare	*CFLS*	Hooded Merganser		Boreal Toad	
Wolverine	*FS*	Horned Grebe		Long-toed Salamander	*CFLS*
BIRDS		House Finch	*CFLS*	Northern Leopard Frog	
American Crow	*CFLS*	Lazuli Bunting		Spotted Frog	
Bald Eagle		Lewis s woodpecker			
Barrow s Goldeneye		Long-billed Curlew			

[1] *FS is a Functional Specialist. See the definition on the preceding page.*
[2] *CFLS is a Critical Functional Link Species. See the definition on the preceding page.*

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2 Characterization of Biomes

For the purposes of this assessment, we divided the subbasin into six biomes: aquatic, riparian, wetland, grassland/shrub, xeric forest, and mesic forest (figure 2.1). In this part, we describe the critical functional processes in each of these biomes and how humans have altered those processes. We then describe four reference conditions: presettlement (1850), present (2004), future potential (2050), and future no action (2050 with no change in current management).

2.1 Aquatic Systems

2.1.1 Critical Aquatic Functional Processes[1]

The most important physical features that affect watershed functions and processes are landform and vegetation. Landforms determine how and where water travels across the landscape, while vegetation influences the erosion processes that occur within the landscape (USFWS 2000).

The Flathead is a geologically young subbasin, and its fluvial geomorphologic processes reflect that. Makepeace (2000) describes how landforms affect channel and floodplain processes for subbasin watersheds. The descriptions of headwater and valley floor areas that follow are adapted from that discussion. Figure 2.2 shows the general downstream trend for subbasin streams.

Headwater Areas

Hillslope processes dominate water and sediment movement in the headwater, forested portions of subbasin watersheds. Water flows beneath the surface and accumulates in depressions or hollows and colluvial till areas at the base of individual hillslopes. At some point on the slope, enough water moves through a depression to develop an incised channel, the general form of which is often a simple scoured channel (Dunne and Leopold 1978). As these channels move downslope, they combine, and the duration of streamflow increases. A more complex channel pattern—typically a cascade channel—develops. Cascade reaches are formed by irregularly spaced boulders and accumulations of wood. The channels are generally incised and there is limited floodplain development.

Step-pool channels develop downstream and between cascade reaches. They are comprised of generally discrete, spaced accumulations of boulders and woody debris, which form steps. The steps in turn are separated by lower gradient

Snapshot

During presettlement times aquatic and hydrologic processes and functions were intact. Dams, diversions, groundwater withdrawls, roads, channelization of streams, logging, agricultural and grazing practices, the introduction of non-native species, and various developments, other human activities have altered these functions and processes. Consequently, water quality, streamflows, streambank stability, sedimentation, channel diversity, and other habitat attributes have been degraded, and native species have declined.

[1] *It should be noted that biophysical features and their associated functional processes are naturally interrelated and interlinked; processes in one place or time may be influenced or controlled by adjacent processes (Stanford and Hauer 1992).*

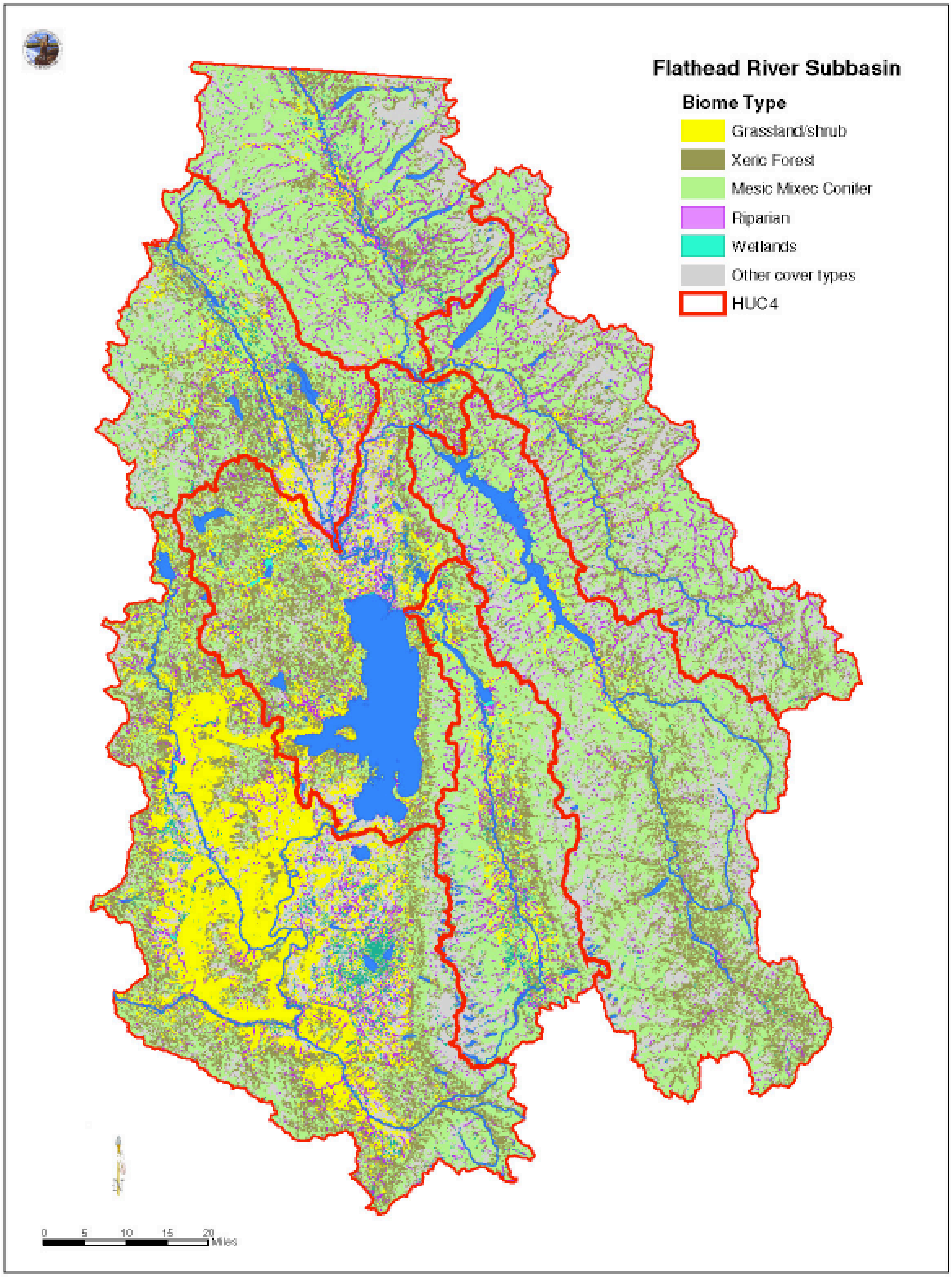

Figure 2.1. Biomes of the U.S. portion of the Flathead Subbasin.

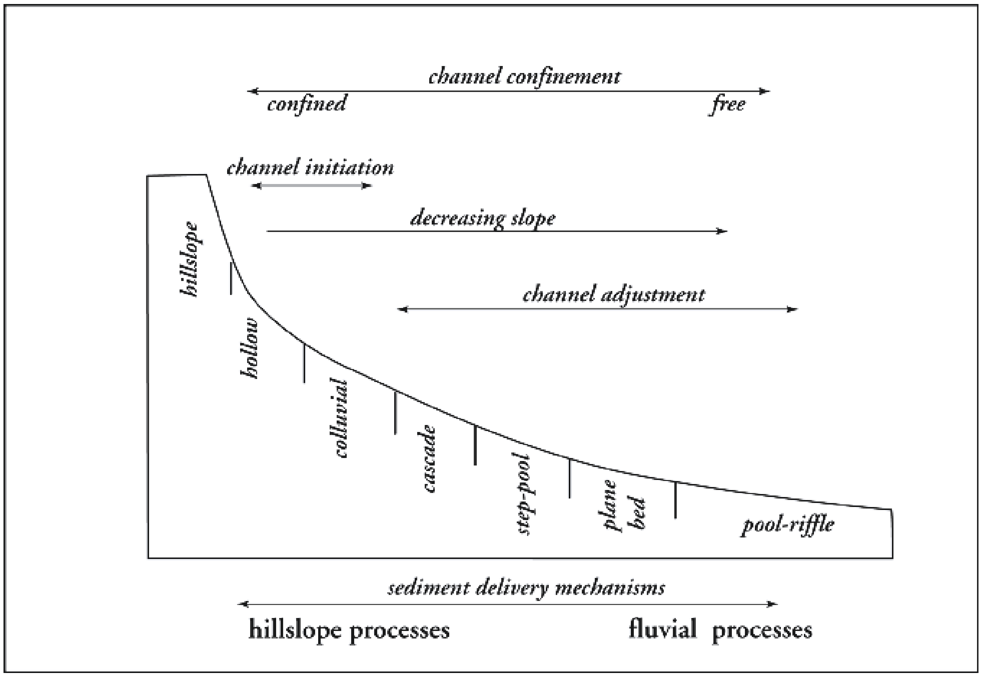

Figure 2.2. Idealized longitudinal profile through a channel network (redrawn from Makepeace 2000, after Montgomery and Buffington 1997).

pool areas with accumulations of gravel-size substrates (Grant et al. 1990). Most forested watersheds and forested stream reaches contain cascade and step-pool channel morphologies.

Plane-bed channels are straight reaches with uniform substrate sizes and channels that lack the rhythmic alteration in bedforms found in most other channels types (Montgomery and Buffington 1997). Plane bed channels are observed in several forested watersheds, but are not as widespread as cascade and step-pool morphologies (Makepeace 1998).

As channel morphologies change in a downstream direction and the width of the floodplain increases, there is a shift in the origin of the sediment carried by the stream from hillslopes to fluvial, or near-channel sources. Hillslope sediment delivery mechanisms include dry gravel from hillslopes, shallow-seated earthflows, and debris flows, all of which are typically episodic, occurring during or after extreme weather. Fluvial sediment comes from the scouring of floodplain channels or from the floodplain itself when flows overtop banks. In forested reaches streambank sediment sources are limited because of the dense vegetation growing along channel margins (Makepeace 1998).

Valley Floor Areas

As streams emerge onto valley floors, geomorphic processes and channel responses change. Valley and floodplain widths increase. Channels tend to flow over materials eroded and deposited by the current stream, and there is a significant decrease in the influence that large, immobile bed elements have on the channel pattern. With the increase in floodplain width and the presence of underlying, unconsolidated aquifer systems, the interconnectivity between the stream and groundwater increases.

As channels migrate laterally within their associated floodplain, they develop a sinuous or meandering pattern characterized by alternating pools and riffles (Leopold et al. 1964). There are approximately three end-member, pool-riffle stream types found within the subbasin.

- Laterally unconstrained gravel-bedded streams such as the Whitefish, North Fork of the Flathead, and Jocko Rivers;
- Free meandering, fine bedded streams that flow through glacial lacustrine silts and other fines (examples include the Little Bitterroot and Stillwater Rivers); and
- Gravel-bedded streams with well developed alluvial floodplains that are entrenched within wide canyons (for example, Crow Creek and Big Creek).

Stream channel movement across broad valleys also tends to correspond with an increase in the diversity of landform types, such as alluvial bars, levees, low-lying wetlands, and riparian and wetland meadows (Hansen et al. 1995).

Flooding, Floodplains and the Hyporheic Zone

Flooding is a key geomorphic process in the Flathead that affects streamflow patterns and riparian communities. Black cottonwood is one of the primary species that benefit from floods, and black cottonwood stands support many species. Floods also create backwater sloughs and log jams, providing resting areas and hiding cover for fish. They move fine sediments out of the river and onto floodplains where they fertilize riverside meadows and riparian communities used by foraging bears, deer, and elk. Floodplains are also highly productive for small rodents such as deer mice, which in turn feed a variety of predators (Long 2000).

Floods are not the only force shaping floodplains and the plant communities that grow on them. The flow of water between the channel and the floodplain during periods of normal flow also plays a major role. In fact, groundwater flow and recharge of surface waters in expansive floodplain settings is a predominant feature of the Flathead system (Stanford and Ellis 2002). The Middle Fork of the Flathead, where there is a pattern of relatively broad floodplains separated by narrow canyon reaches, is a good example. Studies by Stanford and others on the Nyack floodplain have shown that as the Middle Fork leaves the narrow part of the canyon, as much as 20 percent of its water penetrates the porous gravels of the river bottom and flows underground, beneath the bed and floodplain of the river in what is known as the hyporheic zone. Downstream, near the bottom of the floodplain, where the canyon begins to constrict again, there is an upwelling of this same water forced by the encroaching underlying bedrock. Spring brooks appear on the floodplain, and overflow channels begin to flow as far as one quarter mile away from the actual bed of the river.

Wells drilled into the gravel of the floodplain have revealed a community of organisms living and thriving in the hyporheic zone up to half a mile from the river channel. That community includes midge and mayfly larvae, riffle beetles, water mites, stonefly larvae, archiannelids, bathynellids, and amphipods. At the base of this web of life is a subterranean film of fungi and bacteria that coats the alluvial gravels. This film, grazed by the higher organisms, survives by consuming dissolved organic matter from the decomposition of leaves, twigs, algae, insects, and fish. The processing of all this material as it moves through the subsurface gravels releases large amounts of previously unavailable nutrients, especially phosphates and nitrates, into the water. The result is that the river waters, which would otherwise be quite infertile, become charged with nutrients and emerge on the floodplain surface in the form of springs, sometimes several hundred yards from the river, where they fertilize the riparian zone. Aerial photographs reveal that the most productive, vigorous plant communities on the floodplain occur at these upwellings.

The complex interactions between ground water and surface water are key attributes of high quality riverine habitat for both bull trout and westslope cutthroat trout as well as terrestrial species.

Other Influences

Beaver damming of streams is a major natural process on many subbasin streams (both in headwater and valley-bottom areas). Beavers dams can occur on river channels, perennial and intermittent streams, and ponds. The dams regulate runoff in watersheds and store water in river systems without disrupting watershed connectivity. On some stream types, beaver dams, and to a lesser degree, large woody debris, control stream gradient. When the dams are breached, these systems are vulnerable to rapid stream downcutting and lower water tables (USDA FNF 1995).

Large downed trees[2] and coarse woody debris located in the channel and on alluvial floodplain surfaces are key to providing habitat, particularly in the alluvial reaches. Along with riparian vegetation, which provides bank stability and flow resistance, these materials deflect flows creating low-velocity flow refugia, scouring deep pools, and trapping sediments and fine organic material that contributes to aquatic food webs. They provide a diverse and stable habitat mosaic used heavily by many kinds of organisms, including salmonid fishes (Sedell and Froggatt 1984; Naiman 1992). Debris accumulations may also play a direct role in forcing surface flows into alluvial aquifers and promoting the movement of hyporheic flows and shallow groundwater back to the surface (Ebersole 1994). Debris jams also create temporary obstructions in rivers that, during peak flows, cause local channels to move and floodplains to be inundated. These processes in turn create and rejuvenate the diverse mosaic of main channel, backwater, slough, springbrook, and hyporheic habitats common to natural alluvial rivers (Sedell and Froggatt 1984; Stanford and Ward 1993), and they help to sustain the diversity in floodplain vegetation. Debris jams may also function to divert or break up ice accumulations in winter, preventing the downstream propagation of ice drives that tend to naturally channelize rivers in colder, interior areas (Smith 1979).

LINKS

For fish and water information about the Flathead in British Columbia, go to: http://srmwww.gov.bc.ca/aib/

Click Here

For an electronic library of aquatic information for the B.C. portion of the subbasin, go to: http://srmwww.gov.bc.ca/appsdata/acat/html/deploy/acat_p_home.html

Click Here

For a description of the interaction of groundwater and surface water in the Upper Flathead Valley, go to Appendix 17.

Click Here

For more information on critical functional processes of aquatic systems, see Appendix 18.

Click Here

North, Middle and South Forks of the Flathead River

The North Fork of the Flathead, unconstrained by canyon segments, flows through a broad alluvial valley with expansive flood plains. The channel is braided and anastomosed. Cut-and-fill deposition mediated by flooding drives floodplain and riparian-wetland dynamics (Stanford 2000). Floodplains retain piles of wood debris, gravel bars, and flood channels deposited by the largest floods of recent record, which occurred in 1964 and 1974 (Stanford 2000).

During spring runoff, the North Fork typically carries high sediment loads, the sediment coming from erosion and reworking of floodplain terraces (Stanford 2000). While fourth-order tributaries generally remain relatively clear and free of suspended sediments during spring runoff, the mainstem carries 300 mg/l or more of suspended solids during runoff (Appleman et al. 1990). For most of the 20th century, glacial meltwater also contributed to the annual flow of the river, but by the 1980s, most of the glaciers had melted (Fagre et al. 1997).

Except for the Nyack and Shafer Meadows, much of the Middle Fork is constrained by canyons (Stanford 2000). The geomorphology of the Nyak floodplain on the Middle Fork has been extensively studied, and floodplain dynamics there are representative of other river reaches with broad floodplains in

[2] *This paragraph is adapted from Williams et al. (2000).*

the subbasin. Flooding and the deposition of wood debris interacts with gravel and cobble deposits to determine the position of the main river channel (Stanford 1998). The floodplain surface is a patchy mosaic of vegetation and channels that, because of the geomorphic structure of the surface and subsurface, is characterized by a great deal of water movement between the channel and the floodplain. This results in complex seasonal patterns of floodplain inundation, extensive penetration of channel water laterally into the alluvial aquifer, and springbrooks formed by groundwater erupting onto the floodplain surface.

Research on the Nyack floodplain by Stanford was the basis for a Federal reserve water right protecting the virgin flow of the North and Middle Forks (Stanford 2000). The water right ensures that water cannot be diverted or pumped from the alluvial aquifers because it plays such a fundamental role in the functioning of river resources that are protected under the authorizing charter of Glacier National Park.

Upstream from the Nyack floodplain, the Middle Fork is unregulated and the catchment virtually pristine. The South Fork has large floodplain reaches above Hungry Horse Dam (Stanford 2000) that, like the Middle Fork, are mostly pristine because most of the South Fork above Hungry Horse is designated wilderness.

Upper Mainstem Flathead River

The upper 38 km of this river section, from the confluence of the South Fork downstream to 1.2 km southeast of Kalispell, has gravelly substrates, lots of islands and gravel bars, and many side channels (Casey and Wood 1987). Islands and riparian bench areas are primarily dominated by deciduous (black cottonwood) or mixed (black cottonwood/spruce) forests. The most extensively braided area is located near the mouth of the Stillwater River, just southeast of Kalispell, where the river changes abruptly into a single, wide meandering channel of low gradient. This 22 mile reach, which extends downstream all the way to Flathead Lake, has fine sediment substrates and essentially no islands (Casey and Wood 1987). Extensive stands of riparian forest occur along some portions of this reach, but in many places they are absent or limited to a very narrow strip immediately adjacent to the river (Casey and Wood 1987).

Lower Flathead River

Makepeace (2000) describes the lower Flathead River as a unique end member stream type, both because of its size, but also because of the flow regime modification that occurred after the construction of Kerr and Hungry Horse

Dams. Below Flathead Lake, the river is deeply entrenched in glacial lacustrine sediments downstream to approximately Mission Creek (Makepeace 2000). In this reach, the river is a single thread, moderately sinuous system with relatively fast moving water. It averages 328 feet in width. The floodplain, and associated riparian communities are limited to the margins of canyon walls and aggrading point bar surfaces on major river bends (Makepeace 2000). There are five islands that range from 0.25 to 6.2 acres in size.

Downstream of Mission Creek, the river is less confined laterally and slower flowing. Branching channels and elevated mid-channel islands have developed. The river is considered an anastamosing river system (Makepeace 2000). It is a low-gradient, very stable system with multiple channels separated by islands. Sediment loads are generally in the finer grained, suspended-load size fraction (Makepeace 2000). Islands, low relief features on the channel margins, sloughs, backwater areas, and river meanders cut by transportation right of ways form the floodplain and riparian communities (Suchomel 1994). In this stretch, the river averages 656 feet in width, and has 38 islands that range in size from 0.25 to 69.4 acres.

2.1.2 Human Alterations to Critical Aquatic Functional Processes

Dams

Dams have interrupted the natural process in subbasin lakes, rivers, and streams by backing up large stretches of flowing water; blocking sediment from downstream reaches, causing downstream water to be more erosive; affecting nutrient and carbon transport; altering thermal regimes; causing rapid changes in water levels; preventing floods; and altering natural hydrographs. Specifically, the operation of dams has increased the variability of river flows throughout the year. Power peaking and load following have caused the varial zone along rivers and lakes to widen and become biologically unproductive, diminishing overall system health. Aquatic and terrestrial vegetation that would have normally provided secure habitat along river margins and stabilized soils has not been able to fully reestablish each summer, and fine sediment materials are more easily eroded and swept back into the channel.

Other Alterations

Channelization, road fill, bank armoring, and other encroachments along stream segments have narrowed channels and limited meanders inside floodplains. This has created shorter channels, steeper gradients, higher velocities, loss of storage and recharge capacity, bed armoring, and entrenchment.

On impacted stream reaches, even minor flood events have often resulted in significant deterioration. Erosion has increased, and the number of pools and the extent of riparian cover have decreased. The changes have lowered the quality of fish and wildlife habitat (CSKT 2002). In some parts of the subbasin, streams have been completely dewatered for irrigation purposes, and stream channels have been obliterated (CSKT 2000b). Some ponds and small lakes have been filled in or drained and wet meadows have been ditched. Water from creeks has been diverted to human-made ponds.

Forestry-associated impacts have been widespread in the subbasin (Bull Trout Recovery Plan). Progressive practices in recent years have lessened many of the impacts associated with road construction, log skidding, riparian tree harvest, clear-cutting, and splash dams, but decades of poor practices earlier in the century have caused lasting impacts to stream habitats, including increased sediment in streams, increased peak flows, hydrograph and thermal modifications, loss of instream woody debris, channel instability, and increased access by anglers and poachers. These impacts will continue, and they are irreversible in some drainages (USFWS 2002).

LINKS

For a description of human impacts and responses to those impacts framed in terms of the 4-Hs (hydropower, habitat, harvest, and hatcheries), go to Appendix 64.

Click Here

In some watersheds, human activities such as road building, logging operations, agriculture, home development, and mines have at times caused high sediment concentrations in streams. In some areas, disturbance and compaction of topsoil on the forest floor from logging activities has destroyed the soil's ability to filter and absorb water, altering water and sediment movement. Poorly planned, located, or constructed roads, skid trails, and landings have acted as human-made, sediment-laden channels, at times dramatically increasing the sediment load carried by streams. Poor stream crossings have added sediment to streams and damaged stream banks. Road washouts and culverts that have plugged and blown out have caused largescale sedimentation problems. Large clearcuts have altered snow melt patterns and transpiration rates, and as a result have altered streamflows (CSKT 2001; USFWS 2002).

Headwaters

Channels and floodplain environments of headwater streams have been disturbed by a variety of land uses, including agricultural development and grazing pressure, residential and commercial development, irrigation maintenance activities, channelization and floodplain encroachment, and transportation right of ways. These activities have, to varying degrees, affected channel morphologies, substrate composition, and bank/riparian structure across the subbasin (CSKT 2001).

In 1988, a forest practices/water quality and fisheries cooperative program was established to document, evaluate, and monitor whether forest practices affect water quality and fisheries within the Flathead Subbasin (Flathead Basin Commission 1991). As part of this effort, changes in stream flow and the transport and deposition of fine sediments over the past 140 years were evaluated by examining two sources of historical records: mean daily discharge at stream gauging sites and sediment accumulation on lake bottoms. These evaluations indicated the following relationships between lake/stream measures and timber harvest, and other land use activities[3].

Historical Record

- Comparison of spring runoff regimes among major river drainages in the Flathead between 1940 and present indicated that drainages having experienced extensive timber harvest also have spring runoff occurring earlier in the year than similar drainages having little timber harvest.

- It appears that timber harvest may result in a higher peak in spring discharge during above normal runoff years, but not in major flood years.

- Lake coring analyses indicated that past human land disturbance activities increased fine sediment deposition up to tenfold in Whitefish Lake in the 1930s and four to five fold in Lake McDonald between 1930 and 1960.

Lake McDonald

- Initial road construction and upgrading of the Going to the Sun Road from Lake McDonald to the continental divide at Logan Pass during the 1930s and 1940s were accompanied by substantial increases in sediment deposition in Lake McDonald.

- After the road was paved in the early 1950s, the sediment deposition rate in Lake McDonald returned to background levels and has remained at background levels over the last 25 years.

Whitefish Lake

- Large increases in sediment deposition occurred during the early part of this century (1900 to 1910) and were attributed to railroad

[3] *Excerpted from Flathead Basin Commission (1991).*

construction along the lake shore and logging activity around the lake.

- The largest sedimentation increases occurred in the early 1930s when substantial logging and associated road and rail line construction were concentrated in the Lazy Creek drainage and Lower Swift Creek, near the head of Whitefish Lake.

- Sedimentation rates also were elevated from the 1950s through the mid-1970s. These increases were attributed to substantial logging and associated road-building activity, which extended to upper portions of the Whitefish Lake drainage.

- Recent logging activity in the Whitefish watershed was not accompanied by increased sedimentation in Whitefish Lake. Possible explanations for reduced sediment impacts include use of preexisting roads, logging on less-erodible lands, improved logging and road-building practices, and a series of comparatively mild runoff years.

- Results from the two study lakes suggest that roads are the greatest disturbance activity, resulting in increased sediment transport and deposition in downstream lakes. Once road surfaces stabilize (especially when paved), additional delivery of road-related fine sediment was not detected from sediment core analysis in McDonald Lake, and road stabilization is probably also responsible for declining sediments in Whitefish Lake.

- Changes in lake sedimentation directly attributed to floods, fires, and other natural erosion processes during the past 150 years were much smaller than changes attributed to human disturbance activities in the two lake basins. Previous speculation that erosion of naturally unstable stream banks and other natural sources may mask sediment inputs attributed to human activities appear unfounded for the Whitefish Lake and Lake McDonald basins in light of data collected in the present study.

Water Quality and Fisheries

A broad array of streams in the Flathead Basin were evaluated by monitoring various physical, chemical, and biological variables and conducting controlled field experiments. Evaluated stream sites included watersheds with no timber harvest and no roads, no timber harvest with roads, and with timber harvest and roads. Among those watersheds with timber harvest and roads, stream sites were selected to represent different levels of percentage harvest within the basin.

- Monitoring data collected from this research indicated the following statistically significant relationships ($p < 0.1$, or better) between timber harvest activity (that is, road building, harvest, etc.) and several physical, chemical, or biological measures of stream ecosystem quality.

  - Timber harvest activity was positively correlated with suspended sediment concentrations in streams.

  - Timber harvest activity was positively correlated with concentrations of nutrients (nitrogen and phosphorus).

  - Timber harvest activity was positively correlated with the percentage of fine sediment in trout spawning gravels.

  - Timber harvest activity was positively correlated with gravel imbeddedness in streams.

- Field surveys indicated the following statistically significant relationships (correlations analyses; $p < 0.1$, or better).

  - Timber harvest activity was positively correlated with algal growth in the streams.

  - Imbeddedness was negatively correlated with juvenile bull trout densities in streams.

  - The mean percentage of fine sediments in spawning areas of undisturbed watershed streams in the Flathead Basin was 31.7 percent (range 24.8 percent to 39 percent) while in watersheds subject to timber harvest the mean percentage of fine material was 39 percent (range 32.8 percent to 50.3 percent).

- Experimental studies showed that increases in the amount of fine sediment in spawning gravels caused a significant reduction in embryo survivorship of bull trout and westslope cutthroat trout. When the percentage of fine sediment reached 40 percent, survivorship of both species was reduced below 30 percent, and with 50 percent fine sediments, embryo survivorship was only 4 percent.

These evaluations indicate that roads associated with logging activities have a significant impact on fisheries and water quality, and many of the headwater reaches in the subbasin are roaded. The North Fork of the Flathead drainage is but one example. On the U.S. side of the border, every major drainage and some minor drainages on the west side of the river contain either a dirt or gravel road—the USFS has inventoried a total of 650 miles (1048 km) of roads in its Glacier View District (North Fork). In B.C. all the major drainages on both sides of the river, as well as many side drainages contain dirt or gravel roads. Large quantities of sediment stored behind debris dams in the upper Big Creek Basin and behind beaver dams in the South Fork of Coal Creek are apparently related to timber activities dating from the 1950s. Similar sediment sources from past forest management have been noted in the North Fork of Coal Creek, although fine materials in the streambed significantly decreased from 1989-90, becoming relatively stable since then (Flathead Transboundary Network 1999).

On the Flathead Reservation, headwater reaches have been impacted by irrigation structures. The Flathead Agency Irrigation District (FAID) on the Flathead Reservation includes approximately 1,930 km of irrigation canals and 17 reservoirs. The project built large feeder canals that cut across and intercepted many natural streams. Most of the smaller ephemeral and intermittent streams, and some of the larger perennial streams, were completely dewatered. Some stream courses were plowed over (Price 2000a).

South Fork of the Flathead and Upper Mainstem Flathead River

Hydropower and flood control operations from Hungry Horse Dam regulate the lower 43 miles of the Flathead River. Peaking-power operations, which began in 1967, resulted in dramatic short-term (hourly to weekly) fluctuations in flows in the South Fork Flathead River and, to a lesser extent, the mainstem of the upper Flathead River. Peaking operations have been eliminated in recent years.

Historic Hungry Horse Dam operations essentially reversed the natural annual river hydrograph on the South Fork of the Flathead. Dam operations stored reservoir inflows during the spring runoff and summer for power production during fall and winter. Dam discharges were high during the cold months when flows were historically low. Consequently, dam operations produced an unproductive varial zone and increased substrate embeddedness, both of which resulted in a less diverse and productive invertebrate community downstream of the dam (Marotz 2002).

The reduction in natural spring freshets reduced the hydraulic energy needed to maintain the river channel and periodically resort river gravels. Because the confluence of the unregulated flows from the North and Middle Forks of the Flathead River is just a few miles downstream from Hungry Horse Reservoir, the impacts associated with the loss of scouring spring flows has been less pronounced than would otherwise be expected (Williams et al. 1997). Still, collapsing river banks caused by intermittent flow fluctuation combined with the lack of flushing flows has resulted in sediment buildup in the river cobbles, which is detrimental to insect production, fish food availability, and security cover (CSKT 2001).

Kerr Project operations extend the time that Flathead Lake is held at full pool, and as a consequence, transforms 22 miles of the upper Flathead River into a lake-like slough for four months of the year. This has caused sediment deposition to increase seasonally in the upper portion of the reach and shoreline erosion to increase along the entire reach (FERC 2000).

Flathead Lake[4]

Flathead Lake water is used for power production, flood control, recreation, and irrigation. Prior to construction of Kerr Dam, under a natural hydrologic regime, water levels increased in late winter or early spring from snowmelt and reached maximum water levels in late spring or early summer and minimum water levels (2,882 feet) in fall that were maintained until the next snow melt. Kerr dam raised the lake level to 2,893 and caused significant changes in seasonal fluctuations of Flathead Lake levels from natural conditions. Recent relicensing requirements require changes in the dam release pattern. They require the Kerr Project to hold the lake near full pool (2,893 feet) from June through August, and then draft the lake from September through March. Under terms of Article 43 of the current Kerr Project license, the lake reaches minimum pool by April 15, then refills rapidly with spring runoff. The article requires the lake level to be at 2,890 feet by May 30 and 2,893 feet (full pool) by June 15. The lake is usually held at this level until September (FERC 2000). Changes in operations designed to address drought issues were implemented informally in 2002. A drought management plan affecting lake levels during drought years will be adopted in the future.

Operation of the Kerr Project[5] shifts the summer littoral zone of the lake upward from the zone below 2,883 feet, into the zone below 2,893 feet. The littoral zone is wetted into the fall, then drawdown exposes the area through the

[4] *The discussion of historic impacts on the lake and river related to the operations of Kerr Dam are from FERC (1996).*

[5] *This description of Kerr Project effects on Flathead Lake is excerpted from FERC (2000).*

winter. As the lake waters recede during the fall and winter, fine-grained substrate is scoured from above 2,883 feet and deposited into the zone below 2,883 feet (Woessner et al. 1985). Shoreline erosion, intensified by wave action during the strong summer and fall storms when the lake level is high, steepens beach profiles. Sediments are accumulating below 2,883 feet along much of the shoreline, especially in protected coves and bays. Beach widths between 2,893 and 2,883 feet are narrowing (CSKT et al. 1989). Substrate composition in gravel/cobble beach areas is altered by erosion and deposition processes associated with dam operations. Changes in substrate composition bring about shifts in benthic invertebrate communities and productivity (FERC 2000).

LINKS

Stanford and Ellis (2002) give a concise description of Flathead Lake limnology, see Appendix 19

Click Here

For maps showing road densities throughout the subbasin see Appendix 75.

Click Here

Under historic Kerr operations, the higher lake levels during summer and early fall caused erosion along the lake shoreline and along the banks of the upper Flathead River as far north as its confluence with the Stillwater River (FERC 1996). The higher levels were most pronounced along the north shore of the lake between 1938 and 1946. The erosion that occurred after that period is attributed to fall and winter storm waves during periods of higher lake levels that lasted longer than would have occurred naturally (FERC 1996). At least one other factor—the capture of sediment by Hungry Horse Dam, which reduced the sediment load to Flathead Lake —is thought to have contributed to the erosion of the north shore and the Flathead River delta (FERC 1996). Under Article 68 of the Kerr Project License, modified in 1998, the licensee of Kerr Dam, Pacific Power and Light Montana (PPLM), is required to construct an erosion control project that is expected to result in decreased levels of shoreline erosion along a section of the north shore of Flathead Lake (FERC 2000).

Lower Flathead River

Prior to the implementation of Article 55 of the current license, Kerr Dam was operated as a load control and peaking power facility. The dam held back spring flows, decreased peak discharges during the spring and summer, and increased peak discharges in the fall and winter, as compared to a natural hydrograph. Daily fluctuations in flows due to project peaking operations occurred year-round. The hourly and daily discharges in the lower Flathead River were highly variable. Mean daily discharge outside the spring runoff period generally fluctuated between 7,062 cfs and 8,827 cfs, but daily maximum and minimum discharges often ranged from 3,210 cfs to 13,415 cfs (FERC 2000). Water level fluctuations of 2 to 8 feet within 3 hours were recorded at Polson (Mack et al. 1990). Approximately 45 miles farther downstream, near the town of Dixon, water level fluctuations were less pronounced, varying up to 1 foot within 6 hours. Although hourly fluctuations of dam releases were attenuated downstream, daily flow fluctuations occurred 59 miles downstream from Kerr dam at the USGS Perma gage. The mean daily discharge fluctuated approximately 2,000 cfs for all seasons at Perma (Mack et al. 1990). Flow instability, measured by the frequency of flow reversals in tributary streams of the lower Flathead River, was strongly evident during all months under historic Kerr Project operations (Mack et al. 1990).

Winter flows increased the amount of winter ice scouring in the lower river, causing accelerated erosion, turbidity, and stream bank destabilization (Mack et al. 1990).

Under current operations (Article 55 of the license), the dam is operated as a base-load facility. Load-following or peak power generation are precluded. Base-load operations have stabilized flows and more closely approximate the natural flow regime (Les Evarts, CSKT, pers. comm. 2003)

2.1.3 Presettlement Aquatic Habitat Condition[6]

Prior to dam construction, the Flathead River and its tributaries flowed freely. The natural hydraulic cycle in the headwaters of the Columbia River included a high-flow event during the spring melt (late May through early June) and relatively constant, low flows throughout the remainder of the year (Marotz et al. 2002). Waters were cold and clean and stream substrates consisted of clean, stable, and permeable gravels. Non-native species were absent. It is possible, even likely that during presettlement times there was a fish barrier to upstream fish movement in the form of an impassible rapid located at the current site of Kerr Dam. It is also thought that for some cold water species such as bull trout, downstream passage of fish from Flathead Lake was unlikely at least seasonally because of the high temperatures of the outflow waters that originate from the epilimnion of Flathead Lake (USFWS 2004).

Much of the historical habitat complexity of streams in the subbasin was associated with natural accumulations of large woody debris and areas of groundwater upwelling. These and other key habitat elements would have been in optimal condition. There were pulses of sediment associated with natural disturbances, but the magnitude and frequency would have been within the natural range of variability.

Beavers altered the environment by building dams on river channels, perennial and intermittent streams, and ponds, and these dams created an aquatic environment that sustained a rich community of companion species including

[6] *Presettlement conditions are defined as the state of the environment at the time of European settlement or 1850.*

insects, fish, amphibians, waterfowl, herons, mink, muskrat, otters, and many types of aquatic vegetation. The dams helped to regulate runoff in watersheds and buffered the downstream transport of organic matter, nutrients, and sediment. They were a way to store water in river systems without disrupting watershed connectivity (Swan Ecosystem Center 2002).

Mainstem river flows during the low-flow period were relatively stable, and the portion of channel affected by flow fluctuation (varial zone) was a narrow band along the shoreline.

In a natural river environment, the near-shore habitat provides food and security cover critical to fish. High springtime river flows flushed fine sediments from river gravels creating interstitial habitat for insects and improving conditions for fish spawning. High flows defined the channels and removed deltas that form at tributary mouths, creating a healthy environment for fish and their food organisms. Fine sediments were deposited on the river margins providing a fertile medium for water tolerant plants. Riparian vegetation withstood annual flooding or reestablished seasonally, providing secure habitat along river margins and reducing erosion of silt into the river. Fluctuating or abnormally frequent high discharges disrupt this natural floodplain process. (Marotz et al. 2002)

As part of its Section 7 Consultation on bull trout, the Flathead National Forest (USFS 2000) described pre-European conditions for bull trout as optimal. They state that the natural erosional processes that occurred in these drainages created pulse disturbances that resident salmonids evolved with. They assume that if catastrophic events occurred in one drainage, bull trout from an adjacent drainage would recolonize it (Rieman et al. 1993).

LINKS

For a discussion of the importance of woody debris and groundwater upwellings to aquatic habitat, see Appendix 18.

Click Here

The QHA assessment estimates presettlement (reference) conditions for eleven stream and thirteen lake habitat attributes at the 6th-code HUC scale. Go to Appendix 26.

Click Here

2.1.4 Present Aquatic Habitat Conditions

Headwaters

While headwater areas across large parts of the subbasin (Glacier Park and wilderness and roadless areas) remain relatively pristine, aquatic habitats in the headwaters of roaded portions of the subbasin have been impacted to varying degrees by the cumulative effects of logging, road building, dams, grazing, irrigation and cropland agriculture, and urban and suburban development. The magnitude and persistence of these impacts varies widely.

One of the chief impacts has been an increase in the amount of fine sediments entering streams. Fine sediments accumulating in spawning substrates reduce egg-to-fry survival. In some areas sedimentation has reduced natural

LINKS

For a general discussion of how reservoir storage and dam operations affect aquatic habitats, see Appendix 18.

Click Here

reproduction to the point that it is insufficient to fully seed available rearing habitat with juvenile fish. Pools and rearing habitat have become clogged with sediment, reducing the productive capacity of the stream. Sediment has also killed aquatic insects and algae. All of these changes have affected the food base for the many wildlife species that feed on aquatic organisms (CSKT 2001).

Tables 2.1 and 2.2 summarize the sources and causes of impairment on water-quality impaired streams[7] in Flathead County[8], which is probably generally representative of the sources and causes of aquatic habitat impairment across the subbasin when viewed on a broad scale (that is, percentages would not reflect the situation on specific reaches or individual streams). Note that in these two tables, causes and sources, while related, are not linked.

Past forestry practices (road construction, log skidding, riparian tree harvest, clear-cutting, and splash dams) have increased sediment in streams, increased peak flows, caused hydrograph and thermal modifications, and

Table 2.1. Sources of impairment on impaired streams in Flathead County.

Source of Impairment	% of Miles Impaired by all Sources
Siltation	20.1%
Nutrients	11.2%
Nitrate	5.7%
Phosphorus	5.7%
Bank erosion	5.2%
Flow alteration	4.9%
Fish habitat degradation	3.1%
Metals	3.1%
Nitrogen	3.1%
Oil and grease	3.1%
PCB's	3.1%
Priority organics	3.1%
Thermal modifications	3.1%
Suspended solids	2.4%
Dewatering	1.7%
Riparian degradation	1.0%
Other habitat alterations	20.6%

[7] *Identified by the State as waters where quality is impaired (does not fully meet standards) or threatened (is likely to violate standards in the near future) defined by Section 303(d) of the federal Clean Water Act. The state list includes information on the beneficial uses the water is required to support, including aquatic life support and coldwater fishery. The database does not include Flathead Reservation or Glacier National Park waters. For equivalent data for the Flathead Reservation, see Makepace 2000.*

[8] *Flathead County includes the following watersheds: 17010206 North Fork Flathead; 17010207 Middle Fork Flathead; 17010208 Flathead Lak; 17010209 South Fork Flathead; and 17010210 Stillwater.*

Table 2.2. Causes of impairment on impaired streams in Flathead County.

Cause of Impairment	% of Miles Impaired by all Causes
Silviculture	26.22%
Habitat Modification (other than Hydromodification)	12.90%
Construction	12.38%
Land Development	11.04%
Urban Runoff/Storm Sewers	11.04%
Removal of Riparian Vegetation	7.18%
Bank or Shoreline Modification/Destabilization	5.72%
Logging Road Construction/Maintenance	4.18%
Industrial Point Sources	3.86%
Agriculture	2.56%
Highway/Road/Bridge Construction	1.34%
Hydromodification	0.83%
Source Unknown	0.39%
Grazing related Sources	0.37%

contributed to the loss of instream woody debris and channel stability. Although the heaviest timber harvest occurred in the 1960s and 1970s, past forest practices continue to impact aquatic habitats because of the remaining road systems, increased water yields, and increased efficiency of water delivery to the streams that results in changes in the runoff timing (USFWS 2002a). In the early 1990s, impaired water quality as a result of silvicultural activities was identified in 202 miles of 17 streams in the Flathead River drainage (MDHES 1994). Many problems result from road systems around Hungry Horse Reservoir (MBTSG 1995d). Logging access roads up most of the major tributaries on the managed lands are located in the riparian zone (USFWS 2002a). Riparian and adjacent timber harvest have affected stream channel and streambank cover, stability, and integrity on streams in the Swan River drainage as well.

Over the last decade, the population of Flathead County grew by 25.8 percent, placing it among the fastest growing counties in Montana (US Census Data 2003). The population of the Swan River Valley is also among the fastest growing in the state. Requests for State 310 permits to alter the bed and/or immediate banks of streams in the drainage are increasing. Private land in the drainage is concentrated along the Swan River and the lower portions of the tributary drainages. These reaches provide critical migratory corridors and rearing habitat for bull trout (USFWS 2002a). Additional residential development of

LINKS

For the list of surface waters included in the state water quality assessment database go to the DEQ website.

Click Here

Appendix 20 summarizes the information in the state water quality assessment database for Flathead and Lake Counties, excluding the Flathead Reservation and Glacier Park.

Click Here

For summaries of hydrologic data that show daily flow values, pre and post-dam comparative hydrograph charts, pre and post-dam flow duration charts, and pre and post-dam peak flow values charts for any one of eleven USGS gaging stations in the subbasin, go to Appendix 61.

Click Here

The QHA assessment estimates current conditions for eleven stream and thirteen lake habitat attributes at the 6th-code HUC scale. Go to Appendix 26.

Click Here

corporate timberlands is expected in the future, although Plum Creek Timber Company's Habitat Conservation Plan should help to minimize the impacts (USFWS et al. 2000). Domestic sewage from residential developments on tributaries and changes to stream morphology caused by building in the floodplain could reduce the quality of aquatic habitats (USFWS 2002a). Ski area development is expanding into the headwater areas of Big Creek. Big Creek is an important bull trout spawning stream in the North Fork Flathead River drainage (MBTSG 1995c). Downhill ski areas create permanent clearcuts that have the potential to increase sediment loads and water yields and to change hydrologic patterns (USFWS 2002a).

In some streams, human-caused barriers such as road culverts, dewatered stream reaches, and irrigation diversions have blocked fish migrations. For example, many tributaries to Hungry Horse Reservoir (e.g., Felix, Harris, Murray, and Riverside Creeks) in the South Fork of the Flathead River drainage have been blocked by impassable culverts (MBTSG 1995d). In most instances the blockages were on streams that are potential spawning habitat for westslope cutthroat trout or mountain whitefish, and that are used by bull trout, especially for juvenile rearing. Projects to correct passage barriers on some streams have been successfully completed (Knotek et al. 1997) and fish have begun utilizing areas upstream of former blockages (Bull Trout Recovery Plan).

LINKS

Appendix 21 shows stream passage barriers (streams that have blockages to fish passage).

Click Here

Another major impact, perhaps the most significant single impact, on headwater aquatic habitats has been the introduction of non-native species. Non-native species now threaten the diversity and abundance of native species and the ecological stability of ecosystems in many areas of the subbasin. For example in the South Fork of the Flathead, MFWP file records indicate that as early as 1957 fish managers had identified sources of rainbow trout and Yellowstone cutthroat trout in the Graves Creek drainage, and as early as 1965 they had identified unknown sources of rainbow trout in the Big Salmon drainage and were concerned with the potential impacts that hybridization could have on the westslope cutthroat trout populations throughout the South Fork Flathead River drainage (MFWP 1965; MFWP 1957). There is little historical information detailing the stocking of rainbow trout in these areas. However, based on the practices of the times, it is believed that fish stocking in these drainages was unauthorized, or unrecorded during public fish distribution programs. Public distribution of fish actually began to be an issue as early as the late 1890s, when the railroad connected the Flathead Subbasin with the Eastern U.S. The U.S. Bureau of Sport Fisheries had rail cars specifically designed to transport fish, and the Great Northern railroad had an active program of providing fish for stocking of public and private waters, especially in Glacier National Park. Westslope cutthroat trout conservation in Montana became more active around 1980, and in 1983 MFWP commissioned a status review of westslope cutthroat trout west of the continental divide in which the South Fork Flathead River drainage was described as the largest and most secure stronghold for the species in Montana (Liknes 1984). The status review described the primary threat to the South Fork Flathead populations as hybridization with non-native trouts. This threat was defined as especially predictable in drainages with a lake in the headwaters. Many of the lakes had been historically stocked with non-native trout that have since been escaping downstream. By 1988 (Liknes and Graham), the westslope cutthroat trout was believed to exist in only 2.5 percent of its historic range. In 1999, Montana Fish, Wildlife & Parks (MFWP) began a program, which is ongoing, aimed at conserving the genetically pure populations of westslope cutthroat trout in the South Fork Flathead River drainage. The objective of this program is to eliminate all of the non-native and hybrid trout that threaten the genetically pure westslope cutthroat populations in the South Fork Flathead (for a description of the program, see Appendix 74).

LINKS

For more information on the South Fork Flathead Watershed Westslope Cutthroat Trout Conservation Program, also known as the Mountain Lakes Program, go to Appendix 74.

Click Here

The removal of riparian vegetation, especially trees and overhanging shrubs, has changed stream water temperatures, making the water warmer in the summer and colder in the winter. These changes have interfered with fish spawning and generally degraded the quality of stream habitats for native fish and other aquatic life. This has affected the food base for the many wildlife species that feed on aquatic organisms (CSKT 2001).

Habitat conditions in specific headwater reaches, including the distribution of non-natives, are assessed later in this document.

North Fork of the Flathead River

The Canadian and U.S. portions of the North Fork of the Flathead meanders across a floodplain from 0.3 to 0.6 mile in width that supports a complex mix of river and back channel habitats and beaver dam systems that are rich in terms of both aquatic and associated riparian habitat values and play a critical role in riverine ecological function (Jamieson 2002). The North Fork is one of the few remaining, fully functional alluvial floodplain systems in the Columbia River Basin (Jamieson 2002). It supports gravel-dwelling aquatic insects that are often found in well oxygenated gravels up to half a mile from the river channel and a diverse community of stone fly species, part of a substantial and complex benthic community made up of a wide range of organisms that occur in subsurface, river channel, springbrook, wetland, bog and beaver pond habitat types found in alluvial floodplain systems (Jamieson 2002). Aquatic habitats are similar in much of the Middle Fork of the Flathead and the South Fork of the Flathead above Hungry Horse Dam.

LINKS

Appendix 81 is a stream inventory of the B.C. portion of the North Fork of the Flathead conducted in the 1970s.

Click Here

Appendix 82 presents a history of the North Fork of the Flathead as of 1976 from the Canadian perspective.

Click Here

South Fork Below Hungry Horse and Upper Mainstem

Generally speaking, habitat-forming processes affected by reservoir elevations and river flows include erosion and sediment deposition, nutrient cycling and plant succession. Under natural flow conditions, flushing flows sort bottom sediments, creating unembedded cobbles that benefit benthic insect production and fish security cover. Fine sediments are deposited along the river margins and on the tails of islands, providing nutrients and soils for riparian vegetation. Unnatural flow fluctuations disrupt these habitat-forming processes, resulting in a larger varial zone that is biologically unproductive (Hauer et al. 1994). Fine sediments that would normally become stabilized by shoreline vegetation are more easily eroded into the river channel.

When Hungry Horse Reservoir filled, 77 miles of high quality stream habitat was lost, resulting in an estimated minimum annual loss of 65,000 westslope cutthroat trout and 250,000 bull trout (MFWP and CSKT 1991). (The Hungry Horse loss statement (MFWP and CSKT 1991) also identified lost annual production of 100,000 kokanee adults in Flathead Lake to partially replace lost forage for lake trout in Flathead Lake.) Excessive Hungry Horse Reservoir drawdowns now expose vast expanses of reservoir bottom to drying, thus killing aquatic insects, which are the primary spring food supply. Reduced reservoir pool volume impacts all aquatic trophic levels due to the diminished size of the aquatic environment. During summer, reservoir drawdown reduces the availability of terrestrial insects for fish prey because fewer insects are trapped on the diminished surface area. Impoundment by Hungry Horse Dam and the removal of riparian vegetation altered the annual temperature cycle in the river. These changes have affected the food base for the many wildlife species that feed on aquatic organisms (CSKT 2001).

Power production and flood control operations of Hungry Horse Dam have essentially reversed the annual hydrograph, resulting in storing water derived from spring runoff and releasing it during the fall and winter months when flows were historically low. In addition to creating an exposed unproductive varial zone, short-term sporadic releases in the tailwater have resulted in higher substrate embeddedness, and a less diverse and productive aquatic invertebrate community (Hauer et al. 1994). Reduction in natural spring freshets due to flood control has reduced the hydraulic energy needed to maintain the river channel and periodically resort river gravels. Collapsing river banks caused by intermittent flow fluctuation and lack of flushing flows have resulted in sediment buildup in the river cobbles, which is detrimental to insect production, fish food availability, and security cover (Brian Marotz, Montana Fish, Wildlife & Parks, 2003, pers. comm.).

Hungry Horse Dam was originally designed with 4 turbine penstocks located 241 feet below full pool. Water discharge from this depth into the South

Fork Flathead River remained about 39 - 43 °F year round, Occasionally, surface water as warm as 68 °F was also released as spill. Thermal effects included short-term fluctuations of up to 14.9 °F and a gross reduction in annual accumulation of degree days. Rapid thermal spikes corresponded with sudden changes in discharge volume. Seasonal perturbations were typified by summer cooling and winter warming. These unnatural thermal conditions affected invertebrate (Hauer et al. 1994) and fish communities in the 45 miles of the South Fork and main stem Flathead River downstream of Hungry Horse Dam. In August 1995, selective withdrawal structures became operational on Hungry Horse Dam (Christenson et al. 1996). These structures were designed to allow thermally selective release of reservoir water and restore a more natural temperature regime to the Flathead River downstream. Operation of selective withdrawal returned a more normative thermal regime to the Flathead River upstream of Flathead Lake. Temperatures at Columbia Falls now closely parallel natural temperatures measured in the unregulated reach just upstream of the South Fork confluence. Return of normative river temperatures should increase diversity and abundance of certain groups of macroinvertebrates. It is also expected that warmer river temperatures will increase (or alter) the availability of macroinvertebrate forage for fish (Marotz 2002; Deleray et al. 1999).

Impoundment has also greatly benefited the native northern pikeminnow and peamouth chub to the extent that these species now compete with or prey upon aquatic species of special concern for both food and space (CSKT 2001).

Flathead Lake

Flathead Lake, a relatively cold and unproductive lake, has better water quality than most large lakes in the world (Stanford 1998). Stanford describes many of the streams feeding it as pristine, but has also chronicled a long-term decrease in water quality, which he attributes to human nutrient inputs (Stanford 1998). In his 1998 State of the Lake Report, Stanford describes a 15 percent decrease in the amount of phosphorus reaching the lake from sewage treatment systems over the preceding decade, which he attributed to the upgrading of municipal sewage systems. The increasing human population of Flathead and Lake counties has led to an increase in lake eutrophication of other large natural lakes within the Flathead Subbasin (Flathead Basin Commission 1999).

The Biological Assessment of the Kerr Project License, Operations and Proposed Amendment Application (FERC 2000) discusses changes to littoral habitats caused by the Kerr Project. The paragraphs that follow are adapted from that document.

Effects of changes in littoral habitat caused by the Kerr Project on macroinvertebrate production along the shoreline of Flathead Lake have not been quantified because little information exists on macroinvertebrates prior to dam construction. However, based on studies of other reservoirs, it is reasonable to assume that macroinvertebrate production was negatively affected by: (1) substrate instability above 2,883 feet; (2) sedimentation below 2,883 feet; and (3) fall, winter, and spring exposure of the zone between 2,883 feet and 2,893 feet (CSKT et al. 1989). Invertebrate production was reduced in the drawdown zones of Libby and Hungry Horse Reservoirs (May et al. 1988) where seasonal patterns of operation are similar (i.e., fall and winter drawdown). Grimas (1962) reported that regulation in southern Norway reduced many fish food organisms (e.g. Trichoptera and Ephemeroptera) that normally occupied the littoral region of lakes. Chironomids and oligochaetes, in contrast, were favored by regulation.

Kerr Project operations have also caused winter dewatering of preferred shoreline spawning areas for salmonids and degradation of deep spawning habitat (below elevation 2,883) by distribution of fine sediments (a consequence of shoreline erosion during the extended full-pool period) (CSKT 2001). Alteration of the natural littoral habitat and macroinvertebrate communities along the shoreline have affected bull and westslope cutthroat trout rearing in Flathead Lake. Feeding ecology and rearing habitat for younger fish were probably most affected. Estimates of losses of these species are difficult to make because estimates of their abundance either before or after the construction of the Kerr Project are not available. However, it is reasonable to assume that juvenile fish were reduced by changes in the natural littoral habitat, water level fluctuations, winter exposure in the new littoral area, and changes in invertebrate food caused by the Kerr Project (CSKT et al. 1989). In particular, changes in invertebrate distribution, community composition, and production are associated with substrate instability and changes in substrate size composition (Grimas 1962).

Reduction in the productivity of aquatic and terrestrial insects would directly affect westslope cutthroat trout. Terrestrial insects and adult or pre-emergent aquatic insects are the principal food item of westslope cutthroat trout in Flathead Lake during most seasons of the year (Leathe and Graham 1982). Therefore, operation of the Kerr Project has the potential to reduce the food base for westslope cutthroat trout in Flathead Lake.

The introduction of opossum shrimp (*Mysis relicta*) into the Flathead system has had serious repercussions on the Flathead Lake ecosystem. The introduction of kokanee salmon, lake whitefish, and lake trout into Flathead Lake have had significant adverse effects on native bull and westslope cutthroat trout (Subbasin Summary).

Shallow bays, which were emergent marshes during much of the year, are now either dry mudflats or inundated shallow areas, depending upon the time of year. This has eliminated habitat for some species (CSKT 2001).

Montana Department of Environmental Quality (MTDEQ 2001) discusses other habitat conditions in Flathead Lake. The following discussion is adapted from that document.

The fish community in Flathead Lake, the Flathead River and tributaries originally included ten native species with bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhyncus clarki lewisi*) as the dominant species in the upper trophic level of the lake ecosystem. At least eleven non-native fish species have been legally or illegally introduced into the system since the late 19th century. The intentional introduction of non-native fish, coupled with the accidental introduction of the non-native opossum shrimp (*Mysis relicta*) in Flathead Lake (first discovered in 1981) have caused widespread changes in the lake's food web and ecosystem (Spencer et al. 1991). Lake trout are now the dominant predator fish species in the lake. The kokanee salmon population, which flourished through the late 1980s, has now crashed largely as a result of cascading food web interactions triggered by the introduction of opossum shrimp in combination with lake trout and lake whitefish, and efforts are now underway to restore the depleted bull trout and westslope cutthroat trout fishery. The native Flathead Lake fishery is dependent on natural reproduction and recruitment from the tributary system above the lake. The lake and stream systems are dependent upon one another to provide the necessary environment for the sustenance of the fishery.

LINKS

For more information on water quality in Flathead Lake and the type, magnitude, and location of sources of nutrient loading, go to Appendix 22.

Click Here

Algal production in Flathead Lake is co-limited by low availability of both nitrogen and phosphorus, at least during the summer stratification period (Stanford et al. 1997; Spencer and Ellis 1990). Since 1977 when the Flathead Lake Biological Station (FLBS) began focused water quality monitoring, open-water primary production (i.e., the rate of formation of organic plant material such as algae) has steadily increased. The FLBS long-term data bases show that production and standing crops of algae in the water column are influenced by the rate and timing of inputs of bioavailable nitrogen and phosphorus from the tributary watershed, including the lake shoreline and bulk precipitation on the lake surface (Stanford et al. 1997). Interannual variation in these data are high, due to year-to-year differences in temperature, light, mixing of the water column, internal nutrient cycling, water flux through the lake (e.g., as influenced by climate and operations of Kerr and Hungry Horse Dam) (Stanford and Hauer 1992), external nutrient loading and cascading effects associated with food web changes largely mediated by the population dynamics of *Mysis relicta*. The food web changes introduced significant variation into the expected relationship between primary production and nutrient loading. Nonetheless, primary productivity is at least partially linked to the nutrient load reaching Flathead Lake annually after the *Mysis*-mediated food web cascade stabilized (1989 to present).

LINKS

Environmental baseline conditions for bull trout are discussed at the HUC-6 and HUC-5 scale for the North, Middle, and South Forks of the Flathead and for the Stillwater drainage in Appendices 23, 24, and 25.

Click Here

The Flathead Subbasin Aquatic Technical Team scored aquatic habitat attributes at the HUC-6 scale for streams and selected lakes. The results are presented in Appendix 26.

Click Here

Profuse mats of algae have been observed along shoreline rubble adjacent to groundwater seeps and isolated portions of the lake (Hauer 1988). As with primary productivity, shoreline periphyton is also responsive to changes in nutrient availability. However, sufficient time series data for periphyton biomass and productivity does not currently exist to link shoreline scums to external nutrient loading. Short term studies show that Flathead Lake periphyton increases sharply if nutrients, especially phosphorus, are added. Shoreline surveys and previous work by Hauer (1988) clearly link localized scums to shoreline pollution sources. While it can be concluded that periphyton is also a robust indicator of water quality, insufficient monitoring data exists to establish a relationship to annual nutrient load.

Most years the lake appears very clear in late summer and fall because the water column is not producing a high biomass of algae; and, sediments from spring runoff have settled to the lake bottom. However, especially on wet years when external nutrient loading is high during summer, the pollution alga, *Anabaena flos-aquae*, has bloomed lake-wide (e.g., 1983 and 1993). In lakes worldwide, *Anabaena* blooms and oxygen depletion during stratification are very well documented indicators of water quality deterioration associated with excess nutrient loading. Water quality in Flathead Lake remains on or near a threshold with respect to nutrient loading and resulting water quality measured in terms of algal production and associated water clarity (Stanford et al., 1997).

Lower Flathead Valley

Historically, changes in the annual hydrograph for the lower Flathead River from the operations of Kerr Dam caused the normally vegetated varial zone to become abnormally inundated. As a result, the area between the high and low water levels has become a largely unvegetated varial zone dominated by mud and rock (CSKT 2000b). In addition, regulated flows have reduced the hydraulic energy needed to maintain the river channel and periodically resort river gravels. The lack of flushing flows has resulted in sediment buildup in the river cobbles. Under current operations, Kerr Dam is operated as a base-load facility, and load-following and peak-power generation are precluded. Base-load operations have stabilized flows and much more closely approximate the natural flow regime. These changes are expected to substantially improve habitat conditions for aquatic species on the lower Flathead River (Les Evarts, CSKT, Pers. Comm. 2003).

Northern pike, smallmouth bass, largemouth bass, rainbow trout and brown trout have impacted native aquatic species in the river, and bullfrogs have displaced native chorus frogs and spotted frogs (Les Evarts and Art Soukkala, CSKT, Pers. Comm. 2003).

The Jocko River, which flows west from the Mission Mountains and joins the lower Flathead River near Dixon, drains an area of 167400 acres, with approximately 12 percent of the drainage under irrigation (CSKT 2000a). Water quality in the headwater portion of the drainage is impacted by logging, road building, and increasing residential development within the floodplain. Prior to 1986, that portion of the Jocko below Big Knife Creek was dewatered for irrigation. Downstream of Arlee, two streams enter the Jocko, and seasonally, they introduce a considerable amount of sediment. The lower Jocko flows through hay and pasture lands and is channelized and heavily riprapped (DosSantos 1988).

Other tributaries—Post Creek, Mission Creek, North, Middle, and South Crow Creeks, and Crow Creek—are impacted to varying degrees by irrigation dams, irrigation return flows, heavy grazing of riparian zones and stream banks, feedlot runoff, discharges from sewage lagoons, and urban stormwater runoff. Currently, some stream flows are maintained year-round according to an agreement between the Tribes and FIIP (DosSantos 1988).

The Little Bitterroot emerges from Hubbart Reservoir north of the Reservation boundary. Flows are intercepted and diverted into an irrigation canal. The remaining flow continues south through the arid Camas Prairie and Little Bitterroot Valley, cutting through generally heavy, poorly-drained, erosive, alkaline soils. Tributaries contribute hard-rock mine runoff and sediment to the river. Low rainfall and heavy riparian grazing have limited vegetation cover and aggravated serious erosion problems throughout the drainage. Consequently, the river is turbid year-round and contributes considerable sediment to the lower Flathead River (DosSantos 1988).

2.1.5 Potential Aquatic Habitat Condition[9]

Under this scenario, Hungry Horse Dam would be operated consistent with the variable flood control strategy (VARQ) and Integrated Rule Curves (IRC), which would restore and maintain normative hydrologic conditions (conditions that mimic natural processes and minimize impacts on fish and wildlife). Reservoir refill would promote biological productivity in the reservoirs, and downstream there would be a gradual ramping down of river flows after the spring runoff to maintain stable discharges, especially during the biologically productive summer months. Varial zones below and above the dam will have been restored to the maximum extent possible.

Self-supporting native fish populations will have been protected or reestablished in areas where their habitat had been maintained or restored.

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[9] *The potential condition is defined as the desired end state or optimal condition for this subbasin in the year 2050.*

Wherever possible, reestablishment will have been accomplished through natural colonization. Where wild stocks had been extirpated, appropriate source populations will have been established through imprint planting of genetically compatible eyed eggs or fry.

Passage to migratory fish will have been reestablished in all tributaries blocked by human-caused barriers, except those that are preventing introgression by non-native species. Fine sediments will have been reduced in critical spawning areas (this will have been achieved through better compliance with existing habitat-protection laws, lowering forest road densities, the implementation of stream bank stabilization measures and riparian restoration projects, and in extreme cases, by agitating embedded gravels to remove silts and fine sands in areas where needed). Normative surface-water runoff patterns will have been restored in upland areas using the best management practices and habitat improvement measures. Natural stream channel function and form will have been restored using techniques such as bank stabilization, streambank and riparian revegetation, riparian fencing, in-stream channel habitat structures. For example, the natural frequency of pools on disturbed streams will have been returned to that of undisturbed referenced reaches by placing large rocks and woody debris in the channel to restore the appropriate channel morphometry.

Non-native or hybridized populations will have been eradicated where possible, and suppressed where eradication is not possible. Wherever necessary, native populations in headwater areas will have been protected from non-natives through the installation of barriers to upstream invasion by non-native species. Negative non-native species interactions in Flathead Lake will have been substantially reduced.

TMDL goals for reduction in phosphorus will have been reached for Flathead Lake, and the trophic status of all classified lakes will have been protected. Other water-quality impaired streams and lakes will have been restored.

Ecologically significant wetland and riparian habitats will have been protected, restored, and enhanced through acquisition, conservation easements, and restoration projects. This will have resulted in water temperatures that are more within the tolerance range of native fish species.

2.1.6 Future/No New Action Aquatic Habitat Condition[10]

Under this scenario, headwater aquatic habitats in protected areas will have remained relatively pristine, but aquatic habitats in headwater reaches of other

[10] *The future/no new action condition is the state of the environment in 2050 assuming that current trends and current management continues.*

parts of the subbasin will have continued to decline to varying degrees by the cumulative effects of a variety of human activities. The magnitude and persistence of the impacts will vary depending on the type and degree of disturbance. The amount of fine sediments entering streams will have increased slightly and continue to impair the natural reproduction of native fish and reduce the productive capacity of streams. The miles of water-quality-impaired stream segments and lakes will have increased due to impacts from silviculture, habitat modification, construction, land development, urban runoff and storm sewers, removal of riparian vegetation, bank and shoreline modification and destabilization, logging-road construction and maintenance, industrial point sources, and agriculture. In addition to increasing fine sediments in streams, silvicultural practices will have increased peak flows, increase affects on stream temperatures, and reduce woody debris and channel stability.

Thousands of acres of corporate (Plum Creek) timberlands will have been sold and developed as residential property. Between 2004 and 2050, the population of Flathead and Lake Counties will have grown at a rate of 20 to 25 percent per decade, which means by 2050, the population would be over 240,000 (up from the current 101,000). Many if not most of these people will have chosen to live in scenic rural areas rather than within cities and towns. Many will have built along streams, altering the bed or banks. Domestic sewage from these developments and changes to stream morphology caused by building in floodplains will have substantially reduced the quality of aquatic habitats from their current (2003) conditions. Ski area and other recreational developments, especially around Flathead Lake and Whitefish, will have expanded to serve the larger populations. Thousands of acres of riparian areas will have been converted to other uses, potentially altering water temperatures in streams.

At the same time, projects to remove fish passage barriers on streams will have been successfully completed on most blocked streams. Restoration projects will have improved habitats on a number of streams and acquisitions will have protected other areas, however these efforts will have been out paced by impacts caused by residential developments and other human disturbances.

Illegal and unintentional introductions of non-native fish species will have continued, and existing populations of non-natives will have expanded and grown. As a consequence, non-native species will have reduced the diversity and abundance of native species and disturbed the ecological stability of ecosystems.

Hungry Horse Dam will be operated consistent with the variable flood control strategy (VARQ) and Integrated Rule Curves (IRC), which will have restored and maintained normative hydrologic conditions (conditions that mimic natural processes and minimize impacts on fish and wildlife). Reservoir refill will have promoted biological productivity in the reservoirs, and downstream, there will have been a gradual ramp-down of river flows after the spring runoff to maintain stable discharges, especially during the biologically productive summer months. Varial zones below and above dams will have been restored to the maximum extent possible.

Kerr Dam, will have continued to operate under the conditions of the existing Kerr License, and current impacts on the Flathead Lake and the mainstem of the Flathead River above and below Kerr Dam will have continued.

The steadily increasing human population of Flathead and Lake Counties will have worsened lake eutrophication of large natural lakes, including Flathead Lake. Algal production in Flathead Lake will have increased.

In the lower Flathead River, populations of non-natives such as northern pike, smallmouth bass, and bull frogs will have increased at the expense of native species. The impacts on tributaries from irrigation dams, irrigation return flows, heavy grazing of riparian zones and stream banks, feedlot runoff, discharges from sewage lagoons, and urban stormwater runoff will have substantially degraded habitats on the lower Flathead River and its tributaries to the point that the populations of some native species may be extirpated or significantly reduced.

2.2 Riparian and Wetland Systems

2.2.1 Critical Riparian and Wetland Functional Processes[11]

Floodplains and the riparian vegetation they support are a product of floods and sediment dynamics interacting with forest succession. On natural functioning floodplains, rivers regularly leave their beds and cut new channels, leaving behind exposed gravel bars, sandbars, and old riverbeds, the process continuously altering riparian vegetation. Groundwater flow and recharge play a key role in this process. River water flows into and down slope through aquifers, reemerging on the surface of the floodplain wherever it intersects the water table. The aquifer banks water during floods and discharges it during periods of base flow. In the Flathead Subbasin, most of the base flow comes from groundwater, which has been underground anywhere from days to years. These complex dynamics between the floodplain and surface and groundwater create the constantly changing mosaic of riparian habitats (Stanford and Ellis 2002).

Due to their wet condition, the fire-free interval of riparian areas can be quite long. Indeed, centuries may pass without a stand replacement, severe fire (USFS 1995).

Riparian zones and wetlands perform a number of key ecological functions which include sediment filtering, streambank building, storing water, aquifer recharge, and dissipating stream energy. Healthy riparian vegetation stabilizes stream banks, making them less likely to erode during high flow events; helps control sediment transport; influences bank morphology, provides long-term resistance to channel migration; acts like a sponge to soak up and hold water; and aids in reducing streambank damage from ice, log debris, and animal trampling (Karr and Schlosser 1978; Plats 1979; Marlow and Pogacnik 1985). Streambank stabilization is important because much of the sediment carried by a stream, particularly during high flows, is often the result of bank erosion.

Wetlands function in similar ways. By temporarily storing surface water, wetlands prevent flooding and allow water to soak into the ground or evaporate, which reduces peak water flows by slowing the movement of water into tributary streams and allowing potential floodwaters to reach mainstem rivers over a longer period of time. The water stored in wetlands is released into the ground where it serves to recharge water tables and aquifers, extending the period of stream flows. Wetlands and riparian areas also reduce flood damage by dissipating stream energy. As floodwaters spread across the floodplain, wetland and riparian plants absorb much of the force of the water. (NRCS 1996).

[11] *Portions of this general discussion of riparian system function have been adapted from Hansen et al. (1995).*

SNAPSHOT

Prior to European settlement, ecological functions and processes in riparian and wetland areas were intact. 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, floodplain processes, and vegetative diversity. It has eliminated thermal cover from areas, reduced streambank stability, and reduced vegetative cover and vigor. The result is wider and more open channels with lower, warmer, more turbid summer flows, more extensive ice conditions in winter, and flashier more turbid flows during runoff. Dams have inundated riparian habitats, eliminated flood pulses, changed stream temperatures, and created unvegetated varial zones. This in turn has adversely affected the fish and wildlife populations.

LINKS

For a description of how large rivers in general and the lower Flathead River in particular interact with their floodplains and riparian zones, see Appendix 28.

Click Here

Wetlands also improve water quality by removing nutrients, pesticides, and bacteria from surface waters as they are absorbed or broken down by plants, animals, and chemical processes within the wetland. They filter out sediments and particles suspended in runoff water, preventing lakes, reservoirs, and other resources from being affected by downstream sediment loading, and they enhance the decomposition of organic matter, incorporating nutrients back into the food chain (NRCS 1996).

Riparian and wetland ecosystems are likely the most productive wildlife habitats in the subbasin benefiting the greatest number of species. In western Montana, 59 percent of the land bird species use riparian and wetland habitats for breeding purposes, and 36 percent of those breed only in riparian or wetland areas (Mosconi and Hutto 1982). The influence of riparian areas on wildlife is not limited to species restricted to the riparian zone, upland species benefit as well. A number of Montana's special concern animals use riparian areas for foraging and during migration and local movements. The list includes great blue heron, trumpeter swan, northern goshawk, northern hawk-owl, great gray owl, black-backed woodpecker, and all special concern mammals except northern bog lemming. Predators like the gray wolf, grizzly bear, North American wolverine, and Canada lynx may use riparian areas and wet or mesic meadows during seasonal and annual movements but are not particularly dependent upon them.

Even small changes in the structure and composition of wetland and riparian areas can adversely affect populations of a large number of species, including organisms not directly dependent on these habitats (MFWP 2002). Therefore, the welfare of riparian and wetland areas can have the greatest influence (relative to other parts of the system) over the biological health of watersheds.

Wetlands and riparian areas also provide important habitat to fish. In the Flathead Subbasin as elsewhere in the Columbia Basin, the natural habitat complexity of streams is in large measure due to accumulations of large woody debris, particularly in the alluvial reaches where substratum size is smaller and interstitial cover more limited than in the boulder-dominated channels of high gradient streams (Williams et al. 2000). Along with the bank stability and flow resistance provided by living riparian vegetation, coarse woody debris acts to deflect flows, creating low-velocity flow refugia, scouring deep pools, locally trapping sediments and fine organic material that contributes to aquatic food webs, and providing a diverse and stable habitat mosaic used heavily by many kinds of organisms (Williams et al. 2000).

Riparian vegetation provides shade and thereby helps to maintain the cool summertime water temperatures necessary for native aquatic life, everything from macroinvertebrates to fish (Meehan et al. 1977). It also helps to moderate water temperature extremes. Riparian vegetation filters out nutrients and improves water quality. It produces most of the detritus that provides as much as 90 percent of the organic matter necessary to support stream aquatic communities (Campbell and Franklin 1979). In forested ecosystems, up to 99 percent of the stream energy input may come from bordering riparian vegetation with only 1 percent coming from instream photosynthesis by algae and mosses (Cummins 1974). Most of the food consumed by fish in large rivers, too, often comes from riparian vegetation (Kennedy 1977).

Riparian areas generally respond differently to fire than surrounding upland areas. They may not burn at all, or may not burn as hot or as completely (USFS 1998). Consequently, after major fires, riparian zones in burned areas retain more litter, down material, and live vegetation, which can provide diversity and cover to wildlife and serve to protect sensitive fisheries while watersheds recover. Because of their resistance to fire, riparian and adjacent upland sites tend to develop old growth characteristics and to provide linkages between upland old growth stands (USFS 1998).

Upper Flathead

North of Flathead Lake, as elsewhere, riparian areas play a major role in how the ecosystem functions. For aquatic species such as bull trout and westslope cutthroat trout, riparian trees and shrubs provide overhanging cover and shade, which helps maintain the cool stream temperatures required by these species. Plant roots stabilize banks, thereby controlling erosion and sedimentation. Vegetation contributes leaves, twigs, and insects to stream and lake waters, providing basic food and nutrients to both bull trout and cutthroat trout and the other aquatic organisms they coexist with and depend on. Trees provide woody debris recruitment, which creates pools, riffles, backwaters, small dams, and off-channel habitats that are necessary to fish for cover, spawning, rearing, and protection from predators. Riparian plants, litter layers, and soils filter incoming sediments and pollutants, a process that plays a key role in maintaining the high water quality needed for healthy native fish populations. Riparian areas and floodplains also moderate stream volumes by reducing peak flows during flooding periods and by storing and slowly releasing water into streams during low flows.

Terrestrial species that inhabit the drainages north of Flathead Lake also benefit. For example, riparian areas provide nesting habitat for bald eagles, osprey, Canada geese, waterfowl, upland game birds, great blue herons and double-crested cormorants, among others. They are used by seventy percent of migratory bird species that pass through the subbasin and provide some of the highest quality habitats in Montana for white-tailed deer, beaver, river otter, muskrats, and mink (Flathead Lakers 2002).

Because of the seasonal and inter-annual dynamics of rivers like the North, Middle, and South Forks of the Flathead, riparian habitats are in a constant state of succession, and hence the vegetative mosaic of the valley bottom is forever shifting (Stanford 2000). This dynamic maintains a high level of biological diversity. Among the pioneers of the newly exposed sites are cottonwood, willow, and alder, followed by many of the upland species. Gallery forests of the flood plains are composed of 200-300 year old cottonwoods with an understory of only slightly younger spruce, fir, larch and western red cedar, among an enormous diversity of other plants—over 100 species of vascular plants per 10 m^2 were identified on the Nyack floodplain (Stanford 2000).

Cottonwoods, birch, and aspen enhance biodiversity in riparian areas because they provide cavity nesting sites, open nest sites and opportunities for herbivory that are not available in conifer stands (Jamieson and Braatne 2001; Bunnell et al. 1999). They provide an important habitat element for woodpeckers, including pileated woodpeckers and a wide range of songbirds. Cottonwood recruitment generally requires a decline in river stage immediately following the spring peak in the order of 2.5 cm/day. However, in cases of reaches dominated by fine substrates, seedlings may survive stage declines of up to 3 to 5 cm/day (Rood and Mahoney 2000). Stable or slowly declining summer flows help maintain cottonwood and willow seedlings established earlier in the year (Jamieson and Braatne 2001).

One of the most important functions of the river riparian corridors on these streams is the ecological connectivity they offer. The natural tendency of organisms is to utilize stream corridors as primary travel routes (Stanford 2000). Animals are able to migrate longitudinally from the headwater reaches all the way to Flathead Lake and laterally from east to the west across the subbasin (Standford 2000). On the North and Middle Forks, this enables organisms to move between Glacier National Park and National Forest and private lands. In the North Fork, riparian zones also connect wildland areas in British Columbia to Montana. Among the many species dependent on riparian corridors in the North, Middle, and South Forks of the Flathead and the Swan River are ungulates, wolves, grizzly bears, and mountain lions.

The riparian communities of the mainstem of the Flathead River above Flathead Lake function in a similar manner to those of the Middle and North Forks of the Flathead except that the channel of the mainstem is less confined laterally, has a lower gradient, and is more stable (Wright et al. 1982). The mainstem cuts through a low-relief floodplain that broadens markedly south of Kalispell. There has been considerable lateral planation by the river across this floodplain (Smith 2002).

Flathead Lake and the Lower Flathead

The riparian zone around Flathead Lake functions in a manner similar to riparian zones north of the lake. It provides critical habitat for wildlife and fish, filters sediments carried in surface runoff, and helps to remove nutrients that would otherwise enter the lake. Similarly, the processes and functions of riparian areas in the lower Flathead Valley parallel those of the upper Flathead. A key difference is that the lower Flathead is considerably more open and dry with riparian habitats bordered by upland grassland habitats, which means the connectivity, cover, and foraging and nesting habitat provided by riparian areas is even more important.

2.2.2 Human Alterations to Critical Riparian and Wetland Functional Processes

Northwest Power Planning Council document 2000-12 *Return to the River* (Williams et al. 2000) summarizes the effects of various human activities on riparian areas and their key ecological functions. Many of these directly apply to the Flathead Subbasin. For example, the trapping and killing of beaver has significantly reduced beaver populations, resulting in widespread loss of structural elements, floodplain processes, and vegetative diversity. Past commercial logging and clearing for agricultural and other purposes of floodplains and bottomlands has eliminated thermal cover from areas and removed the sources of large woody debris, which is fundamental to the maintenance of stream and river habitat complexity and productivity. Reducing the acres of riparian forests has affected the stability of stream banks and floodplain and toeslope surfaces. In some places, heavy grazing by domestic livestock has reduced vegetative cover and vigor, suppressed or eliminated some vegetation species, introduced noxious weeds, and reduced canopy cover over the channel. These changes have caused wider and more open channels with lower, warmer, more turbid surface flows in summer, more extensive ice conditions in winter, and flashier more turbid flows during runoff periods. Dams have inundated high quality riparian habitats, eliminated flood pulses, and created unvegetated varial zones. Lower and mid-elevation riparian areas have also been impacted by the pressures of erosion control efforts, irrigation withdrawals, and road building.

LINKS

The TBA assessment estimates changes to the riparian and wetland biomes, many of which affect functional processes. Go to Appendix 73.

Click Here

Habitat-forming processes affected by reservoir elevations and river flows include erosion and sediment deposition, nutrient cycling, and plant succession. Under natural flow conditions, flushing flows sort bottom sediments. Fine sediments are deposited along the river margins and on the tails of islands, providing nutrients and soils for riparian vegetation. Unnatural flow fluctuations have disrupted these habitat-forming processes, resulting in a larger varial zone that is biologically unproductive (Hauer et al. 1994, 1997). When the Flathead River was unregulated, normal pattern was for the varial zone to be wetted and dried only once, as spring meltwaters flooded all of the channel perimeter and then subsided. Aquatic life in the river was adapted to this pattern. With regulation, however, the varial zone has been watered and dewatered unpredictably, giving life in the river little chance of naturally colonizing new areas during high water or of migrating when the water volume decreases (Stanford 1990). In addition, terrestrial plants have been less likely to take root in a fluctuating system because seedbeds necessary for establishment of willow, cottonwood and other riparian plant communities are absent. Young cottonwood stands are needed to replace mature stands that are being lost to natural stand aging as well as human activities such as hardwood logging and land clearing. Fine sediments that would normally become stabilized by shoreline vegetation are more easily eroded into the river channel.

LINKS

The TBA assessment estimates presettlement riparian and wetland biome acres. Go to Appendix 73.

Click Here

2.2.3 Presettlement Riparian and Wetland Habitat Conditions[12]

During presettlement times, riparian and wetland plant and animal communities in the subbasin were generally in excellent condition with minimal anthropogenic influences, so riparian functions were largely intact and, by definition, within their historic ranges of variability. The uplands bordering riparian areas were also in pristine condition and thus helped to maintain the hydrologic regime and habitat connectivity.

During the presettlement period, the structure and function of riparian areas throughout forested portions of the Flathead Subbasin was probably similar in many respects to that of today's North Fork of the Flathead River. According to Stanford (2000), the North Fork corridor is composed of a "shifting mosaic" of flood plain structures that provides a broad array of habitats that come and go in a predictable pattern associated with the natural variation in river flow. This "shifting habitat mosaic" mediates very high biodiversity and bioproduction. Stanford hypothesizes that the highest levels of species diversity in the Rocky Mountains, if not the entire continent, may occur on the floodplains of the North Fork of the Flathead River for two reasons that are strongly inferred by the existing science; (1) the Flathead Basin is midway in the north-south gradient of the Rocky Mountains and (2) it is variably dominated by Pacific maritime and continental climatic conditions. Hence, it is a continental biodiversity node or

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[12] *Presettlement conditions are defined as the state of the environment at the time of European settlement or 1850.*

natural mixing zone for biota. Second, the "shifting habitat mosaic" that occurs here provides an array of biophysical conditions that allow maximum coexistence of species. In other words, riparian areas in the Flathead Subbasin were likely exceptionally diverse systems that supported a rich array of aquatic invertebrates, fish, bird species, riparian-dependent mammals, ungulates, bears, and carnivores.

On the upper mainstem of the Flathead River, plant communities probably paralleled those of the North Fork, except that because of the greater stability, natural communities included more extensive old growth bottomland forests of spruce and Douglas-fir or spruce, Douglas-fir, and cottonwood, with open stands of old growth ponderosa pine and Douglas-fir on the more xeric sites (Wright et al. 2002)

Riparian habitats along the lake were extensive. Most of the lake perimeter consisted of a shrub and forested shoreline. In some areas riparian vegetation may have been well established above the exposed shoreline due to infrequent flooding of short duration (Price 2000a). A 494-acre forested delta with grassy meadows dominated the north shore of the lake (Hauer et al. 1988). Early delta vegetation included dense shrub stands of serviceberry, chokecherry, rose, and ninebark willow, and extensive stands of cottonwood, aspen, and birch (Norton, 1919). A review of historical documents provided general descriptions of the north shore area prior to construction of Kerr Dam. Shoreline vegetation in the delta was described by Norton (1919) as dense shrub stands of serviceberry (*Amelanchier* spp.), chokecherry (*Prunus* spp.), rose, ninebark (*Physocarpus* spp.), willow and extensive stands of cottonwood, aspen, and birch. Swamps and meadows were also noted along the north shore. Jones (ca. 1910) reported a "great delta, miles in extent, covered with a forest of cottonwoods interspersed with evergreens, and "one giant species of Populus not found elsewhere." Extensive aquatic beds were reported in the lake at the mouth of the Flathead River, with species composition similar to the large "swamp" at the south end of the lake (Polson Bay) (Casey and Wood 1987).

Prior to construction of Kerr Dam, the wetlands fringing the south half of Flathead Lake also looked very different from what exists today. Historically, abundant wetland habitats were found in the upper ends of the larger bays, primarily East Bay and Polson Bay, where bottom gradients were relatively flat producing wide shallow-water zones. Pre-dam wetlands of East Bay were a band of emergent vegetation at the lake margin grading into a well-developed and much wider zone of wet meadow containing pockets of marsh vegetation in low spots. The meadow merged into a band of shrubs along the upland border. Small streams and seeps flowed through the riparian and wet meadow habitat to the lake. Although not as well documented, similar meadow habitats probably existed in Polson Bay, the upper end of Big Arm Bay and in other scattered pockets around the lake. A zone of seasonal aquatic and mud flat habitat extended into

LINKS

The Critical Lands Status Report evaluates lands in the North Flathead Valley that are critical for maintaining water quality, and other values such as wildlife habitat and recreation. For information on the report, go to: http://www.flatheadlakers.org/flathead_lake_basin/critical_lands/index.html

Click Here

For summaries of hydrologic data showing pre and post-dam flow duration charts and pre and post-dam peak flow values charts for any one of eleven USGS gaging stations in the subbasin, go to Appendix 61.

Click Here

the lake from the edge of the emergent marsh. Large beds of aquatic species became seasonally established in these bays (Price 2000a).

During presettlement times, the species composition of riparian and wetland areas along the lower Flathead River differed from that of the northern part of the subbasin because lower Flathead is drier and lower in elevation (woodland areas of the riparian zone along the lower river supported more ponderosa pine and juniper and little or no Engelmann spruce), although ecological functions were similar.

2.2.4 Present Riparian/Wetland Habitat Conditions

General

The Flathead drainage supports one of the greatest and most diverse concentrations of wetlands in the Rocky Mountains, including peatlands, oxbow ponds, springs and seeps, complexes of pothole ponds, vernal pools, and beaver ponds (Cooper et al. 2000).

A number of human activities have caused significant losses in riparian and wetland acres or substantially impaired riparian function. Some of the most serious impacts have come from water impoundment and diversion, livestock grazing, urban and suburban development, land clearing for agriculture, road development, heavy recreational demand, fires that burn outside the range of natural variability, the elimination or reduction of populations of native organisms such as beavers, the introduction of non-native species, and overall watershed degradation.

Headwaters

Riparian and wetland areas in headwater reaches within protected areas of the subbasin remain intact. However, in other parts of the subbasin, these habitats have been altered by road construction, historic logging practices, over grazing, fires that have burned outside the historic range of variability, and residential development.

Agriculture and grazing have influenced fisheries by degrading water quality and modifying stream bank vegetation. The primary influence from past forestry practices has been extensive road construction in watersheds, which has resulted in increases in sediment and encroachment on channels.

North, Middle, and South Forks of the Flathead River

Because such a large portion of their watersheds are within protected areas, the North and Middle Forks of the Flathead River and the South Fork of the Flathead

Other Sources

In addition to the links in this section, these other documents provide information on subbasin riparian areas and wetlands:

Riparian Landtype Inventory of the Flathead National Forest (1995).

Riparian Habitat Study, North Fork and Mainstem Flathead River Montana (1982).

Wetlands Conservation Plan for the Flathead Indian Reservation. (CSKT 1999).

King (1975) and Wittmier (1986) identify priority wetlands for acquisition and conservation easements.

Mapping of cottonwood, birch and aspen stands in the Canadian portion of the Flathead drainage is available at the Columbia Basin Fish and Wildlife Compensation Program office.

Detailed mapping of the floodplain of the Canadian portion of the North Fork of the Flathead is available with the Cranbrook Forest Service office and the Tembec office in Elko.

Riparian Inventory of the Lower Flathead River (CSKT 1990).

River above Hungry Horse Reservoir have abundant, intact riparian and wetland habitats and are among the least impacted riparian systems in the Flathead Subbasin. In all three forks, riparian communities are dominated by both needle-leaved evergreen and broad-leaved deciduous vegetation. Many islands and alluvial terraces support mostly stands of black cottonwood and Engelmann spruce, but there are also stands of western redcedar and grand fir.

The North Fork, while one of the most intact and richest areas in terms of riparian and wetland habitats in the Flathead, is not uncharacteristic of the Middle Fork and the South Fork of the Flathead above Hungry Horse Reservoir. The North Fork has abundant wetland and riparian habitat due to previous glaciation, high precipitation and the development of floodplain landforms along the river. The importance of these wetlands has long been recognized both locally and regionally (Cooper et al. 2000). In the North Fork, riverine and depressional wetlands are the most widespread wetland types due to glaciation and fluvial processes. The extensive alluvial floodplain, which extends from near Dutch Creek at the lower end of the drainage (31 miles south of the U.S.-Canadian border) to Pollack Creek some 28 miles north of the border, is the dominant landscape and ecological feature in the drainage (Jamieson 2002). Throughout this distance, the river meanders across a floodplain from 0.3 to 0 .6 mile in width that supports a complex mix of river and back channel habitats; beaver dam systems; spruce and other conifers in multiple seral stages; cottonwood and other hardwoods in a mix of age classes; and a series of communities dominated by shrubs, grasses, and forbs (Jamieson 2002). This riparian zone and the wetlands found within the drainage play a critical role in riverine ecological function (Stanford 2000).

LINKS

Appendices 29a & b identify and describe ecologically significant wetlands in the North Fork of the Flathead, mainstem Flathead, Stillwater, and Swan river valleys.

Click Here

In the North Fork the fluvial processes of flooding and sediment deposition that lead to the development of cottonwood bottoms are intact. Mature black cottonwood forests with intact native shrub understory species are common. (This is not the case in other parts of the Flathead Subbasin where understories of many of the mature cottonwood communities that remain have shifted from more palatable species such as red-osier dogwood (*Cornus sericea*), to less palatable ones such as common snowberry (*Symphoricarpos albus*). Similarly in other parts of the subbasin outside of protected areas, intact valley bottom cottonwood forests have declined from conversion to agricultural uses, rural expansion, bank stabilization, and dams (Cooper et al. 2000).

Most of the native herbaceous wetland and riparian communities in the North Fork are locally and regionally common. Although intact wet meadow communities can still be found in headwater reaches, many valley-bottom wet meadows have been invaded by weeds. For example, non-natives like redtop (*Agrostis stolonifera*), Kentucky bluegrass (*Poa pratensis*), meadow foxtail (*Alopecurus pratensis*), common timothy (*Phleum pratensis*) and reed canarygrass (*Phalaris* *arundinacea*) now dominate meadows that once supported tufted hairgrass (*Deschampsia cespitosa*) and bluejoint reedgrass (*Calamagrostis canadensis*) communities. (Cooper et al. 2000).

In terms of wildlife use of the North Fork, Weaver (2001) writes that "the Flathead River floodplain is notable for its breadth and richness of plant communities that provide habitats for small mammals and ungulates. Many grizzly bears and other wildlife select the floodplain and other riparian sites during spring, early summer, and fall." The mix of habitats is critical to moose, elk, white-tailed deer and mule deer (Jamieson 2002). Riparian sites, avalanche chutes, and older burned areas provide key grasses, forbs, and berries for grizzly bears (McLellan and Hovey 1995). In fact, the highest density of grizzly bears (65-80 bears/1000 km^2) recorded anywhere in interior North America occurs in the Flathead in the U.S. and Canada (McLellan 1989, Weaver 2001). Very high concentrations of grizzly bears have been observed in the floodplain of the Flathead River (Singer 1978). Weaver (2001) believes this extraordinary density may be attributed to the diversity, extent, and productivity of the berry species and riparian sites. According to McClellan, the Canadian portion of the North Fork of the Flathead "is likely the last remaining wide, flat-bottomed valley in southern BC where there is no human habitation. It is almost 6 miles wide at the border, much wider than other valleys…and bears still use the valley all year as do wolves and everything else. This is a behavior that has been eradicated everywhere else in British Columbia except north of Prince George."

LINKS

The TBA assessment estimates riparian and wetland biome acres and assesses various impacts by subunit. Go to Appendix 73.

Click Here

Lower South Fork Flathead River

Filling of Hungry Horse Reservoir inundated large areas of low elevation forest, wetland, and riparian habitats, including seasonal habitat for a wide variety of avifauna, spring and fall grizzly bear habitat and important UNGULATE range and calving areas. This was a massive loss of highly-productive and heterogeneous riparian habitats, some of the finest in the subbasin. The loss also altered the annual temperature cycle in the river, affecting the food base for the many wildlife species that feed on aquatic organisms (CSKT 2001). Table 2.3 lists the number of acres of riparian habitat lost by type (Casey et al. 1984).

Upper Mainstem Flathead River

In 1983, an EPA-funded study determined the floodplain along the mainstem of the Flathead River retained less than 22 percent of its natural vegetation (Wright et al. 1983), and that percentage is significantly lower today (Alan Wood, MFWP, pers comm. 2003). The amount of herbaceous meadow area on the mainstem above Flathead Lake is just 13 percent of what it was in 1937 (Hauer et al. 1988).

Table 2.3. Riparian acres lost to Hungry Horse Reservoir. Source: Casey et al. 1984.

Type of Riparian/Wetland Habitat	Acres
River/Stream	702
Pond/Lake	54
Marsh/Slough	147
Gravel Bar	532
Deciduous Shrub	1077
Sub-irrigated Grassland	179
Floodplain Terrace Grassland	466
Deciduous Tree	100
Mixed Forest	3619
Total	**6876**

Another type of riparian community that has decreased in acreage over the last 150 years along the river and elsewhere in the upper Flathead Valley is well-developed valley bottom cottonwood riparian forest types (Alan Wood, MFWP, pers comm. 2003). Many of these communities have been converted to agricultural and urban uses or subdivisions.

An additional factor causing of the loss of wetland and riparian habitats along 22 miles of the Flathead River upstream of Flathead Lake has been Kerr and Hungry Horse dam operations, although the specific acres lost or damaged from the operations of the dams still need to be determined. Various charts—pre- and post-dam comparative hydrograph, flow duration, and peak flow—in Appendix 66 show how the hydrograph has changed in response to the operations of the dams. Areas that once supported riparian habitats have been altered or converted to areas of bare ground due to inundation and subsequent dewatering (Mackey et al. 1987, Mack et al. 1990) and bank stabilization efforts. These changes have affected the food base for the many wildlife species that feed on aquatic organisms. Dam operations combined with bank stabilization efforts have also affected the fluvial processes—flooding and sediment deposition—that lead to the development and reestablishment of cottonwood bottoms (Greenlee 1999). Under many of the mature cottonwood stands that do remain, more palatable understory species such as red-osier dogwood have shifted to less palatable ones such as snowberry (Greenlee 1999). This change has occurred largely in response to livestock grazing (Hansen et al. 1995). Consequently, those parts of the subbasin where agriculture, urban development, subdivision, and grazing have been prominent land uses, or where dam operations have altered fluvial processes, valley bottom cottonwood forests are relatively uncommon (Greenlee 1999).

However, functional expanses of continuous riparian vegetation do remain along the river and provide excellent fish and wildlife habitat. Examples include

Flathead River Islands, Foy's Bend, Fennon Slough, Weaver Slough, the upper braided area, Egan Slough, McWenneger Slough, and Columbia Falls Aluminum Company lands (Flathead Lakers 2002). Bull trout and cutthroat trout use the river system bordering these areas for migration. They also winter in several locations, for example around Flathead River Islands and Foy's Bend, where the water flows are slower, there is protection from predators, and water temperatures are higher. These riparian zones also provide nesting and winter habitat for bald eagles and important year-round habitat for river otter, beaver, osprey, great blue herons, cormorants, wild turkey and pheasants. The area known as the Flathead River Islands has the highest density of beaver colonies in Montana and large populations of river otter and osprey (Flathead Lakers 2002). The riparian areas from Foy's Bend north to Highway 35 has one of the highest concentrations of mature cottonwood forests and bull and westslope cutthroat trout wintering sites on the Flathead River (Flathead Lakers 2002). These areas continue to play a vital role in the ecological functioning of upper part of the subbasin.

Riparian habitat along the Stillwater and Whitefish rivers and Ashley Creek has been significantly reduced and is now patchy, especially in the lower part of the drainages. Of these three, the Whitefish River is the only one that still has some continuous vegetation cover along its banks (Flathead Lakers 2002).

Swan River

According to a 1994 wildlife assessment of the Swan Valley (USFS 1994), one of the watershed's most unique features is the tremendous number and variety of wetlands and riparian areas, which harbor rare species such as the northern bog lemming and ladyslippers. However, timber harvesting in and adjacent to the riparian zone has affected stream channel and streambank cover, stability, and integrity (USFWS 2002a). A 1999 report by the Montana Natural Heritage Program (Greenlee 1999) identified sixteen wetlands of moderate to outstanding significance in the Swan.

Flathead Lake

The Final Environmental Impact Statement for the Kerr Project (FERC 1996) described the changes to riparian vegetation along Flathead Lake since the construction of Kerr Dam. The following description is adapted from that document.

Construction of Kerr dam altered the riparian vegetation in the Flathead Lake area. The rocky shorelines and gravel beaches along the east and west shores were inundated and the new shoreline is characterized by coniferous and mixed forests. The maintenance of high lake levels in the summer, summer storms, and associated wind driven waves caused inundation and erosion of the 494-acre forested delta at the Flathead River mouth (Hauer et al. 1988). Only remnant stumps remain in the delta area.

The east side of the north shore consisted of approximately 1,043 acres of vegetated shoreline in 1937. This area consisted primarily of deciduous forest, herbaceous meadows, some agricultural land, and a 140-acre varial foreshore beach. Approximately 477 acres of vegetated shoreline habitat has eroded since 1937 due to summer storm waves and high lake levels. Currently, varial beach dominates the east side of the north shore. Approximately 99 acres of the original 217-acre coniferous and deciduous mixed forest remain, and developed land is replacing agricultural pasture.

The west side of the north shore consisted of approximately 2,056 acres of vegetative shoreline in 1937. Approximately 1,428 acres succumbed to erosion or inundation by summer full-pool lake levels. The cover types of this area that remain are relatively similar to pre-dam conditions.

Mackey et al. (1987) reported that the construction and operation of Kerr Dam affected approximately 2,179 acres of wetland habitat on Flathead Lake. The extended high water levels resulting from Kerr Dam flooded wet meadow and marsh wetlands and replaced these with large expanses of unvegetated mudflats and seasonal aquatic wetland types. The greatest loss of emergent and marsh wetlands occurred in East Bay and Polson Bay. Numerous other bays, including those at Finley Point, Rocky Point, Big Arm, Elmo, Dayton and the lake outlet have also been impacted. The species diversity of the remaining marsh wetlands was reduced to monotypic stands of cattail (*Typha latifolia*) apparently because cattails can tolerate fluctuating water levels. Data for Dayton Creek, both on and off the Reservation, indicate that approximately 40 percent of the tributary network is in a non-functioning condition, approximately 30 percent of the tributary network is Functioning At Risk, and approximately 30 percent of the tributary network is in a Proper Functioning Condition (Price 2000a).

Wetlands located in the poorly drained lowlands adjacent to East Bay provide refugia for moist-coastal forested wetland habitat types found in few other places on the Flathead Indian Reservation. These are represented by western red-cedar/queenscup beadlily - wild sasparilla phase, and spruce/horsetail habitat types. The spruce/horsetail habitat type is unique by virtue of the presence of pacific skunk cabbage. Although limited in acreage and having experienced past logging, these forested wetlands are extremely important from a wildlife habitat and biological diversity standpoint (Georesearch, Inc. 1994).

Lower Flathead

From Kerr Dam to Mission Creek, the lower Flathead River is a single channel, and the floodplain and associated riparian communities are generally narrow. But because they bisect a relatively dry area with few trees, they are crucial to species like white-tailed deer, black bear, mink, otter, beaver, muskrat, osprey, and bald eagles. Below Mission Creek, the river is less confined and has numerous branching channels and islands with extensive riparian areas and wetlands. These habitats are among the most important wildlife habitats in the southern part of the subbasin (CSKT 1999).

Kerr Dam operations historically had significant impacts to the riparian community due to load-following and power-peaking practices. Many of these impacts were addressed in 1997 when the facility was changed to a "baseload" operation under the new license agreement. Because of historic operations of Kerr Dam, cottonwood habitat types and a mixed deciduous/coniferous overstory on the river have been forced toward a conifer-dominated overstory due to the abatement of periodic flooding activity and constrained flows under recent peaking operations (DosSantos et al. 1988). There has been a dramatic reduction in recruitment of pioneer species such as black cottonwood and sandbar willow (Hansen and Suchomel 1990). Most of the existing black cottonwood forests are between 50 to 100 years old. The relative proportions of immature (seedling, sapling, pole) to mature age classes indicate that if the lack of regeneration continues, the cottonwood gallery forests may be eliminated by the year 2051 (Hansen and Suchomel 1990).

Historic changes in the annual hydrograph for the lower Flathead River also caused the normally vegetated varial zone to become abnormally inundated. This did not allow riparian vegetation to exist where it normally would. The area between the high and low water levels has become a largely unvegetated varial zone dominated by mud and rock. Studies have also shown that the constant fluctuation in water levels and flows under historic dam operations did not allow a stable enough situation for vegetation to become established (Mackey et al. 1987; Mack et al. 1990; Hansen and Suchomel 1990).

In addition, much of the riparian zone has been developed for agriculture because of the reduced frequency and severity of flooding. Riparian habitat losses in the Flathead River corridor are estimated to be as high as 6,731 acres (Mack et al. 1990). Changes in broad riparian habitat cover types since the construction of Kerr Dam include a decrease in deciduous forest (-39.1 percent), herbaceous (-28.7 percent), and mixed forest cover (- 27.6 percent) cover types due to a corresponding conversion to agricultural lands (+94.8 percent), and coniferous forest (+57.2 percent), and shrub (+10.8 percent) types (Hansen and Suchomel 1990). Wetland acres losses along the lower Flathead River attributable to Kerr

Dam are estimated at 2,353 acres (Price 1999). Research by Department of Interior experts and others estimated riparian habitat losses due to hydroelectric operations along the lower Flathead River at 624 acres. Kerr license negotiations between technical and policy representatives in 1994 determined that half of those losses were attributable to Kerr Dam operations and half to the operations of Hungry Horse Dam (Brian Lipscomb, CSKT, pers. comm. 2003; Article 67 of the amended FERC Order for Kerr Project No. 5-021; Makepeace 1996). In addition, it was determined that the losses included an additional 985 acres of varial zone habitat along the lower Flathead River and 1,792 acres of varial zone habitat along Flathead Lake, both of which were attributed to the operations of Kerr Dam.

Otherwise, the river channel itself is largely unaltered by development. The railroad cut off several meander bends or side channels between the town of Dixon and its confluence with the Clark Fork River, but the channel is considered relatively stable. Current impacts include bank trampling and vegetation disturbances from grazing.

Among the earliest impacts to riparian areas in the lower Flathead Valley in general was the construction of the Flathead Indian Irrigation Project (FIIP) in the early 1900s. The project includes large feeder canals that cut across and intercepted many natural streams. Early on, most of the smaller ephemeral and intermittent streams, and some of the larger perennial streams, were completely dewatered. Many of the former channels and riparian areas were then plowed over or otherwise obliterated by agricultural practices made possible by the construction of the irrigation project. For most of the smaller streams, little or no evidence of their former channels and floodplains exist today below the canal intersections. (Price 2000a)

Permit records of the Tribes Shoreline Protection Office and observations by Tribal resource managers indicate Reservation-wide wetland and riparian losses have slowed but are continuing (Price 2000a). Between 1993 and 1997 the University of Montana Riparian and Wetland Research Program evaluated 102 reaches of stream on the Flathead Reservation. The average score for all reaches was 74, which is described as a functional riparian condition, but considered at risk if remedial management actions are not taken. Of the 102 inventoried reaches, 15 rated as nonfunctional, 46 were functional-but-at-risk, and 41 were in proper functioning condition.

The riparian zones along Mud Creek, Crow Creek, Post Creek, and Mission Creek connect the Mission Mountains with the lower Flathead River and are used by a variety of wildlife, including elk and grizzly bears (CSKT 1999). The Little Bitterroot River, which flows through dry and open terrain on the west side of the valley, has been identified by the Confederated Salish and Kootenai Tribes as a priority area for restoration because of its extensive potential for wetland and riparian habitat and habitat connectivity with the lower Flathead River (CSKT 1999).

2.2.5 Potential Riparian/Wetland Habitat Condition[13]

Under this scenario, Hungry Horse Dam would be operated consistent with the variable flood control strategy (VARQ) and Integrated Rule Curves (IRC). Substantially normative hydrologic conditions (conditions that mimic natural processes and minimize impacts on fish and wildlife) will have been restored. Stabilizing summer flows will have allowed some reestablishment of riparian vegetation in the varial zones. An operational impact assessment and plans to mitigate for any impacts caused by the operations of Hungry Horse Dam on the development and successional trends of riparian wildlife habitats and their associated aquatic components will have been completed and fully implemented. Similarly, Kerr Dam would be operated to substantially restore normative hydrologic conditions, allowing recovery of the varial zone and promoting natural vegetative successional processes on the floodplain.

Across the subbasin, the best available remaining riparian and wetland habitats will have been identified and protected through the use of conservation agreements and land acquisitions. In areas where easements or acquisition is not possible, land use activities that are presently degrading these habitats or that are preventing them from recovering will have been modified through education. Education and better enforcement will result in better compliance with existing habitat-protection laws. Riparian fencing and revegetation projects will have protected and effectively restored impacted areas. Collectively, these measures will have resulted in the reestablishment of riparian vegetation, the reconnection of artificially fragmented habitats, and the protection of key migration corridors from future development. Natural stream channel function and form will have been restored using methods such as bank stabilization, streambank and riparian revegetation, riparian fencing, and in-stream channel habitat structures. The miles of road passing through riparian habitats will have been significantly reduced, with roads being relocating out of floodplains and stream bottoms. Minimum flows would be maintained through the purchasing and leasing of water rights and water conservation agreements.

[13] *The potential condition is defined as the desired end state or optimal condition for this subbasin in the year 2050.*

2.2.6 Future/No New Action Riparian and Wetland Habitat Condition[14]

Riparian and wetland habitats in protected areas would remain relatively intact, but in headwater reaches in the other parts of the subbasin, those habitats would continue to be impacted or further degraded to varying degrees by silvicultural activities, roads, grazing, noxious weeds, land development, bank and shoreline modification and destabilization, and agricultural practices. The degradation will have resulted in further impairment of key ecological functions, including sediment filtering, streambank building, water storage, aquifer recharge, dissipation of stream energy, and fish and wildlife habitat.

Human populations will have continued to grow, more than doubling by 2050. Many more people will have built first and second homes along streams. These and other recreation and development pressures will have affected thousands of acres of riparian areas and wetlands, converting them to other uses or seriously reducing their value to fish or as wildlife habitat. Tied to this increasing human population will be a corresponding increase in noxious weeds, further reducing the value of these key habitats to native fish and wildlife species.

Kerr Dam, will have been operated under the conditions of the existing Kerr License, and current impacts on the Flathead Lake and the mainstem of the Flathead River above and below Kerr Dam will have continued. As a result, it is likely that the cottonwood gallery forests along the lower Flathead River will have disappeared by 2050 (Mack, et al. 1990; Hansen and Suchomel 1990).

[14] *The future/no new action condition is the state of the environment in 2050 assuming that current trends and current management continues.*

2.3 Grassland Systems

2.3.1 Critical Grassland Functional Processes

SNAPSHOT

During presettlement times, natural fire frequencies cleared organic debris, encouraged perennial grasses, and played key thermal and nutrient-cycling roles. Over the past one hundred years fires have been mostly excluded, and there have been invasions of woody and non-native plant species. Many sites have been overgrazed. Large areas have been converted to cropland or other uses. Soil crusts have been disturbed, adversely affecting the rates of nitrogen fixation and soil stability, fertility, structure, and water infiltration. Native plant species have been significantly reduced, as has the value of grasslands to native wildlife.

One of the most basic processes in grassland ecosystems involves the production and transfer of nutrients such as carbon (C), nitrogen (N), and phosphorus (P) — elements critical to the biochemical processes of plant and animal life (Connor et al. 2001). Animals use these nutrients in their organic form by consuming the plants. Some of the nutrients are then transformed back to inorganic forms through the by-products of digestion and respiration. This "mineralization" process is critical to grassland ecosystem function because so much of the essential nutrients in the system are bound with organic matter within the soil and cannot be absorbed by plants until they are transformed to inorganic forms through microbial decomposition (Briske and Heitschmidt 1991).

Organisms in and on the surface of grassland soil, including cyanobacteria, bacteria, algae, microfungi, lichens, bryophytes, protozoa, and nematodes, are also key to grassland ecosystem function. Native grassland soils in the Inland Northwest typically have well-developed microbiotic (or cryptobiotic) crusts which affect surface stability, soil fertility and structure, water infiltration, seedling establishment, and plant growth (Weddell 2001). Similarly, mycorrhizae also play an important part in the maintenance of grassland communities because they affect nutrient uptake, growth, and reproduction in associated vascular plants (Dhillion and Friese 1992; Harnett and Wilson 1999). Sagebrush (*Artemisia* spp.), rabbitbrush (*Chrysothamnus* spp.), and native bunchgrasses are highly dependent upon arbuscular mycorrhizae, while many alien annual grasses such as cheatgrass and medusahead (*Taeniatherum caput-medusae*), are non-mycorrhizal or facultatively mycorrhizal (Goodwin 1992; Wicklow-Howard 1994, 1998). The colonization of rangeland by non-mycorrhizal species is associated with declines in arbuscular mycorrhizal fungi, and when arbuscular mycorrhizae are absent, non-mycorrhizal species are able to capture soil resources more effectively than native mycorrhizal species (Goodwin 1992).

Grasslands evolved with frequent disturbances. Prior to European settlement, fire and drought were the major forces shaping and maintaining the palouse prairie. In the southern part of the subbasin, it is estimated that natural fire-return intervals in grasslands ranged from 5 to 15 years (CSKT 2000). The pre-fire structure of grassland vegetation is quick to return after a burn as a new stand of grass shoots up from surviving root systems. Fire converts standing and fallen dead plant matter to ash, and within a year or two the proportion of forbs usually increases (Smith 2000). Frequently, productivity is increased within 1 or 2 years following fire (Wright and Bailey 1982). Within about 3 years the grassland structure has returned at least to pre-fire levels, as have faunal populations (Smith 2000).

A successional process of major importance to pre-1850 grasslands was the continual checking and reduction of woody-plant encroachment. Without fire, subbasin grasslands give way to stands of ponderosa pine and/or Douglas-fir. Fire not only halted encroachment and reduced the buildup of dead material, it performed many other critical ecosystem functions, such as recycling nutrients that might otherwise be trapped for long periods of time in dead organic matter, stimulating the production of nutrients, and providing the specific conditions critical for the reproduction of fire-dependent species.

Grasslands perform a number of important ecological functions. Grasslands, especially those found on basic soils formed on calcium-rich parent material, are capable of sequestering relatively large amounts of carbon. The carbon is held both in organic and inorganic forms. While this function is maintained under light to moderate grazing, grassland soils are likely to lose between 20 and 50 percent of their original organic carbon within the first 40 to 50 years under cultivation (Conner et al. 2001).

Because the quality and quantity of water runoff and infiltration depends upon the quality of ground cover, grasslands also play an important role in hydrologic cycle. When grasslands are converted to other uses, like cropping, soil erosion often increases and water quality decreases through increases in the quantity of sediments, dissolved solids, nutrients, and pesticides carried in runoff. Welch et al. (1991) report that, with a ground cover of bunch grasses, soil loss through erosion from a 10 cm rain in 30 minutes was only 200 kg/ha with 24 percent of the precipitation running off. Alternatively, with the same rainfall, soil loss was 1,400 kg/ha and 45 percent runoff with sod-grass ground cover and 6,000 kg/ha soil loss and 75 percent runoff for land with no vegetative cover.

Grasslands also provide important wildlife habitat for a variety of birds and mammals. This is especially true when riparian corridors are present or when the grasslands encompass areas with high densities of wetlands (as in the Mission Valley), or when the grasslands border forested ecosystems (as throughout the subbasin).

Bobcats, grizzly bears, black bears, mountain lions, coyotes, elk, white-tailed deer, mule deer and moose all utilize subbasin grasslands, as do a variety of ground-nesting waterfowl, raptors, and songbirds. The presence of grasslands in a subbasin like the Flathead, which is dominated by coniferous forest habitats, greatly enhances its overall biological diversity.

2.3.2 Human Alterations to Critical Functional Processes

The greatest losses of native grasslands within the subbasin have occurred through the conversion of these areas to residential areas, tame pastures, croplands, and

LINKS

The TBA assessment estimates changes to the grassland biome, many of which affect functional processes. Go to Appendix 73.

Click Here

other cover types (Art Soukkala, CSKT, pers. comm. 2003). Conversion has also had the greatest impact on the critical functional processes. For example, within four or five decades of cultivation, grasslands often lose up to 50 percent of their original carbon (Conner et al. 2001). Cultivation or conversion to non-grassland types also disrupts the "mineralization" process by displacing native animal species. It typically removes or damages the cryptobiotic crusts of the soils, which alters the rates of such fundamental processes as nitrogen fixation (Evans and Belnap 1999) and adversely affects soil stability, fertility, structure, and water infiltration. Conversion can cause the loss of arbuscular mycorrhizae so essential for growth, reproduction, and nutrient uptake of native plants.

The conversion of grasslands also increases the potential for soil loss from wind and water erosion. Average annual soil loss differences of 10 to greater than 60 times have been measured for similar watersheds with perennial grass cover versus continuous cropping (Conner et al. 2001; Krishna et al. 1988). As the potential for erosion increases, so does the potential for water quality impairment which results from increases in dissolved solids, nutrients, pesticides and sediment (Huntzinger 1995). Finally, conversion often substantially reduces or destroys wildlife habitat values.

Grazing, the elimination of regular, periodic burning by Indian people, and fire exclusion policies have disrupted the disturbance regime of grassland systems and all but eliminated the important ecological role played by fire. In grassland ecosystems where both fire and grazing are excluded, thatch or dead herbaceous litter accumulates, which depresses herbage yields and the number of plant species (Wright and Bailey 1982). Fire can help control encroaching shrubs and trees; increase herbage yield, utilization of coarse grasses, and availability of forage; and improve habitat for some wildlife species (Paysen et al. 2000). As a result of fire exclusion in the Flathead Subbasin, ponderosa pine and Douglas-fir have encroached significantly on grasslands, especially at forest edges (CSKT 2000). In some areas, dense Douglas-fir forests now dominate sites and the only evidence that grasslands once occupied the site is from soils (Bakeman and Nimlos 1985). Removing fire has also reduced the diversity of herbaceous species and slowed the recycling nutrients trapped in dead plant matter. The change in fire regime combined with grazing, the invasion of non-native plants, and the draining of wetlands and destruction of riparian areas within the subbasin's remaining grasslands has changed once-rich ecosystems that were used year-round by a variety of wildlife species to seasonal rangelands of less value to wildlife.

The spread of noxious weeds has also impaired grassland function. Weeds have further reduced the value of grasslands to wildlife and caused a further decline in species diversity and native threatened rare plants.

2.3.3 Presettlement Grassland Habitat Condition

Most of the native grasslands in the Flathead Subbasin consisted of bunchgrasses dominated by bluebunch wheatgrass (*Agropyron spicatum*), rough fescue (*Festuca scabrella*) and Idaho fescue (*Festuca idahoensis*). These Palouse grasslands and savannas once covered large areas of the intermountain west. Another grassland type occurs in the North Fork Valley in what is now Glacier National Park. These are small meadows and pockets of prairie, and because their species composition differs somewhat from that of the Palouse prairie grasslands, they are classified as a distinct type and are called foothills grasslands. They contain plants from the Palouse prairies of Eastern Washington and from the Alberta prairies north and east of the park, including rough fescue, bluebunch wheatgrass, prairie junegrass, Idaho fescue, Richardson's needlegrass, timber oatgrass, and big sagebrush (Peter Lesica, consultant, pers. comm. 2002).

Fire and drought were the major forces shaping both the Palouse and foothills grasslands. It is estimated that Native Americans may have doubled the frequency of lightning-caused fires (Barrett 1980). These periodic (every 5 to 15 years), low-intensity fires generally did not damage perennial grasses but rather helped maintain grassland areas.

LINKS

The TBA assessment estimates presettlement grassland biome acres. Go to Appendix 73.

Click Here

Largely because they were interspersed with wetlands and riparian areas (especially in the Mission Valley) grassland habitats provided some of the most important wildlife habitats in the subbasin (Soukkala, CSKT, pers. comm. 2003), including abundant spring nesting habitat for ground-nesting waterfowl, raptors, and songbirds and winter foraging habitat for migratory waterfowl. Riparian corridors that traversed grassland areas were used by a large variety of birds and mammals, including grizzly bears (*Ursus arctos horribilis*), wolves (*Canis lupus*), bald eagles (*Haliaeetus leucocephalus*), and peregrine falcons (*Falco peregrinus*), the first three of which are now classified as threatened or endangered. Columbian sharp-tailed grouse (*Tympanuchus phasianellus*), trumpeter swan (*Cygnus buccinator*), both later extirpated from the subbasin, also used grassland habitats and associated wetlands.

2.3.4 Present Grassland Habitat Condition

The biotic diversity of North American grasslands is probably the most altered by human impact of any of the continent's terrestrial ecosystems (Conner et al. 2001). Similarly, grasslands are probably the most impacted biome in the Flathead Subbasin (Soukkala 2003). Many of the grasslands in the subbasin have been converted to other types — replaced by introduced tame grasses, cropland, or residential developments. Habitat values on much of the remaining native grasslands have been degraded by fragmentation, fire exclusion, improper grazing, and the spread of non-native plants. Even on grassland habitats with a very small percentage of tame grasses, many of the native plant species once common have declined substantially or even disappeared due to grazing, noxious weeds, and herbicide use. While agriculture and ranching practices can degrade wildlife habitats and can adversely affect wildlife populations, the impacts associated with housing development are often more severe and permanent. Grassland areas now dominated by tame grasses still provide nesting and foraging habitat for migratory birds, and generally, farming and ranching practices are relatively compatible with wildlife habitat. Housing developments, however, have and continue to irreparably destroy habitat (USFWS 1998).

Even though much of the grasslands in the Flathead Valley have been significantly degraded, there remain areas of grassland of high wildlife value. The Ninepipe/Kicking Horse area, with its unusually high density of wetlands, is the most noteworthy example. The following description of the Ninepipe area is adapted from an Environmental Assessment done in 1998 for a US Fish and Wildlife Service Conservation Easement Program in the Mission Valley (USFWS 1998).

LINKS

The TBA assessment estimates grassland biome acres and assesses various impacts by subunit. Go to Appendix 73.

Click Here

The Ninepipe area exhibits excellent species diversity, from waterfowl to short-eared owls (*Asio flammeus*), grizzly bears, white-tailed deer (*Odocoileus virginianus*), wading birds, black terns (*Chlidonias niger*), osprey (*Pandion haliaetus*), rubber boas (*Charina bottae*), and prairie rattlesnakes (*Crotalus viridis*). More than 100 species of neotropical migrant songbirds use the area.

There is also important seasonal use by the rare or special-interest species, such as the threatened bald eagle, peregrine falcon, common loon (*Gavia immer*), long-billed curlew (*Numenius americanus*), river otter (*Lutra canadensis*), trumpeter swan, Virginia rail (*Rallus limicola*), and black-necked stilt (*Himantopus mexicanus*). Thirty species of shorebirds, waders, gulls, and terns commonly use the wetlands for habitat during migration. Caspian terns (*Sterna caspia*), Forester's terns (*Sterna forsteri*), and black terns nest in the area along with all five species of grebes, great blue herons (*Ardea herodias*), American bitterns (*Botaurus lentiginosus*), American avocets (*Recurvirostra americana*), Wilson's phalaropes (*Phalaropus tricolor*), and sora (*Porzana carolina*). The highest nest success was found for common snipe (*Gallinago gallinago*) at 85 percent.

The Mission Valley area is an extremely good area for raptors with high nesting concentrations of ground-nesting short-eared owls and northern harriers (*Circus cyaneus*). Short-eared owls range in nest densities from one nest per 5.5 acres (Holt and Leasure 1993) to one nest per ten acres (MCWRU 1986 - 1995) with 65 percent Mayfield nest success. Northern harriers also have a high nest density with 40 percent nest success (MCWRU 1986 - 1995). Tree nesting species include great horned owls (*Bubo virginianus*) and long-eared owls (*Asio otus*).

Christmas Bird Counts provide evidence of many birds of prey using the area at densities of 6-7 birds per square mile with up to 230 rough-legged hawks (*Buteo lagopus*), and 20-30 red-tailed hawks (*Buteo jamaicensis*). Ten to twenty snowy owls (*Nyctea scandiaca*) winter in the Pablo and Ninepipe NWR areas. The rough-legged hawk figures are from a roosting area where concentrations are the highest recorded in the United States. Other species seen include gyrfalcons (*Falco rusticolus*), northern goshawks (*Accipiter gentilis*), bald eagles, and prairie falcons (*Falco mexicanus*).

Approximately 20 species of waterfowl regularly use the area for nesting, and more than 30 species use the area during migration. For many species of breeding ducks this area achieves some of the highest pair densities (five pairs per wetland acre) and nest success (43 percent) within the U.S., with some parcels achieving 75 percent success in some years (Service pair counts and MCWRU research). Mallards (*Anas platyrhynchos*), northern shovelers (*Anas clypeata*), gadwalls (*Anas strepera*), redheads (*Aythya americana*), and cinnamon teal (*Anas cyanoptera*) are the most common nesting ducks.

The Mission Valley is an important breeding and staging area for a large portion of the Flathead Valley Canada goose (*Branta canadensis*) population. The Valley also supports a large colony of great blue herons (*Ardea herodias*) and the largest double-crested cormorant (*Phalacrocorax auritus*) nest colony west of the continental divide in Montana.

More than 50 species of neotropical migrant songbirds use the area and 14 nest locally. Vesper (*Pooecetes gramineus*), savannah (*Passerculus sandwichenis*), and grasshopper sparrows (*Ammodramus savannarum*)—grassland species that have been found to be declining nationally and statewide (Carter and Barker 1993)—nest in the area. Though vesper and grasshopper sparrows have too low nest numbers to determine nest success numbers, meadowlarks (*Sturnella neglecta*) have 20 percent and savannah sparrows 25 percent nest success (MCWRU 1986 - 1995). Three species of hummingbirds (calliope, rufous, and black-chinned) also use the area. Among the federal endangered or threatened species that have used or currently use the area are the endangered gray wolf, threatened bald eagle, and threatened grizzly bear.

Grizzly bears frequently move out of the Mission Mountains Tribal Wilderness by way of riparian corridors. They are occasionally observed as far as sixteen miles from the base of the mountains. There is a peregrine falcon hack site on the Crow Waterfowl Production Area that fledged three young each year in 1995, 1996, and 1997. Bald eagles and peregrine falcons are frequently seen foraging on Ninepipe NWR and surrounding area. The native plant community of prairie grasslands consist of bunchgrasses dominated by bluebunch wheatgrass (*Agropyron spicatum*), rough fescue (*Festuca scabrella*) and Idaho fescue (*Festuca idahoensis*). However, native grasslands have largely been replaced by introduced grasses, dense nesting cover, and an alfalfa-hay-based agriculture. The native vegetation on most unplowed sites has been overgrazed and severely damaged, but there are opportunities to restore native vegetation.

Rare or uncommon plants found within the Ninepipe area include three state endangered, two state threatened, and 14 state sensitive species.

2.3.5 Potential Grassland Condition

Under this scenario, the best remaining tracts of palouse prairie will have been protected from subdivision and conversion to cropland through conservation easements and purchase. To reduce fragmentation, key areas that were converted to agricultural land or tame grasses will have been restored to varying degrees.

Management plans for these protected grassland areas will have been developed and implemented to restore appropriate plant and animal species composition and vertical and horizontal vegetative structure. Natural fire regimes will have been restored through the use of prescribed fire, and the introduction and spread of noxious weeds will have been held in check. Grazing will be used as a tool to enhance the native grassland community.

Public education efforts and incentive programs will have improved land use practices on remaining grassland areas. These efforts will have substantially reduced the conversion of native grasslands to other land cover types. CSKT Tribal Forestry will use prescribed fire to return encroached acres to grassland and to enhance existing grassland habitats. Riparian areas and wetlands within grassland habitats will have been fenced and protected from development activities.

2.3.6 Future/No New Action Grassland Condition

Grassland areas currently under protection by federal, Tribal, or State governments will remain protected, although expanding weed infestations will likely continue to degrade many of them. Other protected areas will have seen general improvements in grassland species composition and structure from ongoing restoration efforts. Unprotected grasslands, however, will continue to be converted into tame pastures, croplands, or residential developments, and these areas will see continued and significant declines in biological diversity and productivity. Subdivisions, especially, will have increased as the human population in the subbasin expands, and these developed areas will have lost virtually all of their value as wildlife habitat. Fragmentation will have increased substantially. Although there will have been some efforts to restore fire to grassland habitats, fire frequencies will have remained well outside of the historical range of variability. Poor grazing practices will have continued on the majority of unprotected grassland acres, and there will be significant increases in the spread of non-native plants. All these factors will have contributed to the decline of native grassland species and will have resulted in the further decline of listed species.

2.4 Coniferous Forest Systems

2.4.1 Critical Coniferous Forest Functional Processes

Table 2.4 lists major natural disturbance processes occurring within the forest biome. The most significant of these are fire and insects and disease (Monnig and Byler 1992), which are intrinsic components of forested ecosystems, affecting species composition, forest structure, landscape patterns, forest succession, nutrient cycling, and many other fundamental ecological processes. They affect forest communities by delaying or redirecting succession, which in turn influences the productivity and biological diversity of plant and animal communities (McCullough et al. 1998).

SNAPSHOT

During presettlement times, low-elevation dry forests were characterized by large, widely spaced ponderosa pine trees maintained by frequent, low-intensity fires. At mid and higher elevations, cool, moist sites supported fire-dependent, seral old-growth trees. Wildife species easily moved across large habitat blocks. Over the last 100 years, large trees have been harvested and fires have been excluded. Shade tolerant species, more prone to disease and lethal fires, have increased. Habitats have been roaded. Now, stands tend to be overstocked compared to historic conditions, especially on drier sites. Fire regimes have shifted to more lethal fires. Patch sizes are smaller, and the amount of interior habitat is less than historic conditions. Existing forests are more fragmented.

Table 2.4. List of Natural Disturbance Factors and Consequences (adapted from Ecological Planning and Toxicology, Inc. 1997),

Factor	Soil Effects	Direct Veg. Effects	Indirect Veg. Effects
Fire Nonlethal	Removal of soil litter; increase in available phosphorous, potassium, and other cations; decrease in soil organic matter and soil nitrogen	Removal of previously dead, above-ground biomass; kills sensitive trees and shrubs; removes accumulated litter	Fire resistant (surviving) plants generally experience rapid growth due to release from competitive interference and increase in nutrients in ash.
Fire Stand Replacement	Hot spots may alter the physical and biological composition of the soil; removal of surface litter; increase in available phosphorous, postassium and other cations; decrease in soil organic matter and soil nitrogen	Removes virtually all of above ground biomass (living and dead) leaving charred stumps and snags.	Opens area for secondary succession; highly dependent on propagule source and prevailing microclimate conditions.
Insects	None	Selective death of typically a single dominant forest species; increase in standing dead increases potential for fire.	Loss of dominant species typically results in altered microclimate conditions (forest gaps) that may shift to greater ground cover or favor non-affected tree species.
Avalanche/Land-slide	Removal of surface soils	Localized loss of vegetation and top soil	Susceptible to continued erosion; slow re-colonization
Ice Storm	None	Selective breakage of trees and shrubs; increased debris on the forest floor	May alter succession by favoring either early or late successional species

Fire

The specific ecological effects of forest fires vary and are influenced by fire behavior, vegetation type, topography, climate, pre- and post-burn weather, and a number of other factors (McCullough et al. 1998). Fischer and Bradley (1987) synthesize what is known about typical forest community responses to fire in western Montana forests.

Among the changes that fire can trigger in forests are modifications of the microclimate, increases in the range of soil temperatures, changes in soil nutrients and microbial activity, the 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, and changes in water storage capacity and the pattern of runoff (Paysen et al. 2000). Generalized plant succession patterns in western Montana following fires and the effect of fire on other key ecological process are summarized in Appendix 30.

LINKS

See Appendix 30 for more detailed information on the effects of fire on key ecological processes in forested ecosystems.

Click Here

Just as the ecological effects of fires vary, so do the characteristics of the fires themselves—the frequency, season, and size. General patterns do occur, however, and these describe what are called fire regimes. Historical fire regimes were important disturbance processes in western forest ecosystems (Agee 2001) prior to European settlement. They served to alter species composition, nutrient cycling, and other ecosystem structure and function attributes, and acted as one of the primary "coarse filters" that directed the natural diversity of the ecosystem (Hunter 1990). The primary fire regimes in the Flathead Subbasin are the *nonlethal (sometimes called the low-severity)*, the *stand-replacement*, and the *mixed severity* (figure 2.3). Understanding these three fire regimes is critical to understanding fundamental ecological processes in Flathead Subbasin forests. The following descriptions are from the Forest Management Plan for the Flathead Indian Reservation (CSKT 2000).

Nonlethal Fire Regime

The nonlethal fire regime occurs at low-to-mid elevations on mild slopes and dry southeast to west aspects. The fires that occur within this regime generally do not kill mature trees, although some of the most fire-susceptible mature trees often succumb. They are brief, low intensity fires that burn mostly grass and litter on the forest floor and kill seedlings, saplings and pole-size trees. They occurred frequently, sweeping through stands every five to thirty years, and many were started by Indian people. Barrett (1980) estimates Indian people may have doubled the frequency of these types of fires in many areas.

Prior to European settlement, nonlethal fires created a forest of large, old, mostly ponderosa pine trees. Many individual trees were from 200 to 600

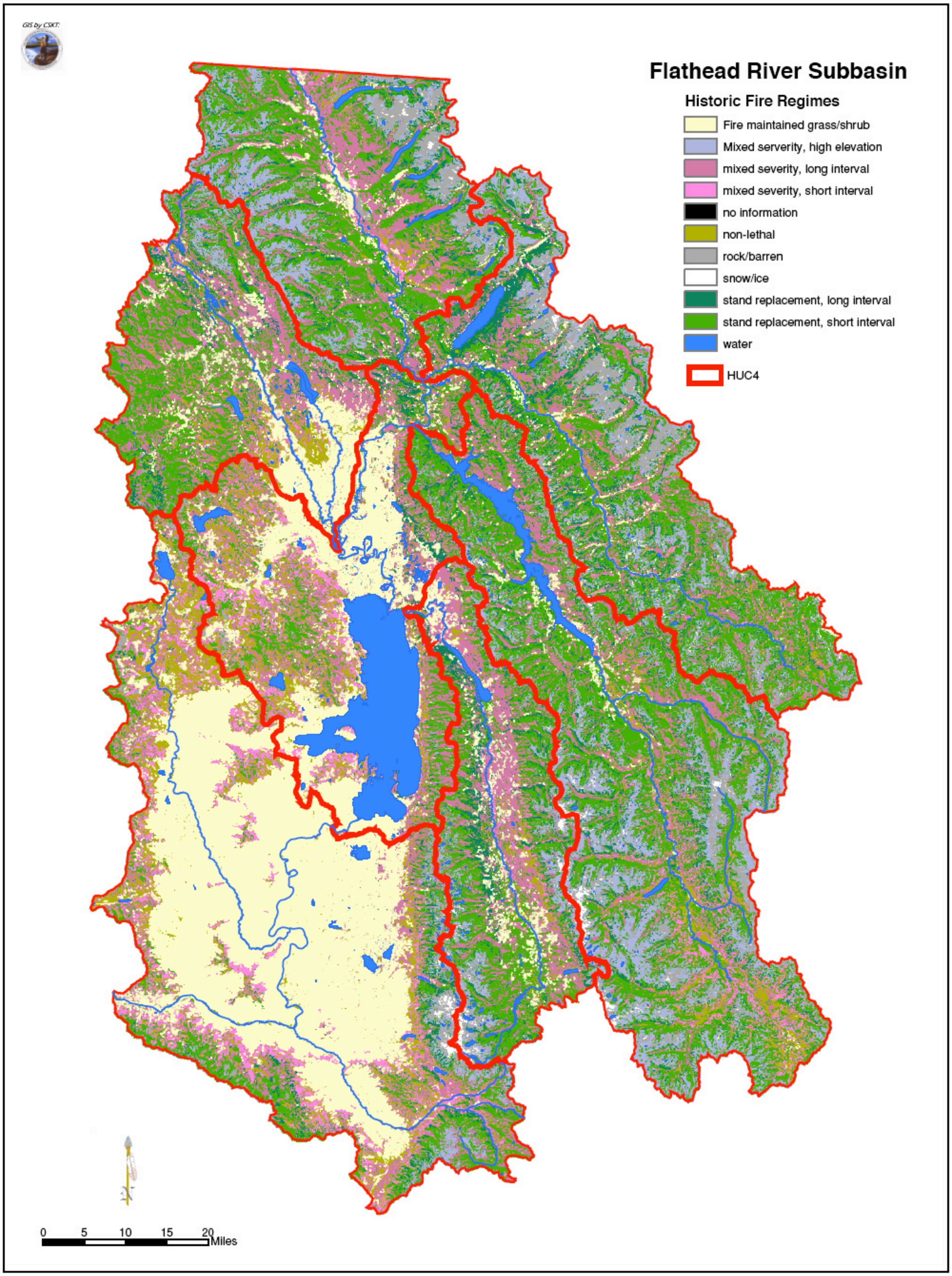


Figure 2.3. Historic fire regimes in the U.S. portion of the Flathead Subbasin.

years old. These stands were open and parklike with few shrubs, understory trees, or downed logs. In most, the duff layer rarely exceeded three inches. Stands tended to be uneven-aged although the pattern was dominated by small clumps of even-aged trees. Stands were also intermixed with fire-maintained grasslands and ponderosa pine woodlands. Occasionally bark beetles killed patches of trees and allowed a new age class to develop.

Stand Replacement Fire Regime

In the stand-replacing fire regime, fires kill most if not all the trees, although the size and intensity of the fire varies with topography, fuels, and burning conditions. Some fires consume thousands of acres in a uniform way; others create a complicated mosaic that consisted mostly of stand replacing burning mixed with smaller patches of unburned or lightly burned timber.

Stand replacement intervals are generally long — from 70 to 500 years — and probably varied with climatic cycles. Stands occur on steep, mid- to high-elevation slopes and are composed of grand fir, Douglas-fir, lodgepole pine, western redcedar, subalpine fir, and spruce. They are dense and typically contain substantial amounts of downed woody material and ladder fuels. The size of fires varied. Large fires occur on more gentle slopes and plateaus, while smaller fires burned in rugged mountain terrain where slopes and aspects create a variety of vegetative conditions. Prior to European settlement in areas where fires occurred relatively frequently, they created numerous open areas dominated by seral shrub species that provided forage for wildlife.

Mixed Severity Fire Regime

The mixed fire regime is characterized by a combination of nonlethal and stand-replacing fires. Fire frequency varies from 30 to 100 years, and individual fires can be either large or small in size. Most burn over relatively long periods. Two patterns are typical: In the first, a stand might experience nonlethal fires every 30 to 40 years and a stand-replacing fire every 150 to 400 years. In the second, fires kill fire-susceptible species growing in the overstory (such as subalpine fir), but leave fire-resistant trees (like big larch, Douglas-fir, and ponderosa pine). Prior to European settlement, the mixed fire regime created many small stands dominated by various age structures and was therefore rich in its diversity. Stands with open overstories of mature Douglas-fir and larch were common, although there were also closed, young stands. The general pattern could be described as a patchy mosaic. The regime occurs on low to mid elevations on all slopes and all aspects.

Among the most important ecological roles of fire in natural functioning ecosystems occurs in the nonlethal and mixed fire regimes. There fire tends to favor tree species that are more fire resistant and less vulnerable to insect attack, disease infection, and catastrophic fire. In all fire regimes fire can increase the variety of habitats for wildlife and is an important part of the forest nutrient cycle, especially on drier sites. Without periodic fires, nutrients become less available to plants and soil organisms, fuels accumulate, and the chance of resource-damaging fire increases.

LINKS

For detailed descriptions of disturbance processes and functions of the habitat groups in the Flathead Subbasin, go to Appendix 31.

Click Here

Insects and Disease

Forest insects and disease also play an important ecological role in properly functioning natural ecosystems. Like fire they have been a major factor shaping forests in the northern Rockies and provide a variety of benefits to wildlife and biotic diversity (Monning and Byler 1992). Indeed, episodic outbreaks of major defoliating insects may have played a similar and harmonizing role to that of surface fires with respect to forest succession (Holling 1981; Wickman 1978). For example, while western spruce budworm (*Choristoneura occidentalis*) and Douglas-fir tussock moth (*Orygia pseudotsugata*) feed on late successional Douglas fir and true firs (species that are relatively susceptible to fire), they do not attack seral pine species (which are fire resistant) (McCullough et al. 1998). Swetnam and others (1995) suggest that prior to European settlement, both low-intensity outbreaks of defoliators and surface fires probably kept fuel accumulations low, which would have prevented, or at least postponed, catastrophic stand-replacing outbreaks or fire. Recent outbreaks of western spruce budworm and Douglas-fir beetle (*Dendroctonus pseudotsugae*) are thought to effectively slowed the rate that Douglas fir replaced seral pines. Thus the insects are playing a role analogous to that of frequent surface fires (Hadley and Veblen 1993).

Because insects affect the accumulation and distribution of fuels and vegetation in profound ways, they often determine the risk of fire ignition, behavior, and intensity (Mccullough et al. 1998). The interplay between insects and fire often directs the process of forest succession after a disturbance (Mccullough et al. 1998).

Trees killed by fire and insects and disease play a key ecological role in subbasin forests. Dead and defective trees are known to be one of the most important contributors to wildlife diversity within forest ecosystems. About 25 percent of bird species in the Rocky Mountains are cavity nesters (McClelland et al. 1979). On the Flathead National Forest, 42 species of birds and 10 species of mammals use cavities found in dead or defective trees for nesting, feeding, or shelter. Dead and defective trees also serve as habitat refugia, enabling species such as lichens to persist that might otherwise be lost from the area; enrich the subsequent forest stand structure by providing a source of large snags and coarse woody debris; and improve the connectivity of the managed forest landscape (USFS 1998).

Appendix 31 (see Links column) includes detailed descriptions of disturbance processes and functions of the habitat groups in the Flathead Subbasin.

2.4.2 Human Alterations to Critical Coniferous Forest Functional Processes

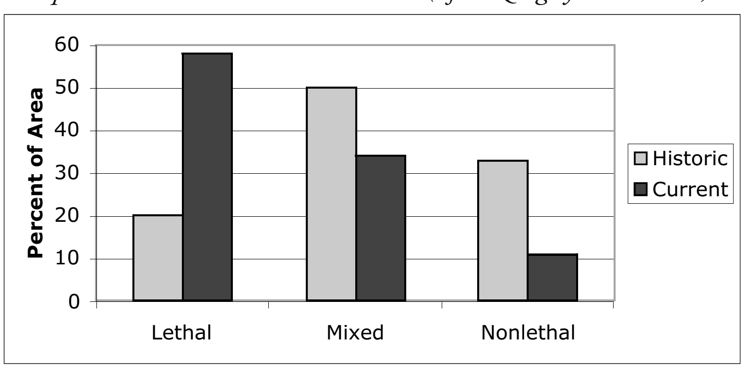
Through fire exclusion, logging, the introduction of non-native species, climate change and other perturbations, Flathead Subbasin forests have, over the last fifty to one hundred years, undergone a series of significant changes, including a loss of plant and animal diversity, shifts in tree species composition, changes in stand structure, and changes in patch size and edge (CSKT 2000). These changes have in turn caused fire regimes to shift. For example, areas that were formerly classified as nonlethal are now classified as stand replacement (CSKT 2000) (Figure 2.4).

LINKS

The TBA assessment estimates changes to the forest biome (xeric and mesic), many of which affect functional processes. Go to Appendix 73.

Click Here

Figure 2.4. Fire severity for FS and BLM administered Forested Potential Vegetation Groups in western Montana and Idaho (after Quigley et al. 1996).



Another result has been an increase in forest health problems, and even more fundamentally, the changes to forest structure, composition, and fuels have also altered basic ecosystem processes, making it difficult to predict how forests will respond to future disturbances.

The shift in the nonlethal and mixed fire regimes from low-density stands of western larch, Douglas-fir, and ponderosa pine to the present high-density stands of Douglas-fir and grand fir has been accompanied by accumulations of woody biomass, dead material, and forest floor fuels. Today these parameters are well beyond their historic range of variability. Essential plant nutrients such as nitrogen, phosphorus, and sulfur from below ground to above ground where they are largely unavailable to plants and are easily volatilized by burning. Burning, in turn, causes substantial losses of these nutrients, which adversely affects site productivity and sustainability, especially in the inland Northwest where nitrogen and sulfur are limited (Mutch et al. 1993).

Excluding fire from subbasin forests has also altered forest succession. The shifts in composition of the overstory have been accompanied by changes in the species composition of the understory. In other areas of the inland Northwest where there has been a similar shift, ecologists fear that seed reserves from pre-fire-exclusion days may no longer be viable, and sprouting species may have lost vigor to the extent that they cannot survive, even when the overstory is removed. These changes are so significant that ecologists now have difficulty predicting how plant succession and vegetation diversity will respond to various intensities of fire, seasons of burn, and fire frequencies (Mutch et al. 1993).

2.4.3 Presettlement Coniferous Forest Habitat Condition

Habitat Groups and PVGs

Table 2.5 summarizes the presettlement characteristics of habitat type groups in the Flathead Subbasin (USFS 1999). The following paragraphs[15] summarize presettlement characteristics of each of the PVGs in the subbasin.

Warm-Dry Potential Vegetation Group

This group is characterized in a naturally functioning ecosystem by open-grown multi-aged stands of ponderosa pine, western larch and Douglas-fir with grass and shrub understories. Most of the sites occur at lower elevations on all aspects or on higher elevations on southerly and westerly aspects.

LINKS

The TBA assessment estimates presettlement coniferous forest biome (xeric and mesic) acres. Go to Appendix 73.

Click Here

In a reconstructive study of the historic conditions of 11 old growth ponderosa pine and western larch stands in western Montana, Arno and others (1997) found that: “Frequent low-intensity surface fires at average intervals of between 5 and 30 years maintained many of the pine and pine-larch stands in an open parklike condition with sparse understories. Old growth larch stands on sites too cold or moist for ponderosa pine generally had a history of either (1) mixed severity fires at intervals of 30 to 75 years, or (2) stand-replacement burning at mean intervals of 120 to 350 years.”

In a discussion of old growth management in the Northern Rocky Mountains, Habeck (1988) states, “Large portions of this region’s pre-1900 timber

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[15] *Excerpted from USFS (1998).*

Table 2.5. Summary of historic conditions of Potential Vegetation Groups (PVGs).

PVG	Habitat Type Group	Predominant Fire Regime	Historic Patch Size	Historic Species Comp.	Historic Stand Structure
Warm and Dry	1	Nonlethal low severity 5 to 25 year FRI (see note)	<5 ac small openings, within 20-200 ac patches	PP with lesser amounts of WL and DF	diverse mix, open stand, well spaced trees (5-20 tpa) interspersed with larger openings and dense patches, multi-aged, 1-2 stories. Ave. basal area 50-80 sq. ft/ac
	2	South aspect-nonlethal, low severity 15-45 yr. FRI	variable size small openings (0-5 ac), within 20-200 ac patches created by mixed and lethal fires	PP/DF dry, lower elevations	diverse mix, open stand well spaced trees (15-30 tpa) interspersed with larger openings and dense patches, multi-aged and 1-2 stories. north slopes more even-aged and single storied with some variety in size/age.
		North aspect-nonuniform mixed severity 15-45 yr. FRI		WL/LP with PP moist upland	
		Nonuniform lethal stand replacement ave. 225 yr. FRI			Ave. basal area 60-100 sq.ft/ac
	3	Nonlethal, low severity 25-50 yr. FRI	5 to 50 ac	WL/DF/PP dry, lower elev	variable, gaps to large even-aged single storied patches to larger area multi-aged multistory and single story open grown stands.
		Mixed severity, 70-250 yr. FRI on cool, wet sites. 30 yr. FRI on warm, moist sites. 75-80 yrs in LP stands			
		Nonuniform, lethal stand replacement 100-250 yr. FRI		WL/DF/LP moist, uplands	ave. basal area 80-120 sq ft/ac, more in riparian areas. tpa ranged from 15-60

cover were dominated by fire-adapted and/or fire-dependent conifers—ponderosa pine, lodgepole pine, western larch and western white pine."

Of the estimated 24 million acres of historic ponderosa pine cover type in the Interior Columbia Basin Ecosystem Management Project area, 1.2 million acres (5 percent) burned annually. Approximately 0.36 million acres or 2 percent of the 19 million acres of interior Douglas-fir and larch burned annually (Barrett et al. 1997).

Table 2.5 (cont.). Summary of historic conditions of Potential Vegetation Groups (PVGs).

PVG	Habitat Type Group	Predominant Fire Regime	Historic Patch Size	Historic Species Comp.	Historic Stand Structure
Warm and Moist	4	South aspects nonuniform, mixed severity 30-85 yr. FRI North aspects nonuniform, lethal stand replacement, ave. 200 yr. FRI	20-75 ac 100-300 ac or more	WL/DF with LP,GF,WP, PP	varies with topography. two storied, even and uneven-aged in lowlands. single and two storied, even-aged in upland areas. basal area ave. 150-200 sq ft/ac and 30-50 overstory tpa in upland areas to over 200 sq ft/ac in valley bottoms
	5	North aspects nonuniform, lethal stand replacement 250+ FRI (110-340 yr. range) South aspects nonuniform, mixed severity 75 yr. FRI (17-113 yr. range)	100-300 ac w/ potential for larger 100 ac or less	WL/DF with WP, ES,LP,GF,WR C,WH	varies with topography. two storied, even and uneven-aged in lowlands. often two-aged and storied in upland areas. basal area ave. 150-200 sq ft/ac and 30-50 overstory tpa in upland areas to over 200 sq ft/ac in valley bottoms

Warm-Moist Potential Vegetation Group

This group is characterized in a naturally functioning ecosystem by multi-aged and even-aged stands of primarily shade-intolerant western larch, Douglas-fir, western white pine, lodgepole pine and Engelmann spruce. Stands also include, and occasionally are dominated by, shade-tolerant western redcedar, western hemlock and grand fir (Arno 1990). Most of the sites occur at lower slopes and valley bottoms, or mid-slope on northerly and easterly aspects.

Historically, fire intensity was variable, with slightly higher proportion of high severity fire regime than the warm-dry PVG. Fire intervals commonly

Table 2.5 (cont.). Summary of historic conditions of Potential Vegetation Groups (PVGs).

PVG	Habitat Type Group	Predominant Fire Regime	Historic Patch Size	Historic Species Comp.	Historic Stand Structure
Cool and Moist	7	Lethal, stand replacement >100 yr. FRI in LP/DF, 120-268 yr. in L/DF, up to 300 yrs in spruce bottoms Less prevalent nonuniform mixed severity, 50-70 yr. FRI in LP/DF, 38-120 yrs in L/DF, up to 120 yr. in ES	5,000 to 100,000 ac 100 ac or less	WL,LP,WP,ES, DF with GF,SAF	mostly even-aged single storied and two storied, some dense LP stands basal area ave. 80-120 sq ft
Cold Moist	9	Nonuniform stand replacement 100-115 yr. FRI Some mixed severity, nonuniform burns 50-71 yr. FRI	5,000 to 100,000 ac 50-300 ac	LP,SAF in frost pockets LP,SAF,ES,DF, WL on moist upland sites	even-aged LP with scattered relic overstory WL, some stands mixed with DF, SAF basal area ave.. 80-120 sq ft
Cold	10	Low -mixed severity 35-300+ years * stand replacement 200+ years	overall 200-30,000 ac, averages 2,400 ac	WBP, ES, LP with SAF,MH	fairly open stands with clustered trees uneven-aged, mosaic
	11	low-mixed severity 35-300+ yrs stand replacement 200+ years	overall 200-30,000 ac, averages 2,400 ac	alpine larch, WBP, ES,SAF	mosaic vegetative patterns, open stands with clustered and shrublike trees, uneven-aged
Riparian	6	Fire is not a significant disturbance agent Infrequent, low severity or stand replacement 300-400 yr. FRI	Varies with stream channel and disturbances from adjacent stands	WRC,WH,WP, WL, ES	old growth characteristics, multi-aged, fairly dense but multi-storied canopy of large trees with shade tolerant understory
	8	Fire is not a dominant disturbance agent infrequent low severity or stand replacement 150-250 yr. FRI (ave. 220 yrs)	varies with stream channel and disturbances from adjacent stands	WRC,WH,WP, WL, ES	old growth characteristics, multi-aged, fairly dense but multi-storied canopy of large trees with shade tolerant understory

range from 50 to 200 years. However, some cedar and hemlock stands are located in topographic and physiographic settings that avoid fire disturbance for several centuries (Camp et al. 1997). On grand fir habitat types in the Swan Valley, when stands over 150 years old burn, western larch frequently dominates the regenerated stand; if stands are younger, lodgepole pine is favored. Historically, only a few stands escaped fire long enough for grand fir to dominate (Antos and Shearer 1980; Antos and Habeck 1981).

Cool-Moist Potential Vegetation Group

In many attributes, this group is intermediate between the warmer and more moist types generally below it in elevation and the cooler and drier types above it. Conifer species diversity can be high, with shade intolerant species including western larch, Douglas-fir, western white pine, lodgepole pine and occasionally ponderosa pine. Shade tolerant conifer species found in this PVG include subalpine fir, grand fir, and Engelmann spruce.

Historical fire regimes were quite variable, with Sneck reporting a fire interval of about 130 years for mixed severity fires at Coram Experimental Forest (Fischer and Bradley 1987). In the Swan Valley, fire intervals before 1905 were about 30 years, with extremes between 10 and 100 years. The presence of larch and lodgepole pine suggest that the fires were of higher intensity (Freedman and Habeck 1984). Fires burned tens of thousands of acres in western Montana during the period 1889 to 1924. An example of this is the August, 1929 Halfmoon Fire in the northern Flathead Valley (Gruell 1983). In a study of fire regimes in Glacier National Park, Barrett and others (1991) found that moist subalpine fir habitat types had evidence of one or two nonlethal surface fires occurring between infrequent stand-replacing, high severity fires. Long (1998) estimates that more than 65 percent of this PVG has a severe fire regime historically and the remainder either moderate or low. In naturally functioning ecosystems, dense, even-aged lodgepole pine cover types usually resulted from lethal fires. In contrast, some ponderosa pine and western larch cover types in the Swan Valley were historically maintained in open parklike stands by mixed severity fires.

Cold-Moist Potential Vegetation Group

This group is typified by even-aged and multi-aged stands of primarily shade intolerant lodgepole pine, Douglas-fir, and western larch in a naturally functioning ecosystem. Stands can be occasionally dominated by shade tolerant subalpine fir and Engelmann spruce. Most of these sites occur on rolling ridges and upper convex mountain slopes on south and west aspects.

Fire regimes were historically about 50 percent lethal (very infrequent), 35 percent moderate severity (infrequent) and 15 percent low severity (very frequent) (Long 1998). Arno (1985) reported approximately 40 to 60 percent of the stands he studied in this PVG had evidence of ground fire after establishment. Usually this happened when the stand was mid seral, before heavy overstory mortality and stand breakup that is typically associated with late seral or old growth conditions. These ground fires readily killed subalpine fir but generally did not kill western larch and Douglas-fir. Lethal fire return intervals were commonly 100 to 200 years or more, and likely were associated with insect epidemics. Nonlethal fires historically occurred on a 50 to 130 year interval (Fischer and Bradley 1987). Generally, lodgepole pine results from the mountain pine beetle outbreak and lethal fire disturbance cycle common to this PVG (Monnig and Byler 1992). Historically these fires created surface fuels that frequently reburned 40 to 80 years later (Lotan et al. 1985). Now with effective fire suppression, mountain pine beetle alone causes significant fuel buildup.

LINKS

For more information on historic forest conditions, see Appendix 32.

Click Here

Cold Potential Vegetation Group

This group is typified by even-aged and multi-aged stands of primarily shade intolerant whitebark pine and occasionally alpine larch in a naturally functioning ecosystem. Stands can be dominated by shade tolerant subalpine fir and Engelmann spruce. This PVG occurs at high elevations on severe sites, significantly extending tree line. In his landscape assessment of the decline of whitebark pine, Keane and others (1994) found: "Fire history was difficult to determine in the BMWC [Bob Marshall Wilderness Complex] because of the rarity of fire-scarred trees in the whitebark pine zone. It appears that stand-replacement fires killed most trees leaving few fire scars on the landscape. However, an approximate fire history was determined from stand age structure and the few fire scars found. The estimated fire return interval for the entire study area was approximately 144 years.

Geographic Area Descriptions

The following paragraphs summarize presettlement forest conditions and fire frequencies for the Flathead National Forest[16] and the Flathead Indian Reservation. Appendix 32 includes more detailed information on presettlement forest conditions in the subbasin.

[16] *Condensed from Losensky (1992) and CSKT (2000).*

In the North Fork of the Flathead River, lower elevation stands of western larch, with ponderosa pine and Douglas-fir on drier sites, and spruce along the drainages, experienced light underburns every 10 to 25 years (Sneck 1977). Ayres noted a large western larch 379 years old, suggesting that the trees on the valley bottom were probably in the 250 to 500 year category. Stand-replacement burns on mid to upper slopes probably occurred on average between 120 and 180 years. Following severe stand-replacing fire events, portions of the drainage regenerated to lodgepole pine, with occasional larch overstory that survived the fires.

The main valley of the Middle Fork of the Flathead River typically had a mixed tree species composition, with stand replacement burns occurring on average every 170 years. Mid to upper slopes typically contained lodgepole pine with lesser amounts of Douglas-fir. Subalpine fir was more common on the upper ridges along with whitebark pine. Fire probably swept the upper part of this drainage repeatedly.

A study in the Coram Experimental Forest (Sneck 1977), which is similar to many areas of both the lower Middle Fork and South Fork, indicated that fire intervals were >117 years on valley bottoms, 121 years on montane slopes, 146 years on lower subalpine slopes, and >146 years for upper subalpine slopes. A fire occurred somewhere in the experimental forest every 11 years during the study period. Most fires were small (50 to 225 acres) and moderately intense, with occasional "runs" of high intensity on the upper slopes. This burn pattern maintained relatively open, mixed stands of western larch, Douglas-fir, and lodgepole pine on the lower slopes. On areas with multiple burns, lodgepole pine was the major species.

Much of the lower portion of the South Fork contained relatively heavy stands of ponderosa pine and larch. These sites were not free from fire, with under-burning commonly occurring at frequent periods. In addition, small stand-replacement burns occurred in the timbered bottoms. The largest trees in this drainage ranged from 40 inches for ponderosa pine and western larch, to 24 inches for lodgepole pine. Some cedar 34 inches in diameter were seen but the size was considered exceptional. Mid and upper slopes showed extensive replacement burns, although old growth stands did develop in areas missed by these events. On average, stand replacement fires occurred every 122 to 148 years.

In the Swan valley, the valley bottom, benches and lower foothills were covered with dense stands of western larch, Douglas-fir and ponderosa pine. Understories of spruce, Douglas-fir and larch were common in the lower valley, while the upper portion was dominated by lodgepole pine and larch. Ayres noted that in the lower valley, these stands were considerably scarred by fires but relatively intact, especially in the tributary streams. Western hemlock, cedar and white pine were found in sheltered areas. Tree sizes reached 48" diameter for ponderosa pine, with spruce and western larch more commonly 30", and lodgepole pine reached 14". The mid to upper slopes were dominated by stand-replacing fires which covered extensive areas, probably occurring on a 100 to 170-year interval. Lodgepole pine appeared to dominate these slopes. On moist sites missed by fire were mixed stands of lodgepole pine, Douglas-fir and spruce. Old stands of spruce and subalpine fir were found in high basins.

The broad valley bottoms of the Stillwater and Flathead Lake watersheds were typified by long intervals between stand replacement events, which normally affected small patches. These areas were dominated by open ponderosa pine and western larch stands. On mid slopes, mixed conifer old growth was most likely found along riparian areas or in areas that escaped the last stand replacement fire.

On the Flathead Reservation, the nonlethal fire regime was generally maintained in a late seral, parklike condition where large trees dominated. Shrubs, understory trees, and downed logs were sparse, as testified to by dozens of historical photos and narrative accounts. Undergrowth was composed primarily of fire-dependent grasses and forbs which resprouted quickly after each burn. The most fire-resistant species — ponderosa pine and western larch — were favored. Pine regeneration occurred whenever overstory trees died, thereby creating small openings. Trees were often distributed in small even-aged clumps. Old pines and scattered Douglas-fir often had scars from numerous fires dating back to the early 1600s. In addition to these parklike stands, woodland structures made up a significant portion of the Nonlethal Fire Regime, and they still do. Woodlands are characterized by widely scattered large ponderosa pine trees on very harsh sites. Bunchgrass and seral shrubs make up the understory. These sites were generally maintained in a parklike condition where large trees dominated.

At lower to mid elevations of the Reservation, the lethal fire regime was characterized by grand fir/western redcedar and Douglas-fir/larch types. At upper elevations subalpine fir, spruce, and whitebark pine types dominated. The warm, moist grand fir and western redcedar habitat types occurred in valley bottoms, riparian areas, benches, and protected exposures (many tree species can occupy these sites, but grand fir and western redcedar are commonly the climax species). Elsewhere at these elevations, western larch, Engelmann spruce, lodgepole pine, and Douglas-fir were a major component of seral stands. Subalpine fir, lodgepole pine, and whitebark pine occurred at mid to upper elevations, the latter on cold, wetter sites. Undergrowth was characterized by a rich variety of moisture-loving herbs and shrubs. Though fires killed trees over large areas (from 25 to 500 acres in fir types and from 100 to 10,000 acres in lodgepole stands), relatively small, partially burned or unburned areas were produced by rugged mountainous topography that contained contrasting site types, microclimates, and vegetation. Patches of surviving trees were generally limited to moist, protected areas, or places where fuels were lighter and more discontinuous.

In the mixed fire regime on the Reservation, fires maintained a diverse pattern of forest vegetation of varying ages, compositions, and health that was shaped by fuels, topography, and climate. Stand- and partial stand-replacing fires typically swept through this zone about every 100 to 200 years, but lower intensity blazes that created small openings of burned understory vegetation and that killed only a few trees occurred as often as every 20 to 30 years. The fires generally killed overstory trees in an irregular pattern as a result of lethal heating at the ground level or fire moving into the crowns of individual trees. The result was a mosaic pattern of various shaped patches of live, mixed-seral forest, and openings occupied by dead trees or even-aged regeneration. Lightning and native-set fires most likely spread over periods of weeks or months in these mixed conifer forests, so burns often covered large areas. Patches were fine grained and had curved edges and a high degree of internal structural diversity (snags, islands of residual trees, etc.). The uneven burning pattern in the Mixed Fire Regime was probably enhanced by the pattern from previous burns and complex mountain topography.

2.4.4 Present Coniferous Forest Habitat Condition

Basic information about current forest conditions (forest types, habitat groups, number of trees, tree sizes, etc.) is summarized in Appendix 33.

Table 2.6 shows the existing proportions of the various seral stages for Flathead National Forest lands and surrounding and intermingled lands in other ownerships (USFS 1998). The following paragraphs, excerpted from USFS (1998), describe the current conditions of potential vegetation groups (PVGs).

LINKS

The TBA assessment estimates coniferous forest biome (xeric and mesic) acres and assesses various impacts by subunit. Go to Appendix 73.

Click Here

Warm-Dry Potential Vegetation Group

Today, fire suppression and selective harvest has reduced the proportion of shade intolerant ponderosa pine and western larch and increased the proportion of dense, shade-tolerant Douglas-fir and grand fir across the landscape. Selective harvest, along with insect or disease mortality associated with increased stand densities, has simplified stand structures by removal of large trees. Together, fire suppression, even-aged and selective harvesting have created stand structures and compositions that differ significantly from the historic conditions. In a recent paper on old growth ponderosa pine and western larch in western Montana, Habeck (1990) states that: "The understory Douglas-firs have the potential to

Table 2.6. Existing proportions of seral stages.

Community Seral Stage	% of All Land	% of National Forest
Subalpine		
Early Seral	3%	4%
Mid Seral	16%	20%
Late Seral	3%	3%
Montane		
Early Seral	9%	9%
Mid Seral	41%	39%
Late Seral	7%	11%
Lower Montane		
Early Seral	<1%	<1%
Mid Seral	2%	1%
Late Seral	<1%	<1%
Non-forest	19%	13%
Total	100%	100%

LINKS

For basic information about current forest conditions, go to Appendix 33

Click Here

serve as fuel ladders, which would conduct a present day fire into the crowns of the surviving old-growth trees, probably ending their lives."

In the Northern Glaciated Mountains, a portion of the Upper Columbia River Basin located in northern Washington, Idaho and Montana, the areal extent of dense, mid-seral forests is estimated to be two to three times the amount found historically. The areal extent of late and early seral conditions is substantially below the historic range (Hann et al. 1997). Ironically, exclusion of low intensity fires has set the stage for a future fire regime where fires are larger, more intense, stand-replacement events because of the increased fuel loads and because of the loss of large fire-resistant ponderosa pine and western larch (Arno et al. 1995; Arno 1996). Currently, native forest insects and pathogens are at endemic levels. Populations are generally expected to rise as trees experience water stress induced by increasing tree densities. A recent analysis of Crane Mountain on the Flathead National Forest by Barrett (1998) found: " ... long-term fire exclusion has promoted canopy closure and increasingly heavy dominance by shade tolerant species in most ponderosa pine stands. Many are now highly decadent because of overstocking, mistletoe infections, and bark beetle attacks. Root rot pockets and heavy downfalls are also common."

At Crane Mountain and in the Island Unit of Swan Lake Ranger District, Douglas-fir dwarf mistletoe infections exceed historic levels. Historically, the extent and severity of dwarf mistletoe infection was controlled by low and moderate severity fires that reduced the proportion of Douglas-fir. In the absence of fire, Douglas-fir is increasingly infected by dwarf mistletoe (Habeck 1990). The stress caused by this parasitic plant leaves the trees more vulnerable to root rot and bark beetle mortality. The large witches' brooms are highly flammable and increase the probability of a high severity, lethal fire (Hawksworth and Wiens 1996).

Warm-Moist Potential Vegetation Group

The combination of the non-native white pine blister rust (Monnig and Byler 1992) and mountain pine beetle, followed by salvage harvest since the 1940s, has changed much of what was historically large multi-storied western white pine to dense medium multi-storied grand fir and Douglas-fir (Byler et al. 1990). While never a dominant cover type in the Flathead Subbasin, the loss of western white pine has removed one of the more fire resistant trees from the ecosystem. More lethal fires are a result as compared to historic regimes.

LINKS

For more specific information on how subbasin forest communities have departed from their presettlement condition, see Appendix 34

Click Here

The most fire resistant tree in western Montana is western larch. Historically, wildfires created the full or nearly full sunlight conditions necessary for regeneration of western larch. Effective fire suppression and selection harvest over the past several decades have put larch at a competitive disadvantage compared to its shade tolerant associates (Fiedler and Lloyd 1995; Carlson et al. 1995). Again, this results in a shift from historically low and moderate severity fire regimes to current high severity, lethal fire regimes as stands become increasingly dominated by shade tolerant trees that are not resistant to fire.

In a discussion of the role of fire in the Cedar/Hemlock zone in Glacier National Park, Habeck and Mutch (1973) suggest that "Man's protection activities now are contributing to forest-cover alterations that may not have occurred before 1900." Current fire regimes produce larger, more intense, stand-replacement fires as a result of the loss of large fire-resistant western white pine and western larch, and the increased fuel loads. Currently, native insects and pathogens are at endemic levels, but are expected to increase due to water stress induced by increasing tree densities.

Cool-Moist Potential Vegetation Group

With continued fire exclusion, old growth stands are undergoing marked change in structure and composition. Stands currently featuring fire-dependent, seral old growth trees are expected to become gradually dominated by shade tolerant species, more prone to lethal stand replacement fires (Elzinga and Shearer 1997).

The Red Bench fire in the North Fork of the Flathead in 1988 is an example of a severe fire. Barrett and others (1991) found that the Red Bench fire "killed many >350 year-old western larch and ponderosa pine that previously had survived up to seven fires each." Similar severe fire effects are likely to become more common in this PVG.

Cold-Moist Potential Vegetation Group

Most lodgepole pine stands today are mid seral, which is a significant departure from the historic proportions of early and late seral structure classes. A widespread mountain pine beetle epidemic over the past 2 decades has killed much of the older mature classes. It is thought that the severity of this mountain pine beetle epidemic was increased as a result of fire suppression efforts over the preceding 3 or 4 decades. Many of the lodgepole pine stands that experienced significant mortality are slow to regenerate in the absence of disturbance by either fire or harvest. These sites will likely regenerate to subalpine fir and create a condition similar to the Bitterroot where the areal extent of subalpine fir nearly doubled between 1900 and 1991 (Arno et al. 1993).

In the absence of mixed severity fires, many of the overstocked Douglas-fir dominated stands on southerly aspects are experiencing significant root rot related mortality (Byler et al. 1990).

Cold Potential Vegetation Group

Whitebark pine is being reduced at accelerated rates by white pine blister rust, mountain pine beetle and advancing succession. At three study sites in the Flathead, Keane and Arno (1993) found an average of 50 percent mortality from blister rust in a 20-year period and nearly all the remaining green trees were infected; a rate similar to that found by Kendall and Arno (1990) in adjacent Glacier National Park. Keane and others (1994) conclude that, while blister rust is killing many trees, perhaps more importantly: Succession replacement of whitebark pine by subalpine fir and Engelmann spruce is also a major cause of whitebark pine decline. Policies of fire exclusion in the BMWC over most of the last 50-60 years has resulted in a high proportion of subalpine forest dominated by subalpine fir and Engelmann spruce."

To describe the magnitude of the decline and corresponding treatments needed, Arno and Weaver (1990) state: "Even management programs that allow some natural fires to burn are probably insufficient for mimicking whitebark pine fire cycles of the past. The most effective fires in the highly discontinuous whitebark pine habitats (atop high isolated ridges) were ones that spread over large expanses — hundreds of thousands of acres."

Arno and others (1993) found at a study area in the Bitterroot, that while in 1900 14 percent of the area was dominated by whitebark pine, by 1991 none were dominated by whitebark pine.

Major Trends

In addition to the changes to each PVG, it is possible to identify major trends that have occurred over the last 150 years within and adjacent to the subbasin's coniferous forest biome. These trends are summarized in the paragraphs that follow[17]:

Shrinking grasslands at the forest edge

In pre-European times, fires kept grasslands free of most trees and shrubs. However, without fire, trees are able to gain a foothold. The net result has been an overall increase in total forest acres and a corresponding decrease in interior and exterior grassland. The trees in this "new forest" zone are often densely stocked and subject to extreme drought stress. They are often weak and susceptible to insect and disease attacks as well as stand-replacing fires. At the same time, the productivity of many seral herbs, shrubs, and aspen stands has declined due to the absence of fire and forest densification. By excluding fires, we have suffered a loss of the meadow and forest-edge habitats that were traditionally key summer calving and wintering areas for ungulate. These open pockets were also home to a variety of songbirds, upland gamebirds, small mammals, specialized insects, and unique plant communities — organisms that require undeveloped open habitats within or at the forest edge. In some areas, we have recreated these openings with clearcuts.

Declines in overall diversity

Because of fire exclusion policies and past forest practices, forest communities in many places are becoming uniform blankets of similarly aged trees. Gone is the complex mosaic of pre-European times, a mosaic that contained a tremendous diversity of forest habitats. That diversity has been traded for a more impoverished forest dominated by just a few kinds of structures. Without changes in management, this trend will continue; our forest will become even more habitat impoverished.

Major shifts in species composition and stand structure

Over the last 50 to 100 years, climax species like Douglas-fir, which tolerate shade, have increased at the expense of seral species like ponderosa pine. The same dynamic—climax species overtaking seral species—continues, although the trend is most apparent at lower elevations in the Nonlethal Fire Regime, where ponderosa pine stands are giving way to Douglas-fir. For example, on the Reservation in 1945, Douglas-fir made up only 26 percent of the forest, while ponderosa pine occupied 59 percent. In 1981, Douglas-fir had increased to cover

[17] *Excerpted from the Flathead Indian Reservation Forest Management Plan (2000).*

42 percent of our forests, while, ponderosa pine had dropped to 22 percent. Douglas-fir is much more susceptible to a variety of insect pests and diseases.

Increases in forest density

Without disturbance like fire, stand density has increased substantially over what it was during pre-European times. The availability of moisture, nutrients, and light limit the number of trees that can grow on each site, so as trees become more crowded, stresses increase due to competition. As stresses increase, trees become more susceptible to attack by insects and disease, agents that kill trees. The result is a build up of fuels giving rise to larger more destructive fires.

Changes in patch-size and edge

A *patch* is an area of vegetation that is relatively homogeneous and that differs from the vegetation that surrounds it. The boundary between two patches is referred to as an *edge*. Fire exclusion policies have caused an increase in the average patch size and a decrease in the amount of edge, particularly in the mid-elevation Mixed Fire Regime. The size of patches and the amount of edge is important for wildlife.

Shifts in the ages and sizes of trees

There have been two kinds of changes, one at low elevations and another at middle to high elevations. During pre-European times, lower elevation forests were shaped principally by frequent, low-intensity fires, which left a forest of ancient pines. Now because most of those large pines have been logged off and fire has been removed from the ecosystem, these stands have, in many areas, been replaced by younger pine and Douglas-fir trees. At higher elevations, stand replacing fires were the rule before European settlement. These fires created more large openings. Today, these higher slopes are covered by similarly aged, older trees. The mosaic of old and young stands present in pre-European times are generally absent. Although logging has created new openings that are now filled with young trees, the general trend in many areas is still toward larger trees in this zone.

Increases in roads and other human developments

Roads increase access for humans, thereby reducing security for ungulate and other animals. Roads also increase runoff and sediment entering streams, which harms fish. Over the past century, road densities in non-wilderness forested acres of the subbasin have greatly increased. Figure 2.5 shows road densities in the U.S. portion of the Flathead. For a description of the effects of roads on focal and target species, see Trombulak and Frissell (2000).

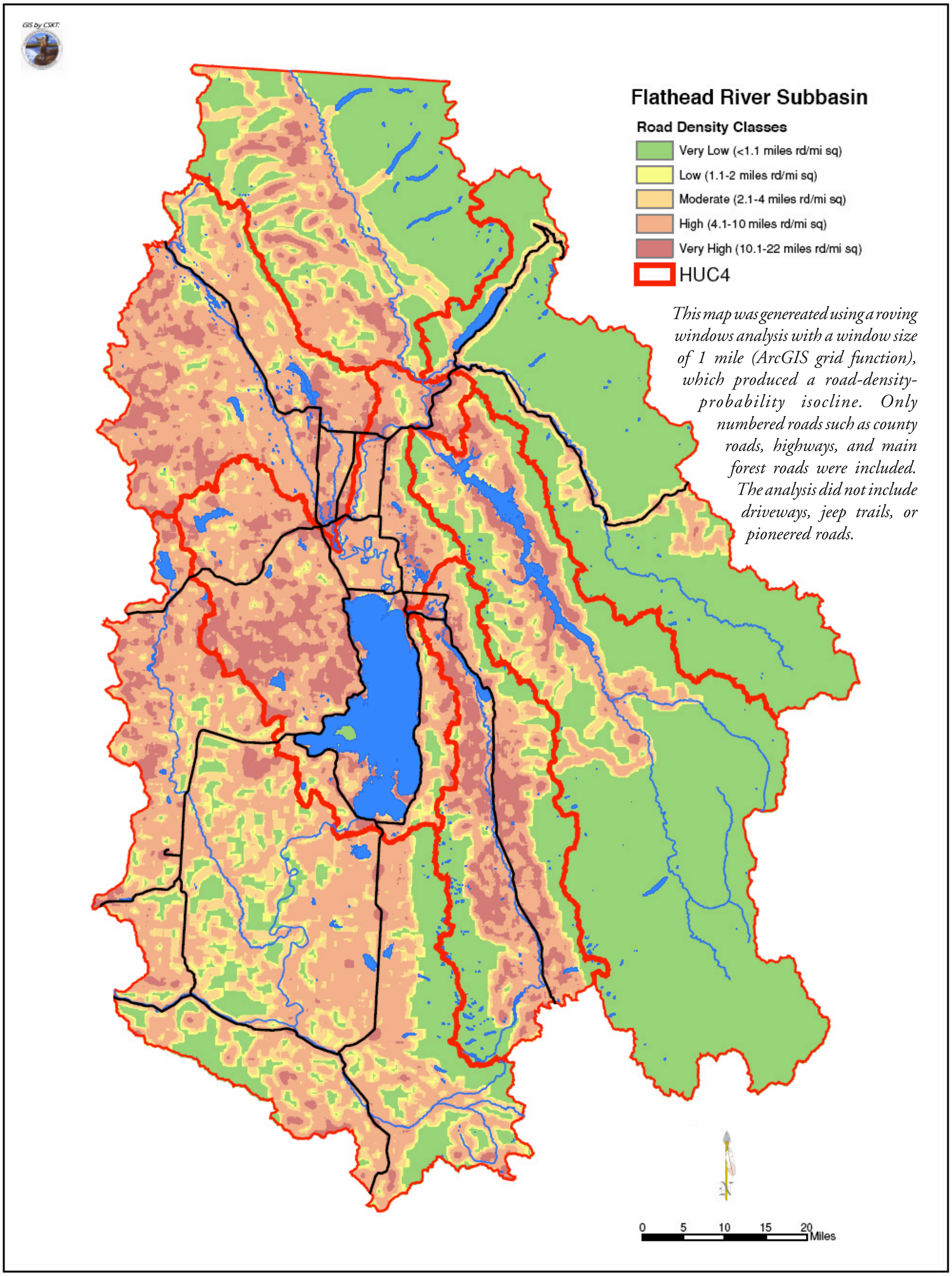

Figure 2.5. Road densities in the U.S. portion of the Flathead Subbasin.

Losses to Hungry Horse

Hungry Horse Reservoir inundated 16,636 acres of forest habitats. The specific forest types that were lost are listed in table 2.7.

Table 2.7. Riparian acres lost to Hungry Horse Reservoir. Source: Casey et al. 1984.

Type of Forest Habitat Lost	Acres
Upland Shrub	5,713
Dense Seral Lodgepole Pine	229
Old Growth Conifer	568
Unspecified Conifer	10,126
Total	**16,636**

2.4.5 Potential Coniferous Forest Condition

Under this scenario, unnatural fuel accumulations will have first been removed using mechanical treatments in coordination with prescribed fire, making it possible for fire to play a more natural role on a larger scale than today. Wherever possible, prescribed fire (broadcast burning, under burning, prescribed natural fire, and stand replacement fire) would have been used for a period of decades on a large scale—landscape-sized prescriptions—to bring forest communities to a more natural condition. Fire will have been prescribed so that some forest floor duff and large woody material remain.

Natural fire frequencies will have been returned to encroached grassland areas that border forests to reduce or eliminate woody species. In the nonlethal fire regime, understory fires will have been repeated about every 7 to 25 years to control fir regeneration and to prevent accumulations of fuel that could support intense wildfires. In this fire regime, the long-term goal will be to maintain a continuous, open overstory of healthy seral pine and larch through innovative forestry systems involving retention shelterwood, single tree selection, and group selection systems in conjunction with periodic under burning. Planting of seedling ponderosa pine and larch will be done in many areas to obtain adequate regeneration.

Where it is not possible to use prescribed fire, managers will apply mechanical management techniques to encourage a fire-adapted ecosystem. They will leave some tree crowns and large downed woody material on site to reduce the loss of nutrients and to improve productivity. On these sites, pine and larch will have been reestablished through a series of stand entries for selective harvesting followed by natural regeneration or planting. Fuel buildup will be reduced by mechanical treatments, and ponderosa pine forests will be managed for lower tree densities and much less of a coniferous understory than we see today.

As a result of these practices, biological diversity will have improved, as will the vigor and vitality of plant communities, the availability of species palatable to ungulates, and the production of cone crops from seral tree species. The fire hazard will have declined, as will the invasion rate of non-native species, and a more natural species composition will have been established. Forests will be more fire tolerant and pest and disease resistant. The effects that fire has on a site—thermal, chemical, nutrient cycling, structure, as well as the unknown roles that fire plays in ecosystems—will also be substantially restored.

Road management policies will have reduced open and closed road densities and local land use will have reduced the rate of development in the wildland urban interface.

2.4.6 Future/No New Action Coniferous Forest Condition

Under this scenario—a continued policy of strict or modified fire suppression; timber harvesting that poorly mimics natural disturbance events; the use of prescribed fire only in isolated situations; continued road building and residential development—the health of the forest biome will have continued to decline. Insect and disease infestations will have spread; lethal wildfires will now occur in areas that during presettlement times supported nonlethal fire regimes; natural reproduction of larch and pine will continue to be poor; Douglas-fir and the true firs will continue to replace shade-intolerant conifers in many areas; and the natural distribution of shrubs, forbs, and wildlife will be adversely affected by the shifts in vegetative makeup and invasion by non-native species (Mutch et al. 1993).

Other trends will have continued as well. Trees and other woody species will have encroached onto grasslands at the forest edge; overall biological diversity will have declined; stand density will have continued to increase; the amount of patch-size and edge will have declined; there will have been shifts in the ages and sizes of trees; and roads and other human developments will have increased. In fifty years, the result will be a seriously degraded biome that offers substantially fewer benefits and significantly greater risks and costs to society.

2.5 Subbasin Biomes in a Regional Context

It is valuable to view the current condition of the Flathead Subbasin in the context of the region and subregion in which it is located, that of the Interior Columbia River Basin ecosystem and the Northern Glaciated Mountains Ecological Reporting Unit. The Interior Columbia River Basin (CRB) assessment showed that the following changes have occurred across these larger landscapes (Quigley and Arbelbide 1997; Quigley et al. 1996):

2.5.1 Interior Columbia River Basin Ecosystem:

- There has been a 27 percent decline in multilayer and 60 percent decline in single-layer old forest structure, predominantly in forest types used commercially.
- Aquatic biodiversity has declined through local extirpations, extinctions, and introduction of non-native species, and the threat to riparian associated species has increased.
- Watershed disturbances, both natural and human induced, have caused and continue to cause risks to ecological integrity, especially owing to isolation and fragmentation of habitat.
- The threat of severe fire has increased; 18 percent more of the fires that burn are in the lethal fire severity class now than historically. In the forest Potential Vegetation Groups, lethal fires have increased by 30 percent.
- Rangeland health and diversity have declined owing to non-native species introductions, changing fire regimes, and increasing woody vegetation.
- Rapid change is taking place in the communities and economies of the Basin although the rates of change are not uniform.

2.5.2 Northern Glaciated Mountains Ecological Reporting Unit:

- Large western larch and ponderosa pine emergent structures are currently much less abundant in areas where historically mixed- and high-severity fire regimes would have encouraged their development.

- Forest landscapes have been substantially fragmented (the break up of contiguous areas into progressively smaller patches of increasing degrees of isolation). The frequency distribution of patch sizes did not coincide with the size ranges typical of the dominant fire regimes within the biophysical template.

- The areal extent of middle-aged multistory structures having grand fir, western hemlock/western redcedar, and subalpine fir understories increased well above the levels that would have been expected for the biophysical templates.

- As a result of fire exclusion, the areal extent of grand fir, Engelmann spruce/subalpine fir, and western hemlock cover types increased. This change was exacerbated by timber harvests that extracted seral Douglas fir, western larch, and white pine. The white pine cover type also declined substantially as a result of epidemic white pine blister rust and mountain pine beetle infestations.

These overall findings were based on large-scale analyses of the entire Basin. This large area was then subdivided into Forest and Rangeland Clusters corresponding to 4th Code HUCs to determine ecological integrity ratings. The Flathead Subbasin includes four forest clusters and two range clusters. The ratings are summarized in table 2.8.

Table 2.8. Summary of ICBEMP ratings of forest and range clusters.

Forest Clusters	Part of the Subbasin	Primary Characteristics	Primary Risks to Ecological Integrity	Primary Opportunities to Address Risks to Integrity
Forest 1	North, Middle, and South Forks of the Flathead	1. Moist and Cold Forest types	1. Severe fire potential in lower elevations	1. Prescription of natural or prescribed fire to reduce risks of severe fire
		2. Minimally roaded	2. Higher elevations sensitive to soil disturbances (i.e., roading)	2. Reduction of stocking levels in lower elevations - Reductions of fire severity. Maintenance of integrity in higher elevations
		3. High aquatic, forest, hydrologic, and composite integrity		
Forest 3	Swan	1. Moderately roaded	1. Fire severity in dry/moist forest types	1. Restoration of forest integrity
		2. Moderate aquatic and composite integrity	2. Aquatic integrity at risk in areas of high fire potential	2. Maintenance of aquatic and hydrologic integrity
		3. Low and moderate forest and hydrologic integrity	3. Old/late forest structures in managed areas	3. Management of road densities
		4. Dry and moist forest types		
Forest 4	Flathead Lake Stillwater	1. Moist forest types	1. Hydrologic and aquatic systems from fire potentials	1. Restoratoion of late and old forest structure in managed areas
		2. Highly roaded	2. Late and old forest structures in managed areas	2. Connection of aquatic strongholds through restoration
		3. Low forest, aquatic, and composite integrity	3. Forest compositions - susceptibility to insect, disease, and fire	3. Treatment of forested areas to reduce fire, insect, and disease susceptibility
		4. Moderate to high hydrologic integrity		
Forest 6	Lower Flathead	1. Dry forest types	1. Forest composition and structures especially old/late	1. Restoration of forest structures
		2. Low hydrologic, forest, aquatic, and composite integrity	2. Primarily present at finer resolutions	2. Maintenance of the scattered aquatic strong-holds that exist
			3. Moderately roaded	3. Reduction of risk of fire, insect, and disease

Table 2.8 (cont.). Summary of ICBEMP ratings of forest and range clusters.

Range Clusters	Part of the Subbasin	Primary Characteristics	Primary Risks to Ecological Integrity	Primary Opportunities to Address Risks to Integrity
Range 2	South Fork of the Flathead	1. Forested rangelands in moderate to high integrity	1. Fish and aquatic systems from dry vegetation types with fire severity/frequency changes	1. Restoration of vegetation and fuels treatments in dry forest types
		2. High aquatic, hydrologic, and composite integrity	2. Dry forest types — especially late/old structures	2. Maintenance of aquatic and hydrologic integrity - emphasize connectivity
		3. Minimally roaded	3. Aquatic system sensitivity to disturbance	3. Restoration of maintenance sagebrush ecotone
				4. Restoration of forage production in winter range
Range 3	Flathead Lake and Lower Flathead	1. Low forest and range integrity	1. Conflicts with big game management from conifer invasion reducing forage	1. Management of to restore/maintain riparian conditions
		2. Low and moderate hydrologic, aquatic, and composite integrity	2. Elevated fuel and fire from conifer invasion	2. Prescription of fire to reduce risks from fire, insect, and disease in forested areas
		3. Highly roaded	3. Riparian conditions from disturbances	3. Containment of noxious weeds
			4. Increased susceptibility to insect, disease, and fire in forested areas	4. Maintenance of water quality for native and desired non-native fish

3. Fish and Wildlife Communities

3.1 Presettlement Fish and Wildlife Communities[1]

3.1.1 Species Extirpations and Re-introductions

While it would be impossible to quantify the population changes that target species have undergone since presettlement times (pre-1850), we do have knowledge of the species that have been extirpated from the subbasin and those that have been introduced into the subbasin since settlement. Table 3.1 lists species known to have been extirpated. Table 3.2 lists those that were locally extirpated and subsequently reintroduced. Table 3.3 lists introduced terrestrial species. Table 3.4 lists introduced fish species.

Table 3.1. Species extirpated within the Kootenai and Flathead Subbasins. Source IBIS Canada (http://habitat.cbt.org/)[2]

Scientific Name	Common Name
Lepus townsendii	White-tailed Jackrabbit
Phrynosoma douglassii	Pygmy Short-horned Lizard

[1] *Unless specified otherwise, the wildlife analyses in this chapter are for the Kootenai and Flathead Subbasins. We have chosen to work at this broader scale for most of our wildlife analysis because of data and time constraints. We emphasize that this is a coarse-scale assessment appropriate for planning at a subbasin scale but not for work at finer scales. Though we used the best subbasin-scale data sets available to us at the time, our technical team has limited confidence in those data. For the aquatic analysis, we worked at a subbasin scale and finer.*

[2] *After careful examination of the differences between US and Canada IBIS lists and after consultation with IBIS staff, we decided that the differences between the databases were not significant for the kinds of analyses we were conducting. Further, IBIS personnel in both the U.S. and Canada felt that the Canada database was probably the best list of species to use of those available at the moment for any detail work beyond what was already provided using the IBIS-USA website.*

Table 3.2. Species extirpated and subsequently reintroduced within the Kootenai and Flathead subbasins.

Scientific Name	Common Name
Cygnus buccinator	Trumpeter Swan
Athene cunicularia	Burrowing Owl
Falco peregrinus	Peregrine Falcon
Rana pipiens	Northern Leopard Frog
Tympanuchus phasianellus	Sharp-tailed grouse
Rangifer tarandus	Mountain Caribou

**Source IBIS Canada (http://habitat.cbt.org/).*

Table 3.3. Terrestrial species introduced into the Kootenai and Flathead subbasins.

Scientific Name	Common Name
Mus musculus	House Mouse
Sturnus vulgaris	European Starling
Columba livia	Rock Dove
Cygnus olor	Mute Swan
Alectoris chukar	Chukar
Phasianus colchicus	Ring-necked Pheasant
Passer domesticus	House Sparrow
Perdix perdix	Gray Partridge
Meleagris gallopavo	Wild Turkey
Callipepla californica	California Quail
Sciurus niger	Eastern Fox Squirrel
Bison bison	Bison
Rana catesbeiana	Bullfrog

**Source IBIS Canada (http://habitat.cbt.org/).*

3.1.2 Anecdotal and Historical Accounts of Populations and Habitats[3]

There are both Native American oral and non-Indian written accounts of wildlife conditions in the western United States prior to European settlement. Oral accounts are documented in Confederated Salish and Kootenai (CSKT) Culture Committee archives. Most of the written records are from early explorers, fur traders, and missionaries. The non-Indian people who traveled through the northwest region give varying accounts of the status of wildlife populations. Differences in the authors' understanding of game and their habitats make it exceedingly difficult to ascertain the conditions of wildlife populations and wildlife habitat before European-Americans arrived. The native oral accounts, however,

[3] *Adapted from Flathead Indian Reservation Forest Management Plan (CSKT 2000)*

Table 3.4. Fish species introduced into the Flathead subbasin. Some species that were introduced did not reproduce and have not persisted. Source: MFWP

Name
Arctic Grayling
Black Bullhead
Walleye
Yellowstone Cutthroat
Black Crappie
Bluegill
Brook Stickleback
Brook Trout
Brown Trout
Central Mudminnow
Fathead Minnow
Golden Trout
Grass Carp
Green Sunfish
Kokanee
Lake Trout
Lake Whitefish
Largemouth Bass
Northern Pike
Pumpkinseed
Rainbow Trout
Smallmouth Bass
Yellow Perch

make it clear that Indian people were acutely aware of the rise and fall of game populations. The tribes used fire for a variety of reasons, chief among them increasing forage for their horses and ungulates. The role of natural fire and fires set by Indian people had a major affect on wildlife habitat and wildlife populations.

Written Historical Accounts

The earliest written records of game abundance come from the journals of the Lewis and Clark expedition (1804-1806). The explorers were astounded by the abundance of game on the prairies east of the Continental Divide. As the expedition reached the Bitterroot Valley, game was still in sufficient quantities to keep the party fed, however animals became scarce after they crossed over the Bitterroot Mountains around Lolo Pass, and the group was forced to subsist on stored supplies. They nearly starved to death. On their return trip through this area in June of the following year, game was still scarce, although they managed to kill a few deer.

It is not clear why there appeared to be few game animals in the area. Koch (1941) states that game herds in Idaho and western Montana were relatively poor compared to the abundant herds on the Plains. Ross Cox, a member of the Peter Skene Ogden Expedition, made a trip in 1812 up the Clark Fork River to around present-day Thompson Falls. That expedition, too, nearly starved and did not see any game until farther up river where they found bighorn sheep in huntable numbers. Cox also noted that the Flathead Indians were depending entirely on dried buffalo meat which they obtained from their annual hunt on the plains. David Thompson, also of the Northwest Company, explored the Clark Fork and Kootenai River drainages between 1808 and 1811. Thompson was able to procure only a few "antelope" and had to rely mostly on dried fish and moss bread, a survival food made by the local Indians from tree lichen. (Thompson's "antelope" were probably deer or bighorn sheep.) The Thompson party reported elk as being rare and only killed one during the expedition.

In contrast to this apparent paucity of game comes the report of Alexander Ross, another fur trapper, on an expedition up the same Clark Fork River twelve years after David Thompson in 1823. The Ross expedition was very large and consisted of 55 men, 25 women, and 64 children. In the dead of winter, this party carried no supplies but subsisted entirely on the abundant game they found in the region, primarily elk, deer, and bighorn sheep.

Other wildlife species have seen drastic range and population reductions since non-Indian settlement. The most visible species were the larger carnivores such as the grizzly bear, which is now generally relegated to protected areas in mountainous parts of the subbasin. The grizzly once roamed the valley bottoms throughout the subbasin. Wolves were also more common and likely lived throughout the subbasin. It is believed that wolves may have also kept coyote populations lower than present conditions and may have at times controlled ungulate populations.

Conflicting Early Reports

The conflicting reports of early explorers makes it difficult to firmly state how much game was present when non-Indians first arrived. It may well be that Lewis and Clark suffered from a visibility bias when they compared the abundance of game of the more open Great Plains to that of the more densely forested mountain ecosystem. Many people of the period believed that the northwest part of Montana had the potential to support larger big-game herds. Some authorities believe that relative to the abundance of the Great Plains, this area supported modest game populations. Wildlife populations are naturally dynamic, always responding to changing conditions. These changing conditions result in periods of population stability as well as population peaks and depressions. Different observations by early explorers may reflect these conditions.

Circa 1850 records of species from IBIS

Appendix 35 lists terrestrial species thought to have occurred in the Flathead Subbasin prior to 1850. The source of this list is the IBIS-USA database. We noted significant differences that are difficult to explain between the same list for the Kootenai subbasin. This raised questions about the accuracy of the list. Perhaps the best and most reliable historical species list would be the present day list of known species (Appendix 13), plus those species known to have been extirpated (table 3.1), and minus the species known to have been introduced (tables 3.2 - 3.4).

LINKS

For a pre-1850 species list for the Flathead Subbasin go to Appendix 35

Click Here

3.2 Present Fish and Wildlife Communities in the Subbasin

3.2.1 Number of Species by Habitat Type and Number of Species at Risk by Habitat Type

Using the Canadian IBIS database[2], we generated a list of the total number of terrestrial species and the number of terrestrial species at risk by wildlife habitat type (table 3.5). This assessment targets several biomes (mesic forest, xeric forest, riparian, wetland, and grasslands) and species-by-biome information for these is summarized in table 3.6 and figure 3.1.

For target biomes, a general trend is evident. For lists derived from either the Federal species status or from IBIS Canada lists, the target biomes with the greatest number of listed species (species at risk) in decreasing order are: grasslands, herbaceous wetlands, riparian wetlands, xeric forest, and mesic forest. Herbaceous wetlands replace grasslands as that biome with the greatest number of "Listed Species" using the IBIS-Status measure (for definitions, see the footnote for table 3.5).

LINKS

For Montana's Natural Heritage Program, which has information on species at risk, go to http:// nhp.nris.state.mt.us/

Click Here

For the Conservation Data Centre for B.C., go to http:// srmwww.gov.bc.ca/cdc/

Click Here

3.2.2 Number of Non-native Species by Wildlife Habitat Type

The number of species that have been introduced into the Canadian portion of the Mountain Columbia Province are listed in Table 3.7 (data not available for US portion of the subbasin). The types with the highest number of non-native species in decreasing order are: agricultural and pasture areas, urban areas, grasslands, riparian-wetlands, and shrub-steppe. Figure 3.2 shows the number of non-native species by target biome.

Table 3.5. The total species and the species at risk present within a given habitat type in the Flathead and Kootenai Subbasins. IBIS Status refers to a local designation of species status present in the IBIS database. State ALL is state/provincial threatened as well as endangered species. State R and E is only endangered species. Federal is Canadian and USA designations combined. Indices are explained in table footnotes.*

IBIS Designation	Total Species	IBIS Status	State ALL	State R & E	Federal	IBIS Index	State ALL Index	State R and E Index	Fed Index
Montane Wetlands	136	9	17	1	3	0.07	0.13	0.01	0.02
Subalpine Parkland	162	8	24	4	5	0.05	0.15	0.02	0.03
Alpine	117	9	16	6	4	0.08	0.14	0.05	0.03
Upland Aspen	143	13	23	6	6	0.09	0.16	0.04	0.04
Urban	204	13	25	6	9	0.06	0.12	0.03	0.04
Montane mixed conifer	169	10	30	6	8	0.06	0.18	0.04	0.05
Interior mixed conifer	208	13	39	8	11	0.06	0.19	0.04	0.05
Lodgepole Pine	155	9	27	7	9	0.06	0.17	0.05	0.06
Open Water	129	22	38	11	8	0.17	0.29	0.09	0.06
Pine	193	16	39	11	12	0.08	0.2	0.06	0.06
Agricultural	253	29	47	14	16	0.11	0.19	0.06	0.06
Riparian Wetlands	247	26	49	14	18	0.11	0.2	0.06	0.07
Herbaceous Wetlands	192	28	49	13	14	0.15	0.26	0.07	0.07
Grasslands	152	19	40	14	16	0.13	0.26	0.09	0.11
Shrub	146	15	41	16	16	0.1	0.28	0.11	0.11

**__Total Species:__ derived from IBIS-Canada.*
***IBIS status:** derived from a column in IBIS-Canada that indicates whether a species is in decline, decreasing, extirpated, stable, or increasing. This column is from IBIS-USA and has been edited to be more accurate for Canada. After careful analysis and consultation with IBIS staff, it was determined the differences between the IBIS-Canada and IBIS-USA lists are not signficant for the kind of analysis we are conducting here.*
***State ALL:** from IBIS-USA for the subbasin planning and derived from the Montana and Idaho Natural Heritage programs lists as well as BC's red and blue list designation. Includes Blue and "Species of concern."*
***State R and E:** from IBIS USA for the subbasin planning and derived from the Montana and Idaho Natural Heritage programs lists. Includes only "Red" and Endangered" species.*
***Federal:** From IBIS USA subbasin planning and derived from Federal lists from Canada and the US.*
***IBIS Index:** the IBIS status species/total species in IBIS-Canada*
***State All Index:** the State ALL species/total species in IBIS-Canada*
***Fed Index:** the Federal species/total species in IBIS-Canada*

Table 3.6. Indices of species at risk impact for target biomes in the Flathead and Kootenai Subbasins.

IBIS Designation	Total Species	IBIS	State ALL	State R and E	Federal	IBIS Index	State ALL Index	State R and E Index	Fed Index
Mesic Forest	169	10	30	6	8	0.06	0.18	0.04	0.05
Xeric Forest	193	16	39	11	12	0.08	0.2	0.06	0.06
Riparian Wetlands	247	26	49	14	18	0.11	0.2	0.06	0.07
Herbaceous Wetlands	192	28	49	13	14	0.15	0.26	0.07	0.07
Grasslands	152	19	40	14	16	0.13	0.26	0.09	0.11

**Total Species:* derived from IBIS-Canada. See footnotes for table 3.5 for how indicies were calculated.

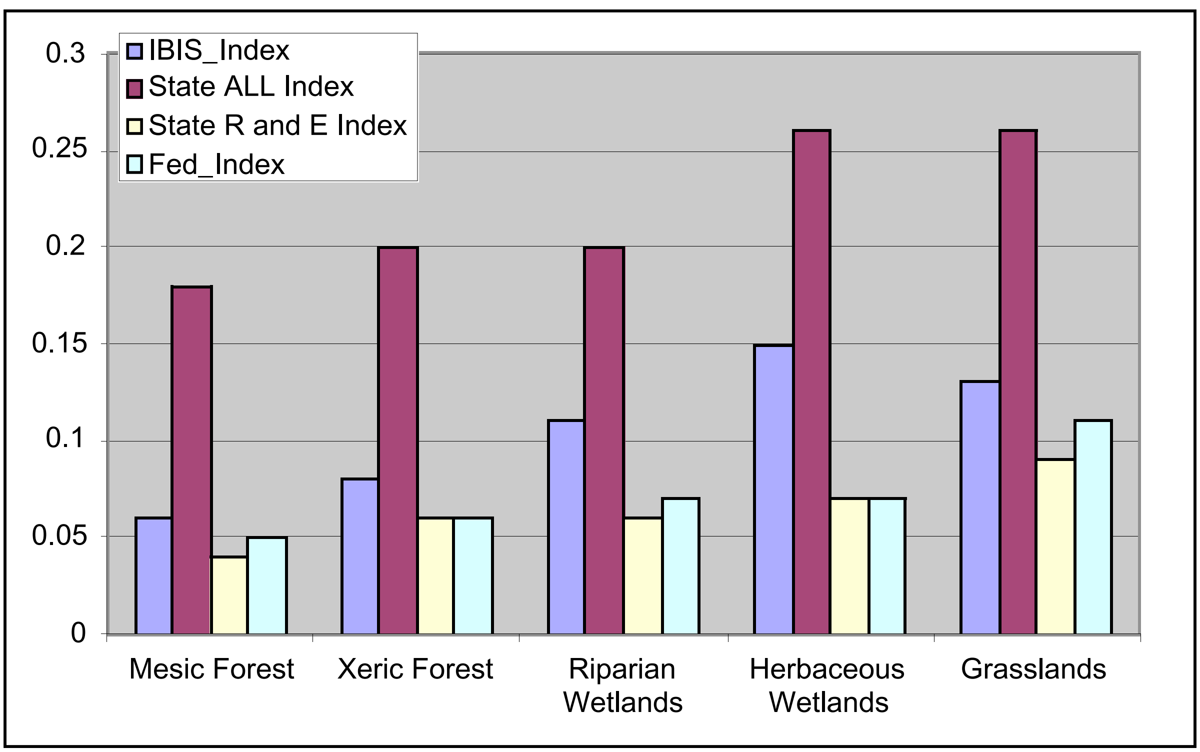

Figure 3.1. The percent of species at risk per total species in targeted biomes in the Flathead and Kootenai Subbasins.

Table 3.7. Number of introduced terrestrial species in Canada portion of the Mountain Columbia Province (source IBIS-Canada).

Biome	Grand Total
Agriculture, Pastures, and Mixed Environs	10
Eastside (Interior) Grasslands	7
Eastside (Interior) Mixed Conifer Forest	2
Eastside (Interior) Riparian-Wetlands	6
Herbaceous Wetlands	3
Lodgepole Pine Forest and Woodlands	1
Montane Coniferous Wetlands	1
Montane Mixed Conifer Forest	1
Open Water - Lakes, Rivers, and Streams	1
Ponderosa Pine Forest and Woodlands	5
Shrub-steppe	6
Upland Aspen Forest	2
Urban and Mixed Environs	9
Grand Total	54

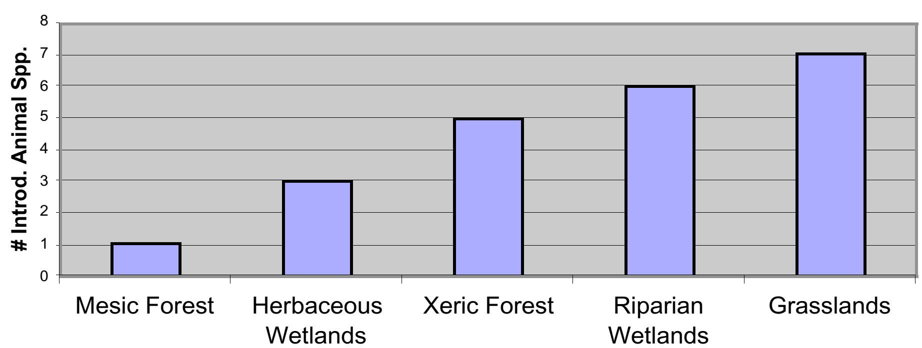

Figure 3.2. Non-native species by target biome (source IBIS-Canada).

3.3 Ecological Relationships

3.3.1 Number of Key Ecological Functions by Biome

Appendix 36 lists the number of key ecological functions (KEFs) by target biome. The list of KEFs comes from the IBIS database, and this analysis provides the background that enables us to identify declines in ecological functions in each of the target biomes.

3.3.2 General KEF Impact Indices

The KEFs are nested categories within the IBIS database, and as a consequence, species can be represented more than once in an analysis. To remove this redundancy, we chose General KEF categories (table 3.8), which are intermediate in the hierarchy (neither too general nor too specific) and for which definitions are well understood.

LINKS

Appendix 36 lists the number of key ecological functions (KEFs) by targeted biome.

Click Here

Table 3.8. General Key Ecological Functions (KEFs). These categories are traditional ecological categories that occur within a food web.

IBIS Designation	Definition
1.1.1) primary consumer (herbivore)	Herbivore of any sort
1.1.2) secondary consumer	Consumer of herbivores
1.1.3) tertiary consumer (secondary predator or secondary carnivore)	Consumer of secondary consumers
1.2) prey relationships	Acts as prey for another organism
2) aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)	Self explanatory
3) organismal relationships	Strong interrelationships with other species. For example, pirating food from other species, using burrows built by other species, or acting as a seed dispersal agent
4) carrier, transmitter, or reservoir of vertebrate diseases	Disease vectors
5) soil relationships	Creates, develops or alters soil
6) wood structure relationships (either living or dead wood)	Processes or requires wood or wood cavities
7) water relationships	Affects water quality
8) vegetation structure and composition relationships	This species may alter vegetation structure or function. For example they may generate snags.

3.3.3 KEF Declines in Target Biomes

To identify possible declines in key ecological functions in the target biomes, we attempted to discover the impact on the key ecological functions that exist as a result of impacts to species. We used species at risk designations to represent impacts to species. We are assuming these designations, while not necessarily indicating a local impact, will nevertheless provide some measure of impact to species composition at the biome level.

By cross-correlating the species composition changes to the key ecological function that each species plays, we have generalized the key ecological functions impacted for each biome. This index of impact is very coarse and does not take into account local population levels for a given species and does not address functional overlaps between different species occupying the same habitats. In other words, there may be a significant decline in species providing a key ecological function but the overall function of a habitat type could be maintained by a large number of another species performing a similar role. With this caveat, determining the implications of species at risk effects on habitat function can serve to compare habitats in a general way and to help identify restoration priorities.

Our index of impact is the simply the average of impacted KEF divided by the total KEF for each General KEF category and normalized, so that the biome with the least amount of impact is given a value of 10. All other biome values are proportionally ranked against this maximum. This makes the trend difference between the three methods of measuring impact more apparent.

The three measures of species impacts are: (1) IBIS Status, (2) State and Federal endangered (including red listed) species only, and (3) all state and federal designations showing any degree of impact including blue listed species and species of concern (see the footnote for table 3.9).

Table 3.9 ranks the General KEF indices for wildlife habitat types in descending order for the three different methods of assessing impact to species. Table 3.10 and figure 3.3 show the General KEF indices for target biomes. According to the IBIS Status index, Mesic Forest has had the least impact of General KEF function followed by Xeric Forest, Riparian Wetlands, Grasslands, and Herbaceous Wetlands. The Endangered Species index as well as the Any Impact index ranked Mesic Forest, Riparian Wetlands, Xeric Forest, Herbaceous Wetlands, and Grasslands from the least to the most impacted.

Table 3.9. Descending list of impacts for each biome type in the Flathead and Kootenai Subbasins using three different methods of assessing level of impact.

Biome order	IBIS Status Index	Biome order	Endangered Index	Biome order	Any Impact Index
Subalpine Parkland	10	Montane Wetlands	10	Montane Wetlands	10
Lodgepole Pine	8.98	Subalpine Parkland	8.35	Subalpine Parkland	4.11
Montane Mixed Conifer	7.91	Lodgepole Pine	7.61	Alpine	2.96
Interior Mixed Conifer	7.87	Alpine	7.43	Lodgepole Pine	2.82
Montane Wetlands	7.56	Urban	6.83	Montane Mixed Conifer	2.62
Urban	7.46	Upland Aspen	6.31	Upland Aspen	2.39
Alpine	6.12	Interior Mixed Conifer	5.96	Interior Mixed Conifer	2.13
Ponderosa Pine	5.6	Montane Mixed Conifer	5.9	Urban	1.91
Upland Aspen	5.13	Rip. Wetlands	5.11	Rip. Wetlands	1.5
Rip. Wetlands	4	Ponderosa Pine	5.08	Ponderosa Pine	1.38
Shrub	3.97	Agricultural	4.76	Agricultural	1.3
Agricultural	3.74	Herb Wetlands	4.15	Herb Wetlands	1.04
Grasslands	3.11	Shrub	3.32	Shrub	0.87
Herb Wetlands	2.83	Grasslands	3.3	Grasslands	0.86

IBIS Status Index is based on IBIS categories of species status (Decreasing, Declining, Extirpated, Stable, Increasing). Endangered Index is based on Endangered species and Red listing from Idaho, Montana, British Columbia, and both Federal governments. Any Impact Index is based on Endangered species and Red listing from Idaho, Montana, British Columbia, and both Federal governments PLUS blue listed species, threatened species and species of concern.

Table 3.10. General KEF impact indices using three methods of impact assessment for targeted biomes in the Flathead and Kootenai Subbasins.

Biome	IBIS Status Index	Endangered Status Index	Any Impact Index
Herb Wetlands	2.83	4.15	1.04
Grasslands	3.11	3.3	0.86
Mesic Forest	7.91	5.9	2.62
Xeric Forest	5.6	5.08	1.38
Riparian Wetlands	4	5.11	1.5

IBIS Status Index is based on IBIS categories of species status (Decreasing, Declining, Extirpated, Stable, Increasing). Endangered Index is based on Endangered Species and Red listings from Idaho, Montana, British Columbia, and both Federal governments. Any Impact Index is based on Endangered species and Red listing from Idaho, Montana, British Columbia, and both Federal governments PLUS blue listed species, threatened species and species of concern.

LINKS

Appendix 37 gives the methodology for the specific KEF analysis used here.
Click Here

The IBIS-USA website has done further analyses that are generally descriptive in nature. These can be viewed at the following URLs:

http://www.nwhi.org/ibis/subbasin/ecos2.asp
Click Here

http://www.nwhi.org/ibis/subbasin/uscan2.asp
Click Here

http://www.nwhi.org/ibis/subbasin/subs2.asp
Click Here

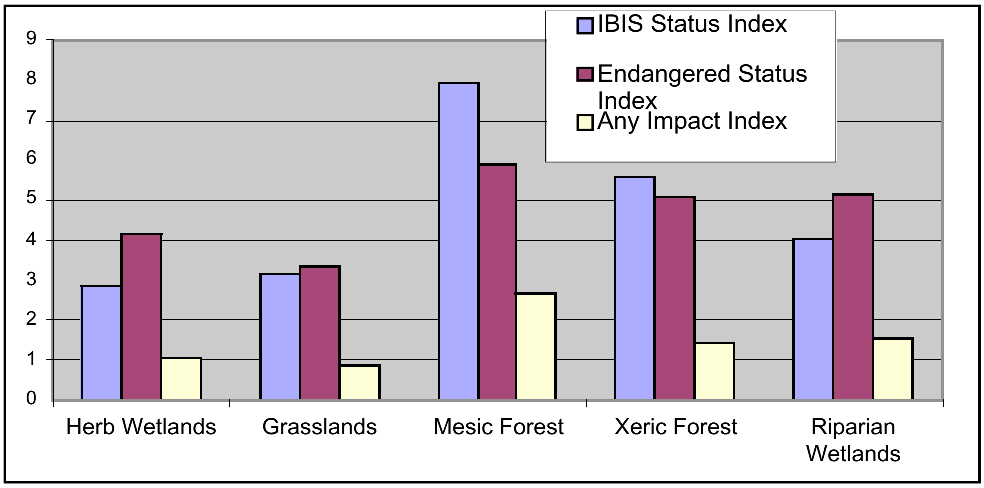

Figure 3.3. General KEF impact indices using three methods of impact assessment for targeted biomes in the Flathead and Kootenai Subbasins.

3.3.4 Functional Specialists

The IBIS-USA group performed an analysis of specific KEF functions (methodology is presented in Appendix 37). Functional specialists[4] that IBIS-USA has identified for the Mountain Columbia Ecological Province are listed in table 3.11. The Critical Functional Link Species[5] pertinent to the sub basin planning process are listed in table 3.12.

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[4] *Functional specialists are species that have only one or a very few number of key ecological functions. An example is turkey vulture, which is a carrion-feeder functional specialist. Note that functional specialists may not necessarily be (and often are not) also critical functional link species (functional keystone species), and vice versa. Thus, the manager may want to understand degree of functional specialization of a species) as well as the number of species that perform a given category of key ecological function (functional redundancy); these are complementary measures of the functionally of species and systems.*

[5] *Critical functional link species are species that are the only ones that perform a specific ecological function in a community. Their removal would signal loss of that function in that community. Thus, critical functional link species are critical to maintaining the full functionality of a system. The function associated with a critical functional link species is termed a "critical function." Reduction or extirpation of populations of functional keystone species and critical functional links may have a ripple effect in their ecosystem, causing unexpected or undue changes in biodiversity, biotic processes, and the functional web of a community. Critical functional link species may be usefully identified as focal species for subbasin planning. A limitation of the concept is that little research has been done on the quantitative effects, on other species or ecosystems, of reduction or loss of critical functional link species."*

Table 3.11. The functional specialists for the Mountain Columbia Province (Source: IBIS-USA).

Common Name	Scientific Name	Count of KEFs
Turkey Vulture	*Cathartes aura*	3
Gyrfalcon	*Falco rusticolus*	5
Peregrine Falcon	*Falco peregrinus*	5
Snowy Owl	*Nyctea scandiaca*	5
Common Nighthawk	*Chordeiles minor*	5
Black Swift	*Cypseloides niger*	5
Wolverine	*Gulo gulo*	5
Ringneck Snake	*Diadophis punctatus*	6
Harlequin Duck	*Histrionicus histrionicus*	6
Red-shouldered Hawk	*Buteo lineatus*	6
Merlin	*Falco columbarius*	6
Northern Pygmy-owl	*Glaucidium gnoma*	6
Boreal Owl	*Aegolius funereus*	6
Northern Bog Lemming	*Synaptomys borealis*	6
Lynx	*Lynx canadensis*	6

Table 3.12. Species performing critical functional links (Source: IBIS-USA).

Common Name	Scientific Name
American Beaver	*Castor canadensis*
American Crow	*Corvus brachyrhynchos*
American Pika	*Ochotona princeps*
Big Brown Bat	*Eptesicus fuscus*
Black Bear	*Ursus americanus*
Black Tern	*Chlidonias niger*
Black-chinned Hummingbird	*Archilochus alexandri*
Brown-headed Cowbird	*Molothrus ater*
Bushy-tailed Woodrat	*Neotoma cinerea*
Canada Goose	*Branta canadensis*
Deer Mouse	*Peromyscus maniculatus*
Fisher	*Martes pennanti*
Golden-mantled Ground Squirrel	*Spermophilus lateralis*
Great Basin Spadefoot	*Scaphiopus intermontanus*
Great Blue Heron	*Ardea herodias*
Great Horned Owl	*Bubo virginianus*
Grizzly Bear	*Ursus arctos*
House Finch	*Carpodacus mexicanus*
Long-toed Salamander	*Ambystoma macrodactylum*
Mink	*Mustela vison*
Montane Vole	*Microtus montanus*
Moose	*Alces alces*
Mule Deer	*Odocoileus hemionus*
Northern Pocket Gopher	*Thomomys talpoides*
Nuttall’s (Mountain) Cottontail	*Sylvilagus nuttallii*
Raccoon	*Procyon lotor*
Red Squirrel	*Tamiasciurus hudsonicus*
Rocky Mountain Elk	*Cervus elaphus nelsoni*
Rufous Hummingbird	*Selasphorus rufus*
Snowshoe Hare	*Lepus americanus*
Tundra Swan	*Cygnus columbianus*
Williamson’s Sapsucker	*Sphyrapicus thyroideus*

3.3.5 Key Ecological Correlates (KECs)

LINKS

The results of our Key Ecological Correlate (KEC) analysis are presented in Appendix 66.

Click Here

Key Ecological Correlates[6] (KEC) are more specific habitat features within the biomes—for example, specific substrates, habitat elements, and attributes of species' environments. They are called "habitat elements" within the tables of the Canada IBIS Access database[7]. In this discussion we use the term KEC because that is the term most commonly used in subbasin planning. The results of our analysis are presented in Appendix 66. Table 1 of this appendix lists the KECs in the IBIS Canada database. Table 2 of Appendix 66 shows the total number of species associated with each of the main categories of KECs for each IBIS biome.

Table 3.13 shows the percentage of the species within each of the main KEC categories[8] that are in decline or decreasing (distressed species) for those main KEC categories with distressed species. For the biomes, this table reveals a pattern of disturbance similar to that seen in the analysis of key ecological function and biome types, which is to be expected since the same species list is used for each analysis and the relationship of those species to biome type remains the same. It shows that for the KECs, "Non-vegetative, Abiotic" and "Freshwater Riparian and Aquatic Bodies" have the greatest percentage of distressed species at 12 percent and 13 percent respectively (figure 3.4). Tables 5 through 10 of Appendix 66 provide the same information for each of the KECs listed under the main KEC categories. They report the number of species and the percentage of distressed species associated with a group of biome-related KECs listed according to their presence in that particular biome.

Having presented the results of this analysis, we want to alert readers to some of our concerns about its use. First, one limitation of the KEC data is that

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[6] *Key environmental correlates (KECs) are specific substrates, habitat elements, and attributes of species' environments that are not represented by overall (macro)habitats and vegetation structural conditions. Specific examples of KECs include snags, down wood, type of stream substrate, and many others. KECs are denoted for each species using a standard classification system, which include the KECs for vegetation habitat elements, non-vegetation terrestrial elements, aquatic bodies and substrates, anthropogenic structures, and other categories.*

[7] *As we explained in a footnote at the beginning of this chapter, we made a careful examination of the differences between US and Canada IBIS lists and consulted with IBIS staff to determine which IBIS database—U.S. or Canada—we should use, given our specific needs. We decided that the differences between the databases were not significant for the kinds of analyses we were conducting. Further, IBIS personnel in the U.S. and Canada felt that the Canada database was probably the best list of species to use of those available at the time for any detail work beyond what was already provided using the IBIS-USA website. Hence we have chosen to use the Canada database.*

[8] *The advantage of examining the main categories of KECs for this analysis is that there are sufficient data within these broad categories to illustrate frequency without fear of exceeding the limitations of the data. Of course the disadvantage of using these broader categories is that the analysis lacks specificity.*

they are represented as simple categorical relations with species (e.g., a list of KECs pertinent to each species) rather than as quantified correlations (e.g., specific amounts, levels, or rates of each KEC and corresponding population densities or trends of each species). Similarly, the relative contribution of a given species to the proper functioning of a KEC as a habitat is not evident. Second, there appears to be a fair amount of error within the KEC table in the database (for example, redundant categories are present and some categories appear to be missing). We also discovered other potential errors (that would require too much space to go into here) that concern us when it comes to using KEC data (for a description of some of these problems see Appendix 66).

Table 3.13. The percentage of species within each of the main KEC categories in decline or decreasing for the main KEC categories with distressed species.

Key Ecological Correlate	Agriculture, Pastures, and Mixed Environs	Alpine Grasslands and Shrublands	Eastside (Interior) Grasslands	Eastside (Interior) Mixed Conifer Forest	Eastside (Interior) Riparian-Wetlands	Herbaceous Wetlands	Lodgepole Pine Forest and Woodlands	Montane Coniferous Wetlands	Montane Mixed Conifer Forest	Open Water - Lakes, Rivers, and Streams	Ponderosa Pine Forest and Woodlands	Shrub-steppe	Subalpine Parkland	Upland Aspen Forest	Urban and Mixed Environs	Total
1) Forest, Shrubland, & Grassland KECs	9%	11%	11%	7%	10%	**16%**	7%	8%	7%	**28%**	7%	8%	6%	8%	6%	**9%**
2) Ecological KECs	10%	9%	**18%**	6%	12%	15%	6%	6%	6%	**20%**	9%	14%	3%	11%	6%	**10%**
3) Non-vegetative, Abiotic KECs	11%	13%	14%	12%	**15%**	11%	9%	11%	10%	9%	**15%**	**15%**	9%	**15%**	13%	**12%**
4) Freshwater Riparian & Aquatic Bodies KECs	13%	16%	13%	8%	13%	**19%**	10%	12%	11%	**21%**	8%	10%	9%	7%	8%	**13%**
7) Fire as a KEC	9%		**14%**	4%	8%		2%				6%	**13%**		7%	5%	**5%**
8) Anthropogenic-related KECs	11%	10%	**14%**	8%	12%	**17%**	6%	8%	8%	20%	9%	12%	5%	11%	6%	**11%**
Totals	**64%**	**58%**	**85%**	**45%**	**70%**	**78%**	**40%**	**46%**	**42%**	**98%**	**53%**	**71%**	**32%**	**59%**	**44%**	**60%**

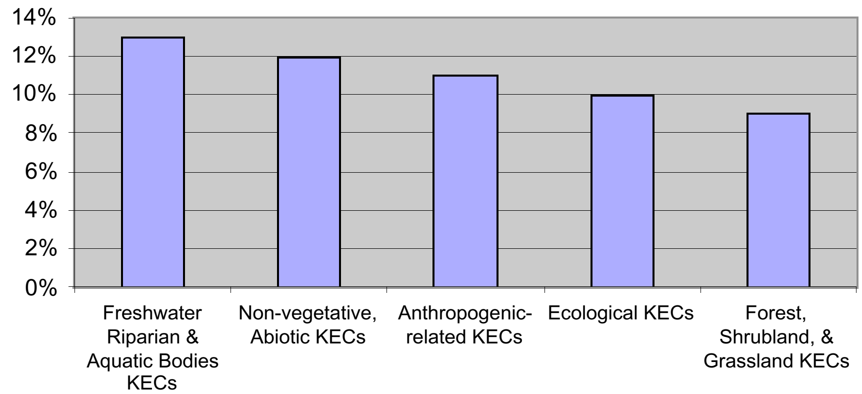

Figure 3.4. Percentage of the species in each main KEC category that are distressed (for those main KEC categories with distressed species).

At best, the KEC analysis we present here might be used to formulate hypotheses that could be used to drive further inquiry or investigation (beyond what is possible within this assessment) regarding where within a biome impacts are most serious. One might utilize Tables 5 through 10 of Appendix 66 to identify KECs that have a large number of species associated with them and also where disproportionate numbers of species appear to be distressed. This might be particularly valuable at a project-specific planning level, once priority restoration areas have been identified. For example, based on IBIS data, 3 out of 21 or 14 percent of species associated with downed wood are considered to be decreasing or in decline in the herbaceous wetland biome category. Water depth is an important consideration for 50 species, and 17 out of the 50 species (34 percent) are in decline. Both water depth and downed wood are specific and local in scale and could conceivably be compared informally to formulate hypotheses regarding what sort of restoration projects or measures are needed and where they might be conducted.

3.3.6 The Aquatic-Terrestrial Relationship

Because aquatic habitats are the product of a complex set of processes such as the routing of precipitation, erosion rates, sediment transport, woody debris recruitment, and channel migration, their quality is directly tied to the terrestrial environment within their catchment basin (CSKT 2002). Aquatic habitats are influenced by any number of small or subtle changes occurring anywhere within a watershed, though they are most vulnerable to degradation from activities that occur on lands adjacent to them (riparian and wetland areas). The health of these systems is of critical importance to the maintenance and formation of stream channels that sustain native fish populations. But uplands, too, have profound effects on aquatic habitats and native fish populations. Human-induced changes to uplands can, for example, alter runoff patterns, rates of sedimentation, stream morphology, and water chemistry. An example of the latter is the effect that a clearcut can have on aquatic productivity. A clearcut can represent a significant loss of phosphorous (P-export) from forested landscapes both from biomass removal and erosion of humus and mineral soil caused by road construction, log skidding, and related activities. Initially, soil-water retention capacities decrease, and runoff and turbidity (P-export) increases. But after new trees and shrubs become established, they absorb high levels of phosphorous, reducing the amount entering streams and lakes (Stockner and Ashley 2003).

Just as the quality of terrestrial habitats can affect fish and other aquatic organisms, the functioning and quality of aquatic habitats influences or impacts a number of terrestrial wildlife species. Figure 3.5 shows the number of Mountain Columbia Province terrestrial focal species with aquatic key environmental correlates.

3.3.7 Wildlife Relationships to Salmonids

While anadromous fish are not present in the subbasin, resident salmonids are important, playing a key ecological role that human activities have certainly influenced.

A now famous example of how landlocked salmonids can affect terrestrial wildlife communities occurred in the Flathead Subbasin about twenty years ago. Prior to their decline in the mid-to-late 1980s, tens of thousands of introduced kokanee salmon migrated upstream from Flathead Lake to McDonald Creek in Glacier National Park to spawn. There they drew a diverse array of terrestrial species. In 1981, in excess of 100,000 kokanee spawned there, and more than 1,000 bald eagles congregated to feed on the spent fish. California gulls, herring gulls, mallards, common mergansers, crows, ravens, jays, and magpies gathered and scavenged the carcasses. Common goldeneye, Barrow's goldeneye, and dippers fed on the millions of eggs buried in the gravel. Minks, otters, and coyotes patrolled the banks. Even white-tailed deer, which are herbivores, were seen pulling dead fish from the creek and eating them. Grizzly bears, too, worked the stream, chasing and stranding fish in shallow riffles or diving to the bottom of 15-foot-deep pools after carcasses. Some bears lingered beside McDonald Creek long past the time they would have normally entered hibernation to gorge on the

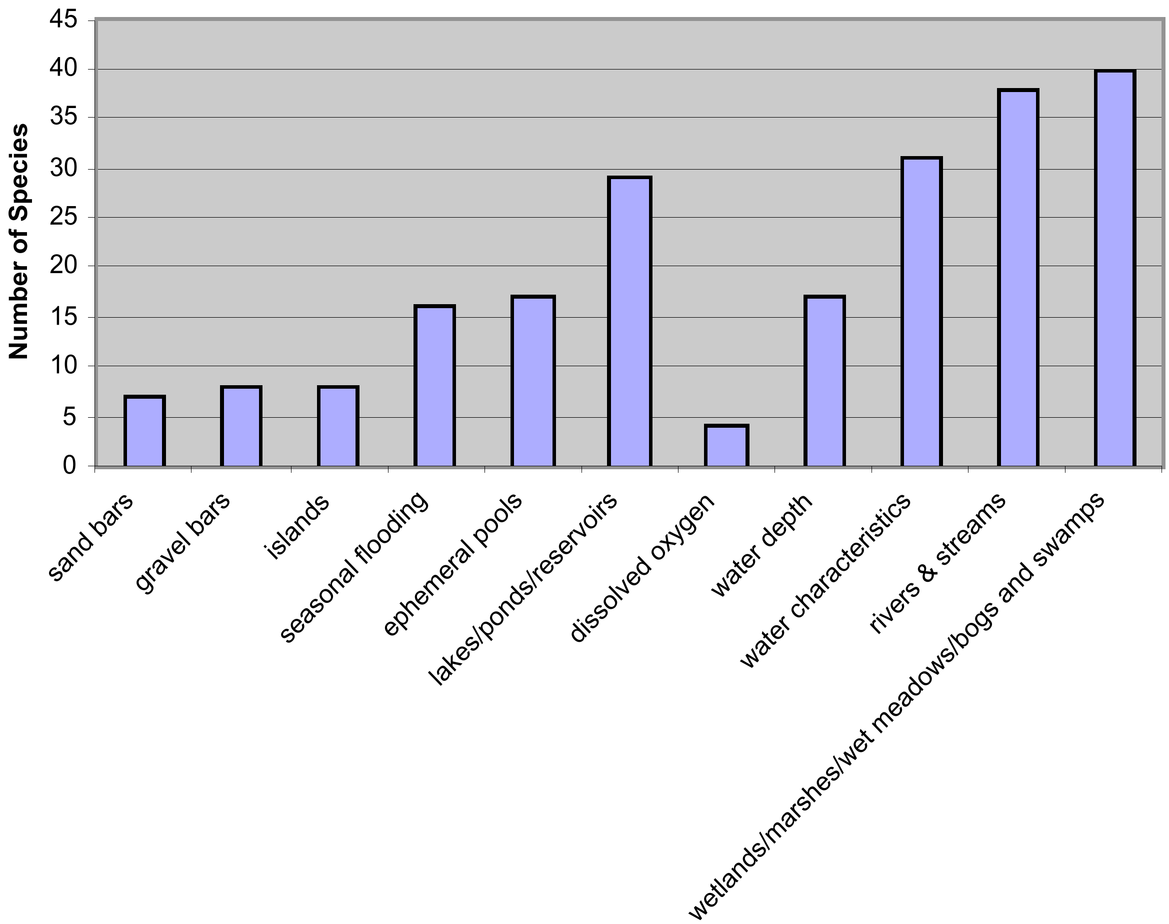

Figure 3.5. The number of Mountain Columbia Province terrestrial focal species with aquatic key environmental correlates.

thousands of carcasses of decaying fish. And the estimated 9 million fry hatching from the eggs fed everything from bull trout to stoneflies (Rockwell 2002).

While this is an exceptional example, it does show that adult migrating salmonids can and do convey nutrients from one ecosystem to another and from one biome to another. Each year, albeit on a much smaller scale, adfluvial bull trout, westslope cutthroat trout, and kokanee play this role in the Kootenai Subbasin, transporting lake-derived nitrogen and phosphorous to tributaries upstream.

Table 3.14 shows the number of species by biome in the Kootenai and Flathead Subbasins that possess an ecological relationship to salmonids. Table

3.15 lists the specific terrestrial species in the Flathead tied ecologically to salmonids.

3.3.8 KEFs Affected by the Loss of Salmonids

The key ecological functions performed by species dependent upon salmonids are listed in Table 3.16.

Table 3.14. The number of species in each biome dependent upon or affecting salmonids. Source: IBIS-USA.

Biome	Salmonid dependent species
Agriculture, Pastures, and Mixed Environs	51
Alpine Grasslands and Shrublands	31
Eastside (Interior) Grasslands	33
Eastside (Interior) Mixed Conifer Forest	44
Eastside (Interior) Riparian-Wetlands	60
Herbaceous Wetlands	61
Lodgepole Pine Forest and Woodlands	36
Montane Coniferous Wetlands	33
Montane Mixed Conifer Forest	37
Open Water - Lakes, Rivers, and Streams	49
Ponderosa Pine Forest and Woodlands	40
Shrub-steppe	28
Subalpine Parkland	38
Upland Aspen Forest	32
Urban and Mixed Environs	49

Table 3.15. Terrestrial species in the Flathead Subbasin with an ecological relationship to salmonids. Source: IBIS-USA.

Amphibians	
Idaho Giant Salamander	*Dicamptodon aterrimus*
Birds	
Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Red-necked Grebe	*Podiceps grisegena*
Western Grebe	*Aechmophorus occidentalis*
Clark's Grebe	*Aechmophorus clarkii*
American White Pelican	*Pelecanus erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Green Heron	*Butorides virescens*
Black-crowned Night-heron	*Nycticorax nycticorax*
Turkey Vulture	*Cathartes aura*
Trumpeter Swan	*Cygnus buccinator*
Mallard	*Anas platyrhynchos*
Green-winged Teal	*Anas crecca*
Canvasback	*Aythya valisineria*
Greater Scaup	*Aythya marila*
Harlequin Duck	*Histrionicus histrionicus*
Surf Scoter	*Melanitta perspicillata*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Red-tailed Hawk	*Buteo jamaicensis*
Golden Eagle	*Aquila chrysaetos*
Gyrfalcon	*Falco rusticolus*
Peregrine Falcon	*Falco peregrinus*
Killdeer	*Charadrius vociferus*
Greater Yellowlegs	*Tringa melanoleuca*
Spotted Sandpiper	*Actitis macularia*
Franklin's Gull	*Larus pipixcan*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
California Gull	*Larus californicus*
Herring Gull	*Larus argentatus*
Glaucous Gull	*Larus hyperboreus*
Caspian Tern	*Sterna caspia*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Birds (Cont.)	
Snowy Owl	*Nyctea scandiaca*
Belted Kingfisher	*Ceryle alcyon*
Willow Flycatcher	*Empidonax traillii*
Gray Jay	*Perisoreus canadensis*
Steller's Jay	*Cyanocitta stelleri*
Black-billed Magpie	*Pica pica*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Winter Wren	*Troglodytes troglodytes*
American Dipper	*Cinclus mexicanus*
American Robin	*Turdus migratorius*
Varied Thrush	*Ixoreus naevius*
Spotted Towhee	*Pipilo maculatus*
Song Sparrow	*Melospiza melodia*
Mammals	
Masked Shrew	*Sorex cinereus*
Vagrant Shrew	*Sorex vagrans*
Montane Shrew	*Sorex monticolus*
Water Shrew	*Sorex palustris*
Northern Flying Squirrel	*Glaucomys sabrinus*
Deer Mouse	*Peromyscus maniculatus*
Coyote	*Canis latrans*
Gray Wolf	*Canis lupus*
Red Fox	*Vulpes vulpes*
Black Bear	*Ursus americanus*
Grizzly Bear	*Ursus arctos*
Raccoon	*Procyon lotor*
American Marten	*Martes americana*
Fisher	*Martes pennanti*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Wolverine	*Gulo gulo*
Striped Skunk	*Mephitis mephitis*
Northern River Otter	*Lutra canadensis*
Mountain Lion	*Puma concolor*
Bobcat	*Lynx rufus*
Reptiles	
Western Terrestrial Garter	*Thamnophis elegans*
Common Garter Snake	*Thamnophis sirtalis*

Table 3.16. Key Ecological Functions (KEFs) performed by salmonid-dependent species. The link to salmonids may not be direct in some habitats. This means that a habitat might have a species that would use salmonids if that species lived in an area with salmonids.

Biome	1.1.1) primary consumer (herbivore)	1.1.2) secondary consumer (primary predator or primary carnivore)	1.1.3) tertiary consumer (secondary predator or secondary carnivore)	1.2) prey relationships	2) aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)	3) organismal relationships	4) carrier, transmitter, or reservoir of vertebrate diseases	5) soil relationships	6) wood structure relationships (either living or dead wood)	8) vegetation structure and composition relationships	Grand Total	Percent of total	Index based on max value
Herbaceous Wetlands	15	61	4	35	8	55	19	1	2	2	202	**0.1**	**10**
Eastside (Interior) Riparian-Wetlands	20	58	3	33	2	52	12	2	2	2	186	**0.09**	**9**
Agriculture, Pastures, and Mixed Environs	19	50	5	31	5	45	15	1	1	1	173	**0.09**	**9**
Urban and Mixed Environs	18	47	4	32	5	44	13	1	1	1	166	**0.08**	**8**
Open Water - Lakes, Rivers, and Streams	6	51	3	29	8	43	18	1		1	160	**0.08**	**8**
Eastside (Interior) Mixed Conifer Forest	15	42	3	24		40	6	1	2	1	134	**0.07**	**7**
Ponderosa Pine Forest and Woodlands	15	38	3	23		38	6	1	1	1	126	**0.06**	**6**
Subalpine Parkland	17	37	3	21		34	6	1	2	1	122	**0.06**	**6**
Montane Mixed Conifer Forest	14	35	3	19		33	4	1	2	1	112	**0.06**	**6**
Lodgepole Pine Forest and Woodlands	13	34	3	17		33	4	1	2	1	108	**0.05**	**5**
Eastside (Interior) Grasslands	13	32	5	19		28	6	1	1	1	106	**0.05**	**5**
Montane Coniferous Wetlands	14	31	2	18		28	2	1	2	1	99	**0.05**	**5**
Alpine Grasslands and Shrublands	13	30	3	15		27	6	1	2	1	98	**0.05**	**5**
Upland Aspen Forest	11	30	3	18		29	3	1	2	1	98	**0.05**	**5**
Shrub-steppe	9	27	2	16		25	5	1	1	1	87	**0.04**	**4**
Grand Total	212	603	49	350	28	554	125	16	23	17	1977	**1**	

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4 Focal and Target Species

4.1 Bull Trout

4.1.1 Background

Reasons for Selection as Focal Species

Globally, bull trout have a G3 ranking: 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. The federal government listed bull trout (*Salvelinus confluentus*) in the coterminous United States as threatened on November 1, 1999 (64 FR 58910) (go to: http://pacific.fws.gov/bulltrout/. Earlier rulemakings had listed distinct population segments of bull trout as threatened in the Columbia River and Klamath River (June 1998; 63 FR 31647, 63 FR 42757), and Jarbidge River basins (November 1999; 64 FR 17110).

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 (FSM 2670). The Flathead National Forest has named bull trout as an indicator species to guide stream and riparian management and to monitor progress toward achieving Forest Plan objectives. Forest Plan standards must be met regarding habitat needs of these species, thereby ensuring a quality environment for other aquatic organisms, such as sculpins, amphibians, and aquatic insects (USFS 1998).

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 it very vulnerable to extinction throughout its range.

Montana Fish, Wildlife & Parks (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.

The Confederated Tribes of the Salish and Kootenai consider bull trout a sensitive species and an important cultural resource.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild Canadian species, subspecies and separate populations suspected of being at risk. In British Columbia, bull trout are listed as an intermediate priority candidate species (COSEWIC 2003). COSEWIC candidate species are those that are suspected of being in some category

LINKS

State, federal and tribal biologists in Montana have done extensive work on bull trout. Results from these efforts, which have resulted in some of the best and most detailed information available for bull trout in the Flathead Subbasin, are entered onto the Montana Fisheries Information System (MFISH) database accessible on the internet at: http://nris.state.mt.us/scripts/esrimap.dll?name=MFISH&Cmd=INST.

Click Here

For definitions of terms such as recovery unit, core unit, core area, local population, subpopulation go to Appendix 84.

Click Here

of risk of extinction or extirpation at the national level, before being examined through the status assessment process.

The British Columbia *Forest Practices Code* includes an "Identified Wildlife Management Strategy" that lists wildlife, wildlife habitat areas and associated landscape units. "Identified Wildlife" lists species considered to be at risk (e.g., endangered, threatened, vulnerable or sensitive) and that require management of critical habitats in order to maintain populations and/ or distributions (B.C. Ministry of Forest 1997). Bull trout are blue-listed, that is they are a species considered to be vulnerable, or of special concern because of characteristics that make them particularly sensitive to human activities or natural events (B.C. Ministry of Sustainable Resource Management 2003).

LINKS

For more information on the federal listing, go to the USFWS bull trout website at: http://pacific.fws.gov/bulltrout/

Click Here

The bull trout is an indicator of the health of the aquatic ecosystem. They have relatively strict habitat requirements. They require high quality, cold water; high levels of shade, undercut banks, and 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 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 Flathead Lake, the river, and tributaries, impacts in any single component are potentially reflected by bull trout. Because of this and their status, we have selected bull trout as a focal species in this assessment.

Summary of population data

For listing purposes, the USFWS divided the range of bull trout into distinct population segments (DPS). The agency further identified 27 recovery units based on large river basins and generally following existing boundaries of conservation units for other fish species described in state plans, where possible. The Flathead Subbasin falls within the Clark Fork River Recovery Unit. The Clark Fork River population, which includes Lake Pend Oreille and the entire Clark Fork River drainage upstream, was once perhaps the largest metapopulation[1] in the historic

[1] *Metapopulations are composed of one or more local populations. As in the Bull Trout Recovery Plan, in this assessment, bull trout have been grouped into distinct population segments, recovery units, core areas, and local populations. Core areas are composed of one or more local populations, recovery units are composed of one or more core areas, and a distinct population segment is composed of one or more recovery units. The lexicon for describing bull trout population units has evolved. The term "subpopulation" although used in places in this document, was considered less useful and the use of this term was officially discontinued by the Bull Trout Recovery Team. For more thourough definitions of these and other terms used in this section, go to Appendix 84.*

range of bull trout (Montana Bull Trout Restoration Team 2000). The Clark Fork River Recovery Unit encompasses four subunits—the Upper Clark Fork, Lower Clark Fork (which includes the lower Flathead and its tributaries), Flathead (which includes the rest of the Flathead Subbasin), and Priest (figure 4.1). The following parts of the Clark Fork River Recovery Unit encompass the portions of the Flathead Subbasin that have been designated as primary core areas: lower Clark Fork River (which encompasses the lower Flathead River and its tributaries), Flathead Lake, Swan Lake, and Hungry Horse Reservoir. In addition, twenty-two lakes in the Flathead Recovery Subunit have been designated as secondary core areas for the purposes of recovery.

Within the Clark Fork Recovery Unit the historical distribution of bull trout is considered to be relatively intact, with some notable exceptions in the headwaters. However, numbers have been reduced and some remaining populations are highly fragmented (USFWS 2002a).

Tables 4.1 to 4.3 summarize upper Flathead subbasin bull trout spawning site inventories in the stream sections monitored annually. 2003 was the twenty-fourth year of bull trout redd counts for the Flathead Lake population, which spawns in tributaries of the Middle Fork and North Fork drainages. The 2003 index count of 130 redds in eight index streams is 68 percent of the 2002 count.

2003 was the twenty-second year of bull trout redd counts in the Swan drainage. Survey teams completed a basin-wide count in the Swan, and the ten streams contained 592 redds. The four annual index stream sections had 425 redds in 2003, which is nearly identical to the 2002 count. Over the past 21 years, the index count has averaged 387 redds ranging from 109 to 612. Biologists observed an increasing trend since counts began in 1982. Redd numbers peaked in 1998, then dropped approximately 15 percent for the next three years (1999-2001). In 2002 and 2003, MFWP observed another decline of 15 percent to the present level. Swan Lake remains open to bull trout angling with a limit of one fish per day (MFWP 2003). In 1998, lake trout were first reported in angler catch from Swan Lake. Since that time, ten more specimens have been reported taken by anglers. In the fall of 2003, a juvenile lake trout approximately 9 inches long was captured in a gill net. There is an urgent need to assess this potential lake trout expansion and the threat it presents to the bull trout population in Swan, as well as Holland and Lindbergh lakes upstream.

Due to logistical constraints caused by a severe fire season, only the four Hungry Horse Reservoir index sections were surveyed in 2003. These four sections support approximately 22 percent of all spawning by bull trout in Hungry Horse Reservoir. The 2003 redd count totaled 76 redds. The reservoir index count has averaged 76 redds and ranged from 50 to 102 during the past eleven years. Both the gill-net catch from fall sets in Hungry Horse Reservoir and juvenile bull trout

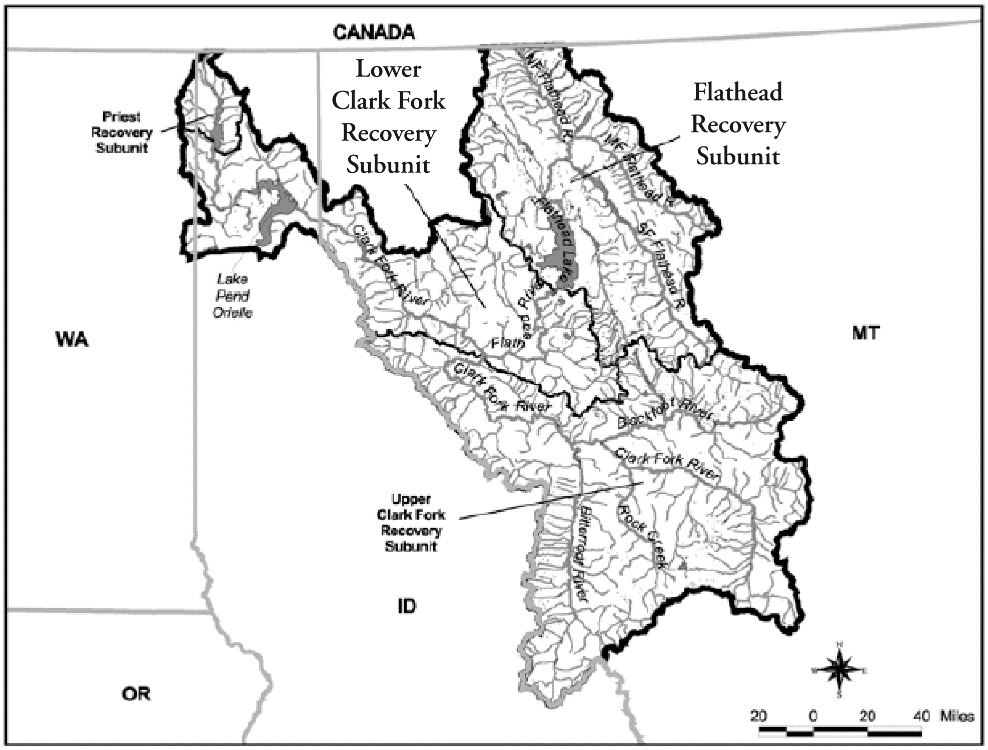

Figure 4.1. The Clark Fork Recovery Unit showing relationship of recovery subunits and major watersheds (From Bull Trout Recovery Plan).

Table 4.1. Summary of Flathead Basin bull trout spawning site inventories from 1980-2003 in the stream sections monitored annually (continued on next page).

	80	81	82	83	84	85	86	87	88	89	90
					Number of Redds						
North Fork:											
Big	20	18	41	22	9	9	12	22	19	24	25
Coal	34	23	60	61	53	40	13	48	52	50	29
Whale	45	98	211	141	133	94	90	143	136	119	109
Trail	31[a]	78	94	56	32	25	69	64	62	51	65
Total	130	217	406	280	227	168[b]	184	277	269	244	228
Middle Fork:											
Morrison	75	32[a]	86	67	38	99	52	49	50	63	24
Granite	34	14[a]	34	31	47	24	37	34	32	31	21
Lodgepole	14	18	23	23	23	20	42	21	19	43	12
Ole	19	19	51	35	26	30	36	45	59	21	20
Total	142	83	194	156	134	173[b]	167	149	160	158	77
Flathead Drainage Monitoring Count	272[a]	300[a]	600	436	361	341[b]	351	426	429	402	305

a/Counts may be low due to incomplete survey.

b/High flows may have obliterated some redds.

Table 4.1 (cont). Summary of Flathead Basin bull trout spawning site inventories from 1980-2003 in the stream sections monitored annually.

	Number of Redds												
North Fork:													
Big	24	16	2	11	14	6	13	30	34	32	22	12	12
Coal	34	7	10	6	13	3	5	14	7	3	0	0	1
Whale	61	12	46	32	28	35	17	40	49	68	77	71	34
Trail	27	26	13	15	28	8	9	17	21	42	27	26	14
Total	146	61	71	64	83	52	44	101	111	145	126	109	61
Middle Fork:													
Morrison	45	17	14	21	28	9	39	35	30	44	40	30	21
Granite	20	16	9	18	25	4	12	22	37	26	18	18	17
Lodgepole	9	13	9	6	9	8	5	7	11	3	17	12	10
Ole	23	16	19	6	16	10	14	22	26	33	29	21	21
Total	97	62	51	51	78	31	70	86	104	106	104	81	69
Flathead Drainage	243	123	122	115	161	83	114	187	215	251	230	190	130

a/Counts may be low due to incomplete survey.
b/High flows may have obliterated some redds.

Table 4.2. Summary of Swan Drainage bull trout spawning site inventories from 1982-2002 in the stream sections monitored annually.

	82	83	84	85	86	87	88	89	90	91	92
	Number of Redds										
Swan River:											
Elk	56	91	93	19	53	162	201	186	136	140	143
Goat	33	39	31	40	56	31	46	34	27	31	17
Squeezer	41	57	83	24	55	64	9a/	67	42	101	115
Lion	63	49	88	26	46	33	65	84	58	94	100
TOTAL	193	236	295	109a/	210	290	321a/	371	263	366	375

	93	94	95	96	97	98	99	2000	2001	2002	2003
	Number of Redds										
Swan River:											
Elk	139	195	150	176	186	259	261	209	165	152	168
Goat	64	66	32	52	85	71	46	71	91	54	80
Squeezer	106	91	149	117	125	141	59a/	105	114	122	85
Lion	123	141	170	181	190	141	135	120	132	102	92
TOTAL	432	493	501	526	586	612	501a/	505	502	430	425

a/High flows may have obliterated some redds.

Table 4.3. Summary of South Fork Flathead Drainage bull trout spawning site inventories from 1993-2002 counts in the stream sections monitored annually.

	Reservoir Tributaries										
	93	94	95	96	97	98	99	2000	2001	2002	2003
South Fork											
Wounded Buck	22	29	34	41	14	5	3	3	9	5	10
Wheeler	12	10	1	3	1	4	12	23	25	12	17
Sullivan	25	8	--	52	50	54	55	45	51	18	45
Quintonkin	5	3	7	4	0	11	15	15	17	21	4[b]
Totals	64	50	42	100	65	74	85	86	102	56	76
Wilderness Tributaries											
Youngs	40	24	34	74	43	--	85	--	61	--	--
Gordon	35	44	46	58	30	--	99	--	120	--	--
Little Salmon	56	47	43	134	100	--	138	--	111	--	--
White River	39	60	45	86	31	--	76	--	76	--	--
Total	170	175	168	353	204	--	398	--	368	--	--
Combined Total	234	225	210[a]	453	269	74	483	86	470	56	76

a/High flows may have obliterated some redds.
b/Ice may have obscured some redds.

densities in tributary streams show a stable population. The Hungry Horse Reservoir fishery is being reopened to limited bull trout harvest on an experimental basis beginning in 2004.

In the Stillwater and Whitefish drainages, population data regarding the four disjunct populations has been sparse, and not enough information exists to determine trends. Table 4.4 displays available redd count information for the Upper Stillwater and Swift Creek. The Stillwater population is not considered healthy by the Montana Bull Trout Scientific Group (1995c). Although a few bull trout are found near the mouth of the Stillwater River they may be migrants from the Flathead River system and are generally considered absent from the lower rivers.

From September 1983 through October 1986, seventeen bull trout were captured in 3,000 hours of effort in the lower Flathead River (CSKT et al. 1989). In 1998, electrofishing of the lower Flathead River yielded only three bull trout, one in May and two in October (FERC 2000). While little is known about the seasonal use of the lower Flathead River by bull trout, it is clear they are at very low densities. The Jocko River and Mission Creek are the only tributaries to the Flathead River known to contain bull trout. In 1998 bull trout were found in one reach of the mainstem Jocko River and in two reaches of the South Fork of the Jocko River. No bull trout were sampled in the other mainstem reaches or in Crow Creek, however the possibility remains that bull trout are present in these reaches in low numbers (FERC 2000).

LINKS

Appendix 68 has additional information on bull trout in Hungry Horse Reservoir and the South Fork of the Flathead.

Click Here

Table 4.4. Redd count data for Stillwater and Whitefish drainages. Source: MFWP.

Stream	93	94	95	96	97	98	99	2000	2001	2002	2003
Fitzsimmons Creek & Upper Stillwater	7	4	3	8	6	47	30	34	12	19	25
Logan Creek	-	7	0	2	-	-	0	-	-	-	-
East Fork Swift Creek	0	0	0	0	0	0	0	0	0	0	0
West Fork Swift Creek & Swift Creek	6	4	3	3	0	12	9	10	14	5	6

Less is known about bull trout in the Mission Creek drainage. In Mission Creek and its tributaries, densities are too low for sampling. Irrigation impoundments (McDonald, Mission, and Tabor reservoirs) situated at the foothills harbor populations that are considered by the bull trout recovery plan to be local populations of the lower Flathead River core area. There is some uncertainty about whether these headwater lakes functioned as true disjunct lakes for bull trout prior to the construction of the irrigation reservoirs in the early 1900s. Bull trout moving out of the reservoirs are trapped below the impoundment and may show up in sampling. It is unknown at this time if the bull trout below these reservoirs are self-sustaining or simply an artifact of straying (FERC 2000).

Historic and Current Distribution

Prior to European settlement, bull trout lived throughout the Columbia River Basin. Today they are found primarily in upper tributary streams and several lake and reservoir systems. On a regional scale, they have either been eliminated from, or their numbers have been reduced in, the main stems of most large rivers (USFWS 2003).

Good information on the historical distribution of bull trout is limited. However it is known that during the presettlement period, adult bull trout were distributed throughout the Flathead System, and that the Flathead Lake population had access to the North, Middle, and South Forks of the Flathead and the Lower Flathead River and seasonal access to the Whitefish, Stillwater, and Swan Rivers (MBTSG 1995c). Appendix 39 lists streams and lakes in the North and Middle Forks of the Flathead and Stillwater Rivers that historically had bull trout populations. Appendix 85 includes excerpts from the Inter Lake newspaper, circa 1900, that demonstrate there were strong bull trout populations at the time as well as widespread distribution of the species.

Before Hungry Horse Dam was built, the South Fork of the Flathead River was a major spawning and rearing area for bull trout from Flathead Lake. In the mid-1930s, the Forest Service recorded bull trout in the following creeks now feeding Hungry Horse Reservoir: *Hungry Horse*, Wounded Buck, *Flossy, Riverside, Clayton, Deep, Logan*, Wheeler, *Forest*, Sullivan and Quintonkon Creeks. They also reported bull trout in the following drainages above where the reservoir is now: *Lower and Upper Twin Creeks*, Spotted Bear River, and Bunker, *Mid, Black Bear, Bartlett*, Gordon,

LINKS

For maps showing bull trout status and distribution, go to Appendix 41.

Click Here

Appendix 39 provides more detail on bull trout historic occurrence in the North and Middle Forks of the Flathead River and Stillwater River

Click Here

QHA bull trout spreadsheets contain current and historic bull trout distribution by lifestage for HUC-6 watersheds and selected lakes in the U.S. and B.C. portions of the Flathead. These data are a compilation put together by our Technical Team. Go to Appendix 26.

Click Here

LINKS

Appendix 85 includes excerpts from the Inter Lake newspaper, circa 1900, that demonstrate there were strong bull trout populations and widespread distribution of bull trout at that time.

Click Here

and Youngs Creeks (MBTSG 1995d) (streams in italics support only incidental juvenile use, no spawning adults) (Tom Weaver, MFWP, pers. comm. 2004).

Early accounts for the Swan drainage suggest catches of bull trout from Swan Lake were common year round. A 1937-38 Forest Service report documents the presence of bull trout in Swan and Holland Lakes and the Swan River as well as in Lion, *Fatty*, Elk, *Cedar*, Cold, *Pony, Dog, Cat, Condon*, Piper, Jim, Glacier, *Rumble, Buck, Barber*, and *Cooney* Creeks (MBTSG 1996c) (streams in italics support only incidental juvenile use, no spawning adults) (Tom Weaver, MFWP, pers. comm. 2004).

It is assumed that prior to dams being built on the Clark Fork, the lower Flathead River functioned as part of the Lake Pend Oreille-Clark Fork River metapopulation and had a considerable migratory component (FERC 2000). Fish from Lake Pend Oreille had access to the lower Flathead and bull trout from Flathead Lake may have moved downstream out of the lake into the lower Flathead River (MBTSG 1996e). It is likely that historically both the Jocko River and Mission Creek drainage supported distinct subpopulations of bull trout that had adfluvial, fluvial, and resident life history components (FERC 2000). Ethnographic literature supports this, indicating that bull trout were found in the Jocko River, Mission Creek, lower Flathead River, Flathead Lake, St. Mary's Lake and McDonald Lake (FERC 2000).

Status of Bull Trout Introductions, Artificial Production and Captive Breeding Programs

LINKS

For current and Historic Fish Stocking Records in Montana, go to: http://www.fwp.state.mt.us/fishing/stock02.asp

Click Here

The only captive bull trout propagation program currently ongoing in the United States is conducted ate the Creston National Fish Hatchery near Kalispell, MT. This has been a successful experimental program for over ten years, and progeny from the Creston NFH broodstock have been used for a wide variety of research and educational purposes (Mark Maskill, USFWS, pers. comm. 2004). Fish produced from the current stock are not available for outplanting to the wild, due in part to the legal terms of a settlement agreement.

Historic and current harvest[2]

Since at least the 1950s, fisheries management programs in the Flathead River basin have attempted to protect native species (bull trout and westslope cutthroat) (MBTSG 1995c). Despite those attempts, native populations have decreased, resulting in increasingly restrictive angling regulations. A collateral rise in populations of introduced species (particularly lake trout and northern pike) led to a shift in angler support toward those species. These events created a dilemma within the regulatory environment, which in recent times has attempted to provide quality angling opportunities for both native and introduced species—a difficult

[2] *This section is excerpted from USFWS (2002).*

challenge. In the past, legal angler harvest of bull trout throughout the Flathead River basin may have been significant. Harvest and escapement limited data collected in 1981 suggest that anglers may have taken up to 40 percent of the adult bull trout that entered the river that year (Fraley et al. 1989).

Angling regulations for bull trout in the Flathead River basin have been gradually tightened over the past 45 years (MBTSG 1995c). The earliest regulations allowed an aggregate limit of 15 trout, but imposed a minimum size limit of 46 centimeters (18 inches) for bull trout. Spawning stream closures first occurred in 1953 in the North Fork Flathead River and in 1962 in the Middle Fork Flathead River. In 1985, bull trout were assigned a separate limit of one fish and the minimum length was dropped.

Since July 6, 1992, it has been illegal to "take and/or intentionally fish for bull trout" (MFWP 2000) throughout northwest Montana. In addition, some of the primary spawning streams and the rivers around their mouths are closed to fishing entirely. There is one current exception to the no-take regulation: Swan Lake, with a daily limit of one fish. The Swan River and tributaries are closed to fishing for bull trout. Bull trout management objectives for Swan Lake are focused on maintaining the local populations at a stable level (MBTSG 1996b). According to a Swan Lake creel survey conducted in 1983 to 1984, bull trout were the third most abundant fish species harvested. Creeled bull trout averaged 46 centimeters (18 inches) long (Leathe and Enk 1985). The total estimated harvest was 739 bull trout (Leathe and Enk 1985). A more recent survey, conducted in 1995, indicated an estimated 482 bull trout were harvested (Rumsey and Werner 1997). This level of harvest has not deterred an increasing trend in population of bull trout in Swan Lake, and the fishery has remained open; this lake, Hungry Horse and Kookanusa Reservoirs, and the South Fork of the Flathead River are the only waters under Montana Fish, Wildlife & Parks jurisdiction where fishing for bull trout is legal.

Hungry Horse Reservoir remained open to bull trout harvest until March 1995, when it was closed due to concern about the impact of deep reservoir drawdowns on the fish community. The Montana Bull Trout Scientific Group estimated that roughly 100 to 250 bull trout were harvested annually in Hungry Horse Reservoir between 1985 and 1993 (MBTSG 1995d). The most recent estimate of harvest was that anglers removed less than 10 percent of the adult population of bull trout from the reservoir in 1993 (MBTSG 1995d). Montana Fish, Wildlife & Parks has interpreted the data as indicating a stable trend in bull trout numbers in the South Fork Flathead River since the dam was built in the 1950s. A limited, experimental harvest fishery for bull trout opened in 2004 in Hungry Horse Reservoir and Lake Koocanusa. Individual anglers will be limited to the harvest of two bull trout per year (one per day) and will be required to possess and validate a catch card to fish for bull trout. The potential for illegal

LINKS

For bull trout information in the Flathead in British Columbia, go to: http://srmwww.gov.bc.ca/aib/

Click Here

For an electronic library of aquatic information (including reports pertaining to bull trout) for the B.C. portion of the subbasin, go to: http://srmwww.gov.bc.ca/appsdata/acat/html/deploy/acat_p_home.html

Click Here

For the B.C. Fisheries Inventory Data Queries site go to: http://srmapps.gov.bc.ca/apps/fidq/

Click Here

For the Conservation Data Centre, which also has bull trout information for B.C., go to http://srmwww.gov.bc.ca/cdc/

Click Here

introduction by anglers wishing to supplement their potential harvest remains a major concern in this drainage (MBTSG 1995d).

In recent years, Flathead Subbasin waters have received substantial angling pressure (table 4.5).

Table 4.5. Estimated 1999 angling pressure on Flathead subbasin waters (source: MFWP Angling Pressure Survey 1999)

Waterbody	Angler Days
Flathead Lake	47,000 to 53,000
Flathead River above FH Lake	31,223
Middle Fork Flathead River	5,352
North Fork Flathead River	6,590
Hungry Horse Reservoir	7,568
South Fork Flathead River	11,488
Swan Lake	12,716
Swan River	16,319
Lower Flathead River	3,180

With increasing fishing pressure, some hooking mortality is inevitable, as well as problems with identifying fish that are caught (i.e., mistaking bull trout for lake trout, brook trout, or other species). Illegal harvest of bull trout in northwest Montana has been an ongoing problem for at least 100 years. After Long (1997) interviewed poachers in northwest Montana to learn about their fishing habits and success rate, he estimated that, on average, 22 bull trout were killed per week per poacher during 3 months, July through September. Of the 9 poachers interviewed, 7 felt that poaching could have a major impact on reducing bull trout numbers. The numbers of fish harvested per poacher were much higher than expected, pointing out the danger that illegal harvest posed to local bull trout populations, especially because of the species' declining status (Long 1997). In response to this information, Montana Fish, Wildlife & Parks increased enforcement efforts, and penalties for illegal harvest of bull trout were raised.

4.1.2 Population Delineation and Characterization

Population Units:

In a 1998 letter, the governor of Montana argued that under the U.S. Fish and Wildlife Service distinct population segment policy, the Clark Fork River bull trout population(s) meets the criteria of a separate distinct population segment (Montana Bull Trout Restoration Team 2000). No formal action to analyze and reevaluate the designated population segment has been undertaken (USFWS 2002a).

In the Flathead Recovery Subunit, the status summary prepared for the final listing rule (USFWS 1998c) recognized 29 lakes with local populations, Flathead Lake being the largest. Each of these lakes was considered to hold a separate bull trout subpopulation, and because of the degree of physical isolation (usually the temperature of the outflow), most of the disconnected lake-based local populations were referred to as "disjunct" by the Montana Bull Trout Scientific Group (MBTSG 1995c, 1995d, 1996b). Table 4.6 lists local populations by core area. The lexicon for describing bull trout population units has evolved. In the USFWS Draft Bull Trout Recovery Plan (USFWS 2002a), the bull trout population units are hierarchically described, from the Columbia River Basin DPS at the largest scale, to recovery units, to core areas, each of which are comprised of one to many local populations (see glossary (Appendix 84)). The term "subpopulation" was considered less useful and the use of this term was officially discontinued by the Bull Trout Recovery Team.

LINKS

For a glossary of bull trout terms, go to Appendix 84.

Click Here

There are four known life-history forms of bull trout: adfluvial stocks migrate between lakes and streams: fluvial stocks move between rivers and tributaries; and resident stocks complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Anadromous bull trout occur in some coastal rivers, but are not found in Montana. Of the three forms found in the upper Columbia River Basin, the predominant in the Flathead River basin is adfluvial (Deleray et al. 1999). There is little historical evidence of the presence of discrete fluvial or resident stocks, though recent work suggests individual fish may have a primarily fluvial life history (USFWS 2002a).

Flathead Lake supports a population of large, adfluvial bull trout that spawn in tributaries to the Flathead River, primarily in the North and Middle Fork drainages (MBTSG 1995c). Because of the geology in the North Fork of the Flathead, streams entering from the west side of the river (issuing from the Whitefish Range and lands managed by the USFS) support migratory bull trout, while streams entering from the east side (coming out of Glacier National Park) do not. In large measure, this is due to the very different temperature regime of the Park streams that emanate from large lakes. They are typically too warm in the fall to support bull trout spawning in the reaches downstream from the lakes. However, many of those Park streams have large lakes—Kintla, Bowman, Quartz, Logging—that support disjunct populations in their headwaters. Disjunct populations generally mature in a natural lake and then ascend tributary streams to spawn. Like east-side North Fork tributaries, tributaries to the Middle Fork support migratory bull trout that come from Flathead Lake. In addition, there are a number of disjunct lakes in the Middle Fork that contain bull trout (MBTSG 1995c). Genetic studies of these headwater lakes has shown a strong degree of

LINKS

For a Genetic Analysis of Bull Trout in Glacier National Park (Spruell et al. 2002) go to Appendix 86.

Click Here

Table 4.6. List of local populations (in bold) by core area, in the Flathead Subbasin. Streams designated by (mc) are migratory corridors only and are not considered to host their own local population. Source: Draft Bull Trout Recovery Plan, Chapter 3. *(Continued on next page)*

Core Area	Local Population
Lower Flathead River	Mission Creek (mc)
	Post Creek (trib. to McDonald Lake)
	Mission Creek (trib. to Mission Reservoir)
	Dry Creek (trib. to Tabor (St. Marys) Res.)
	Jocko River
	South Fork Jocko River
	Middle Fork Jocko River
	North Fork Jocko River
Frozen Lake	**Unnamed headwater tributary (and stream flowing out of Frozen Lake)**
Upper Kintla Lake	**Kintla Creek (trib. to Upper Kintla Lake)**
Kintla Lake	**Kintla Creek (trib. to Kintla Lake)**
Akokala Lake	**Akokala Creek (trib. to Akokala Lake)**
Bowman Lake	**Bowman Creek (trib. to Bowman Lake)**
Cerulean Lake, Quartz Lake, Middle Quartz Lake	**Quartz Creek (trib. to Middle Quartz Lake)**
Lower Quartz Lake	**Quartz Creek (trib. to Lower Quartz Lake)**
Cyclone Lake	**Cyclone Creek (entire drainage)**
Logging Lake	**Logging Creek (trib. to Logging Lake)**
Trout Lake	**Camas Creek (trib. to Trout Lake)**
Arrow Lake	**Camas Creek (trib. to Arrow Lake)**
Isabel Lake(s)	**Park Creek (trib. to Lower Isabel Lake)**
Harrison Lake	**Harrison Creek (trib. to Harrison Lake)**
Lincoln Lake	**Lincoln Creek (trib. to Lincoln Lake)**
Lake McDonald	**McDonald Creek (trib. to Lake McDonald)**
Doctor Lake	**Doctor Creek (trib. to Doctor Lake)**
Big Salmon Lake	**Big Salmon Creek (trib. to Big Salmon Lake)**

Table 4.6 (cont). List of local populations (in bold) by core area, in the Flathead Subbasin. *(Continued on next page.)*

Core Area	Local Population
Hungry Horse Reservoir	South Fork Flathead River (mc)
	Danaher Creek
	Youngs Creek
	Gordon Creek
	White River
	Little Salmon Creek
	Bunker Creek
	Spotted Bear River
	Sullivan Creek (trib. Hungry Horse Res.)
	Wheeler Creek (trib. H. Horse Res.)
	Wounded Buck Creek (trib. H. Horse Res.)
Upper Stillwater Lake	**Stillwater River (trib. to Upper Stillwater Lake)**
Whitefish Lake	**Swift Creek (trib. to Whitefish Lake)**
Upper Whitefish Lake	**East Fork Swift Creek (trib. and downstream)**
Lindbergh Lake	**Swan River (trib. to Lindbergh Lake)**
Holland Lake	**Holland Creek (trib. to Holland Lake)**
Swan Lake	Swan River (mc)
	Elk Creek
	Cold Creek
	Jim Creek
	Piper Creek
	Lion Creek
	Goat Creek
	Woodward Creek
	Soup Creek
	Lost Creek

Table 4.6 (cont). List of local populations (in bold) by core area, in the Flathead Subbasin.

Core Area	Local Population
Flathead Lake	Flathead River (mc)
	North Fork Flathead River (U.S. / B.C.)
	Howell Creek (B. C.)
	Kishinena Creek (B. C.)
	Trail Creek
	Whale Creek
	Red Meadow Creek
	Coal Creek
	Big Creek
	Middle Fork Flathead River (mc)
	Strawberry Creek (includes Trail)
	Bowl Creek
	Clack Creek
	Schafer Creek (includes Dolly Varden)
	Morrison Creek

genetic isolation, suggesting they have functioned largely independent of the downstream Flathead Lake bull trout for thousands of years (Spruell et al. 2002).

The Stillwater River system supports only three or four small disjunct populations: the upper Stillwater Lake population spawns and rears in the upper portions of the Stillwater River and in Fitzsimmons Creek; the upper Whitefish Lake population likely spawns in the East Fork of Swift Creek; and the Whitefish Lake population is believed to spawn in Swift Creek or the West Fork of Swift Creek. The degree to which these populations may have been previously connected is unknown, but they are now all at low levels and completely fragmented and it is unlikely individual bull trout successfully migrate between these waters.

The South Fork Flathead River population, isolated in the 1950s by Hungry Horse dam, matures in Hungry Horse reservoir and spawns in the tributaries to the South Fork. Disjunct populations occur in the South Fork in Big Salmon and Doctor Lakes (MBTSG 1995d).

The Swan Lake population, isolated in 1902 by Bigfork Dam (and which may have been naturally isolated by temperature), matures in Swan Lake, and then moves into the Swan River and its tributaries to spawn. Two lakes in the Swan River drainage—Holland and Lindbergh—support disjunct populations of bull trout.

In the lower half of the subbasin on the Flathead Indian Reservation, bull trout currently exist as resident and/or disjunct populations in the Jocko River and Mission Creek drainages (FERC 2000).

Life History[3]

Bull trout are long-lived fish, growing to lengths of over 40 inches and weighing as much as 32 pounds. They generally do not reach breeding age until they are at least five years old. As subadults and adults, they eat mostly other fish.

Migratory bull trout spawn and rear in smaller streams and mature and overwinter in larger rivers or lakes. In the Flathead Subbasin, adfluvial fish reach sexual maturity in lakes like Flathead Lake and Hungry Horse Reservoir at about age 6 and migrate up the river system in April. They arrive in the North Fork and Middle Fork Rivers in June and July, and the majority of fish enter the tributary streams in August. Spawning occurs during September and October when water temperatures drop near 9-10 °C (Fraley and Shepard 1989). Most spawners are in their 7th year and can be alternate year spawners. Fecundity averaged 5,482 eggs per female fish averaging 645 mm in length; one 6.8 kg female had 12,800 eggs (Fraley and Shepard 1989). Spawning occurs in gravel substrates with groundwater influence and in proximity to cover. Incubation of eggs to emergence of swim-up fry lasts about 220 days. Emergence occurs in late April-early May and bull trout rear for 2-3 years in the streams until they migrate downstream to Flathead Lake generally from June through August. Juvenile bull trout prefer complex habitat types with low water temperatures (<15 °C), clean cobble/boulder substrates associated with cover, and slow velocity areas along the margins of streams (Shepard et al. 1984). It is common to find juvenile bull trout in tributary streams where adult spawners have not been found as they migrate into cooler tributaries to rear.

Genetic Integrity

No introgression of bull trout has been documented in the North, Middle, and South Forks of the Flathead. In all watersheds except for several in the Middle Fork the potential for hybridization is considered nonexistent because brook trout are absent. In Bear Creek, brook trout are present, and the potential for hybridization is considered high. Brook trout occur in high numbers in the upper Stillwater and Whitefish Lake watersheds. While brook trout threaten the genetic integrity of bull trout, genetic samples collected to date have not found evidence of hybridization. Brook trout are widely dispersed throughout the Swan drainage to the extent that there are no bull trout streams without resident brook trout populations. Recent genetic data (Kanda et al. 1994) and observations from Squeezer Creek within the Swan River drainage (Kitano et al. 1994) indicate that large, spawning, migratory bull trout mate with smaller brook trout, producing hybrid offspring. Bull trout/brook trout hybrids have been observed

[3] *Excerpted from MBTSG 1995c.*

LINKS

Appendix 40 contains more detailed information on life histories of Montana bull trout. See also Shepard et al. 1984.

Click Here

Appendix 67 is a review of bull trout life history and habitat use.

Click Here

LINKS

Maps in Appendix 41 show (1) bull trout genetic distribution and status in the Flathead Subbasin and (2) bull trout distribution, restoration/conservation areas, and core habitat areas.

Click Here

Appendix 42 lists the streams in the Flathead Subbasin that contain brook trout as of February 2003.

Click Here

For current and Historic Fish Stocking Records in Montana, go to: http://www.fwp.state.mt.us/fishing/stock02.asp

Click Here

in several of the primary bull trout nursery streams (Swan River Drainage Bull Trout Status Report). Hybridized offspring are often sterile (Leary et al. 1983). Similarly, in the lower Flathead, brook trout are present in all the bull trout streams with the possible exception of Post Creek (Middle Clark Fork River Drainage Bull Trout Status Report). Brook trout are known to be extensively hybridized with bull trout in Mission Creek (Hansen and DosSantos 1993).

4.1.3 Population Status

Current Status

The section titled *Summary of Population Data* includes data on populations of index streams between 1998 and 2003. Appendix 43 (see links column) summarizes a USFS characterization of the status of bull trout subpopulations as part of their Section 7 consultation with the USFWS.

LINKS

Appendix 43 summarizes the Flathead National Forest's characterization of bull trout subpopulations as part of their Section 7 consultation with the USFWS.

Click Here

Historic Status

Quantitative data on historic bull trout abundance and productivity in the Flathead Subbasin are not available. Evermann (1892) reported bull trout were common in most of the larger tributaries of the Columbia River in Montana, and it is assumed bull trout were common to abundant throughout the North, Middle, and South Forks of the Flathead River drainage. It is believed the Swan, Whitefish, and Stillwater drainages all supported distinct populations. Anecdotal accounts of bull trout in these streams from the late 1800s to the present are common (MBTSG 1995c). The interconnected Flathead system (pre-dam) possibly supported the largest migratory bull trout assemblage in the world (USFWS 1998c). It is believed that at that time the lower Flathead River had a considerable migratory component as well and that both the Jocko River and Mission Creek supported distinct subpopulations that had adfluvial, fluvial, and resident life-history components (FERC 2000).

Theoretical Reference Condition[4]

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.

[4] *Northwest Power Planning Council direction for this section is that the determination of a theoretical reference condition that ensures the long-term sustainablility for ESA-listed species should be made by the approprate ESA recovery team. This section is adapted from the Bull Trout Draft Recovery Plan (2002).*

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.
- 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.

In this recovery unit, the historical distribution of bull trout is relatively intact, and no vacant core habitat is recommended at this time for reestablishment of extirpated local populations. Instead, emphasis is placed on securing the existing distribution within core areas and increasing the abundance and connectivity of local populations.

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).

Table 4.7 presents numeric standards necessary to achieve recovered abundance of bull trout in primary and secondary core areas of the Flathead Subbasin.

Primary core areas in the Clark Fork Recovery Unit are typically located in watersheds of major river systems, often contain large lakes or reservoirs, and have migratory corridors that usually extend 50 to 100 kilometers (30 to 60 miles) or more. Each primary core area includes 7 to 19 identified local populations of bull trout. In recovered condition, a primary core area is expected to support at least 5 local populations with 100 or more adults each and to contain 1,000 or more adult bull trout in total.

Table 4.7. Numeric standards necessary to achieve recovered abundance of bull trout in primary and secondary core areas.

Core Areas	Existing No. (Estimated) Local Populations	Existing No. (Estimated) Local Populatons with > 100 (# adults spawning annually)	Recovered Minimum No. Local Populations with > 100 (# adults spawning annually)	Recovered Min. No. Core Area Total Adult Abundance (# adults spawning annually)
Primary				
Lower Clark Fork River Complex (Clark Fork River Section 3, Lower Flathead River, Noxon Reservoir, and Cabinet Gorge Reservoir)	16	0	5	1,000
Flathead Lake	19	9	10	2,500
Swan Lake	9	7	5	2,500
Hungry Horse Reservoir	10	5	5	1,000
Secondary				
Flathead Disjuncts (22 separate adfluvial cores)	22 (1 each)	1	22 (1 each)	Maximize with goal of > 100 in each

Secondary core areas are based in smaller watersheds and typically contain adfluvial populations of bull trout that have become naturally isolated, with restricted upstream spawning and rearing habitat extending less than 50 kilometers (30 miles). Each secondary core area includes one identified local population of bull trout and is not believed to contain sufficient size and complexity to accommodate 5 or more local populations with 100 or more adults to meet the abundance criteria defined above for primary core areas. Most secondary core areas have the potential to support fewer than a few hundred adult bull trout, even in a recovered condition. In extreme cases, secondary core areas may include small isolated lakes that occupy as little as 10 surface hectares (25 acres) and that are connected to 100 meters (about 100 yards) or less of accessible spawning and rearing habitat. In most cases, these conditions are natural, and, in some situations, these bull trout have probably existed for thousands of years with populations that seldom exceed 100 adults.

Listed below are the proposed recovery criteria for 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. An exception to such an increase may occur in the Flathead Recovery Subunit where historical distribution is nearly intact. The intention of the Clark Fork Recovery Unit Teams is also to maintain the existing bull trout distribution within all secondary core areas, but the teams recognize that stochastic events or deterministic processes already occurring are likely to cause a loss of distribution in some cases. The significance of such losses in the ultimate determination of whether or not distribution criteria have been met need to be judged on a case-by-case basis.

2. Abundance criteria will be met when, in all primary core areas, each of at least 5 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 1 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.

LINKS

Appendix 69 is Chapter 3 of the Bull Trout Draft Recovery Plan. Chapter 3 addresses the Clark Fork River Recovery Unit, which encompasses the Flathead Subbasin.

Click Here

4.1.4 Out-of-Subbasin Effects and Assumptions

Mainstem Columbia River operations profoundly influence dam operations as far upstream as headwater reservoirs. Dam operations affect environmental conditions in the reservoirs upstream and rivers downstream of Hungry Horse Dam. The abundance, productivity and diversity of fish and wildlife species inhabiting the headwaters of the Columbia River are dependent on their immediate environment that changes with river management. Mainstem Columbia River operations affect bull trout in the following ways (Brian Marotz, MFWP, pers. comm. 2003):

LINKS

For a more complete discussion of how Mainstem Columbia River operations affect subbasin fisheries, and how those effects might be minimized see Appendix 12.

Click Here

- Unnaturally high flows during summer and winter negatively impact resident fish and migrating juveniles, subadults, and adults. The effects can be mitigated by releasing flows at a constant rate, producing constant stable, or slowly declining (unidirectional) flows.

- Summer flow augmentation causes reservoirs to be drafted during the biologically productive summer months. This impacts productivity in the reservoirs, with potentially cascading food web interactions that could affect bull trout or their prey species.

- Drafting the reservoirs too hard prior to receiving the January 1 inflow forecast places the reservoirs at a disadvantage for reservoir refill. This is especially important during less than average water years.

- Flow fluctuations caused by power, flood control or fish flows create a wide varial zone in the river, which becomes biologically unproductive.

- The planned reservoir refill date in the NOAA Fisheries BiOp of June 30 will cause the dam to spill in roughly the highest 30 percent of water years. This is because inflows remain above turbine capacity into July on high years. That means the reservoirs fill and have no remaining capacity to control spill. This causes gas super saturation problems. A sliding refill date allows filling later in high water years.

4.1.5 Environment-Population Relationships

Environmental Factors Particularly Important to Bull Trout Survival or Key Ecological Correlates (KECs)[5]

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993, 1995; Rich 1996; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), fish should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997b).

Migratory corridors link seasonal habitats for all bull trout life histories. For example, in Montana, migratory bull trout make extensive migrations in the Flathead River system (Fraley and Shepard 1989), and resident bull trout in tributaries of the Bitterroot River move downstream to overwinter in tributary pools (Jakober 1995). The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Gilpin 1997; Rieman et al. 1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed, or stray, to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants.

Bull trout are found primarily in cold streams, although individual fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Water temperature above 15 degrees Celsius (59 degrees Fahrenheit) is believed to limit juvenile bull trout distribution, a limitation that may partially explain the patchy distribution within a watershed (Fraley and Shepard 1989; Rieman and McIntyre 1995). Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Rieman et al. 1997; Baxter et al. 1999). Goetz (1989) suggested optimum water temperatures for rearing of about 7 to 8 degrees Celsius (44 to 46 degrees

[5] *This section is adapted from USFWS (2002).*

Fahrenheit) and optimum water temperatures for egg incubation of 2 to 4 degrees Celsius (35 to 39 degrees Fahrenheit).

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 deep beaver ponds or pools containing large woody debris in the Bitterroot River drainage, Montana, and suggested that suitable winter habitat may be more restricted than summer habitat. Maintaining bull trout habitat requires stability of stream channels and flow (Rieman and McIntyre 1993). Juvenile and adult bull trout 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; Pratt 1992; Pratt and Huston 1993).

Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989) and water temperatures of 5 to 9 degrees Celsius (41 to 48 degrees Fahrenheit) in late summer to early fall (Goetz 1989). In the Swan River, Montana, abundance of bull trout redds (spawning areas) was positively correlated with the extent of bounded alluvial valley reaches, which are likely areas of groundwater to surface water exchange (Baxter et al. 1999). Survival of bull trout embryos planted in stream areas of groundwater upwelling used by bull trout for spawning were significantly higher than embryos planted in areas of surface-water recharge not used by bull trout for spawning (Baxter and McPhail 1999). Pratt (1992) and Weaver and Fraley (1991) indicated that increases in fine sediment reduce egg survival and emergence.

In addition to the above variables — channel form and stability; valley form; water temperature; cover; discharge; the presence of loose, clean gravels; and migratory corridors — the geologic makeup of watersheds has been shown to be an important habitat parameter for bull trout in the subbasin. Fraley and Graham (1981b) found that of five geologic types in the North and Middle Forks of the Flathead, watersheds composed of quartzite and those underlain by a combination of limestone and argillite/siltite have significantly higher trout densities than those composed of limestone alone, argillite/siltite alone, or shales, sandstone, and limestones. They caution however that geology is not independent of other key habitat variables and must be considered in combination with them.

LINKS

For the website containing descriptions of surface waters included in the state water quality assessment database go to:http://nris.state.mt.us/wis/environet/2002_305bhome.html.

Click Here

Appendix 20 summarizes the information in the state water quality assessment database for Flathead and Lake Counties, excluding the Flathead Reservation and Glacier Park.

Click Here

For more detailed results of the QHA assessment, including attribute scores, see Appendix 26.

Click Here

Appendix 43 summarizes the baseline condition for bull trout in bull trout drainages in the upper Flathead.

Click Here

Environment's Ability to Provide Key Ecological Correlates

As part of our assessment, the Flathead Subbasin Technical Team[6] evaluated all the sixth code HUCs[7] and selected lakes in the Montana and Canadian portions of the Flathead Subbasin on the basis of eleven stream habitat attributes (Parkin and McConnaha 2003) and thirteen lake habitat attributes considered key to resident salmonids. This was done utilizing a spreadsheet tool developed by Mobrand Biometrics called Qualitative Habitat Assessment (QHA). Mobrand Biometrics and Dr. Paul Anders developed the lacustrine or lake version of QHA, called LQHA. 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) (table 4.8). Those used in LQHA are the ones considered by our Technical Team to be the main habitat drivers in lakes in the subbasin (table 4.9). For each 6th-code HUC, the technical team used quantitative data (when it existed) and professional knowledge to score each of the attributes for each HUC. We did the same for selected lakes (table 4.10).

Table 4.11 ranks stream habitat-attributes for the regulated mainstem for bull trout. Table 4.12 ranks the same attributes for a typical or average 6th-code HUC in the Flathead Subbasin for bull trout. Table 4.13 shows the rankings at the HUC-4 scale. Table 4.14 makes a similar ranking for selected subbasin lake habitat attributes. The ranking provides an indication of the subbasin's ability to provide the key ecological correlates for bull trout and the habitat attributes that may be the most limiting for bull trout in the subbasin. It should be noted, however, that these rankings have been generalized for the subbasin and at 4th-code HUC scale. Rankings for individual 6th-code HUCs will vary.

Based on this analysis, of the eleven stream-habitat attributes considered key to resident salmonids, the four most limiting to bull trout in the regulated mainstem are riparian condition, habitat diversity, altered hydrograph, and fine sediments. The four most limiting attributes in tributaries (when averaged across all the HUCs in the subbasin) are channel stability, fine sediment, riparian condition, and habitat diversity, in that order. The rankings are different at the HUC-4 scale.

LINKS

Appendix 44 presents the results of a GIS-based fisheries vulnerability analysis conducted by the Cohesive Strategy Team of Region 1 of the USFS.

Click Here

Appendix 45 presents the results of an American Wildlands GIS-based, coarse-scale analysis of the current condition of native aquatic integrity across an Upper Columbia basin (called the Aquatic Integrity Areas (AIA) model). Go also to: http://www.y2y.net/science/aquatic_research.asp#aia

Click Here

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[6] The Flathead Subbasin Technical Team members particiapating in the HUC-by-HUC assessment included fisheries biologists and hydrologists from Montana Fish, Wildlife & Parks, Montana Department of Environmental Quality, US Army Corps of Engineers, US Fish and Wildlife Service, the Flathead National Forest, two provincial Canadian ministries, the Confederated Salish and Kootenai Tribes, and a private consulting firm.

[7] In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portion of the subbasin, time limitations prevented the use of 6th-code HUCs. Instead, the Canadian members of the team used analogous watersheds developed during a previous watershed restoration planning exercise in B.C.

Of the thirteen lake/reservoir-habitat attributes considered key to resident salmonids, the four most limiting to bull trout in reservoirs are: hydraulic regime, migratory obstructions, volumetric turnover rates, and shoreline condition. The habitat in lakes is in significantly better condition, and none of the lake habitat attributes scored low enough to be considered limiting.

LINKS

Appendix 26 presents the results of our QHA assessment.

Click Here

Appendix 62, the QHA User's Guide, explains how QHA works.

Click Here

Table 4.8. Eleven habitat attributes used in the Flathead Subbasin QHA analysis of 6th-field HUCs with definitions.

Attribute	Brief Definition
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 flow events.
Low Flow	Frequency and amount of low flow events.
Oxygen	Dissolved oxygen in water column and stream substrate
High Temperature	Duration and amount of high summer water temperature that can be limiting to fish survival
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
Obstructions	Barriers to fish passage

Table 4.9. Thirteen habitat attributes used in the Flathead Subbasin Lacustrine or Lake QHA analysis of selected lakes with definitions.

Attribute	Brief Definition
Temperature	Duration and amount of high or low water temperatures that can be limiting to fish survival
Dissolved Oxygen	Dissolved oxygen in water column and stream substrate
Gas Saturation	Percent water is saturated (<100%) or super-saturated (>100%) with Nitrogen gas
Volumetric Turnover Rates	Time required to replace entire reservoir with new water based on rate of its downstream expulsion
Pollutants	Introduction of toxic (acute and chronic) substances into the lake or reservoir
Trophic Status	Level (status) of biological productivity in lake or reservoir
Entrainment	Downstream fish loss through a hydropower dam, other than through a spillway of fish ladder
Migratory Obstacles	Natural and artificial barriers to upstream and/or downstream fish migration
Macrophytes	Emergent and submergent aquatic plant species and community structure in lakes and reservoirs
Hydraulic Regime	Temporal and volumetric characteristics of hydrograph
Shoreline Condition	Physical condition of water-land interface, riparian and varial zones
Habitat Diversity	Relative degree of habitat heterogeneity
Substrate Condition	Physical condition of substrates

Table 4.10. Lakes assessed in the Flathead Subbasin using the Lacustrine QHA spreadsheet tool.

Lake	Drainage
Upper Stillwater	Stillwater
Whitefish	Stillwater
Lindbergh	Swan
Holland	Swan
Swan	Swan
Flathead	Flathead
Ashley	Flathead
Bitterroot	Lower Flathead
Tally	Flathead
Mcdonald	Lower Flathead
Kintla	North Fork Flathead
Bowman	North Fork Flathead
Quartz	North Fork Flathead
Logging	North Fork Flathead
Harrison	Middle Fork Flathead
McDonald	Middle Fork Flathead
Big Salmon	South Fork Flathead
Hungry Horse	South Fork Flathead

Table 4.11. Ranking of key stream-habitat attributes in the regulated mainstem of the Flathead River Subbasin for bull trout based on a QHA analysis of 6th-code HUCs. Those with the highest rank (with 1 being highest) scored highest in terms of their condition with respect to bull trout. The higher the QHA score, the more degraded the attribute.

Habitat Attribute	Score	Rank
Low Temperature	0.00	1
Obstructions	0.00	1
Oxygen	0.00	1
High Temperature	0.07	2
Channel stability	0.10	3
Pollutants	0.10	3
High Flow	0.14	4
Fine sediment	0.22	5
Low Flow	0.28	6
Habitat Diversity	0.34	7
Riparian Condition	0.46	8

Table 4.12. Ranking of key stream-habitat attributes in Flathead Subbasin tributaries for bull trout based on a QHA analysis of 6th-code HUCs.

Habitat Attribute	Score	Rank
Low Temperature	0.00	1
Pollutants	0.01	2
Oxygen	0.01	2
High Temperature	0.02	3
Obstructions	0.03	4
High Flow	0.06	5
Low Flow	0.08	6
Habitat Diversity	0.10	7
Riparian Condition	0.12	8
Fine sediment	0.12	8
Channel stability	0.13	9

Table 4.13. Ranking of key stream-habitat attributes for the regulated mainstem and at the HUC-4 scale for bull trout based on a QHA analysis of 6th-code HUCs. Those with the highest rank scored highest in terms of their condition with respect to bull trout. The higher the QHA score, the more degraded the attribute for the species. The most limiting attributes are highlighted in yellow. Note that the QHA scores for the regulated mainstem and some HUC-4 watersheds are significantly higher than for other HUC-4 watersheds (the Lower Flathead and Stillwater, for example, are in much worse shape than the North, Middle, and South Forks of the Flathead). Also note that Low Flow, High Flow, and Oxygen are attributes that showed up as QHA limiting factors for bull trout in a few 4th-code HUCs. Except in the regulated mainstem, these are due to natural watershed conditions that restoration projects cannot effectively address.

	Regulated Mainstem		North Fork Flathead		Middle Fork Flathead		South Fork Flathead		Swan River		Lower Flathead		Stillwater River	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
Channel stability	0.10	3	0.06	3	0.15	6	0.08	5	0.12	6	0.35	6	0.43	10
Fine sediment	0.22	5	0.17	7	0.02	3	0.06	4	0.14	7	0.38	8	0.46	11
Habitat Diversity	0.34	7	0.15	6	0.07	5	0.02	3	0.07	5	0.38	8	0.15	5
High Flow	0.14	4	0.07	4	0.00	1	0.01	2	0.04	4	0.37	7	0.19	6
High Temperature	0.07	2	0.00	1	0.00	1	0.01	2	0.03	3	0.17	3	0.10	4
Low Flow	0.28	6	0.12	5	0.04	4	0.02	3	0.04	4	0.28	5	0.33	9
Low Temperature	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.01	2	0.00	1
Obstructions	0.00	1	0.01	2	0.01	2	0.02	3	0.04	4	0.19	4	0.04	2
Oxygen	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.20	7
Pollutants	0.10	3	0.00	1	0.00	1	0.00	1	0.02	2	0.00	1	0.07	3
Riparian Condition	0.46	8	0.15	6	0.04	4	0.08	5	0.14	7	0.41	9	0.23	8

Because this analysis ranks attributes at the HUC-4 scale, it generalizes conditions across multiple HUC-6 watersheds. Certain attributes not considered limiting at the HUC-4 scale may be limiting within one or more specific HUC-6 watersheds. For example, in the Lower Flathead low flows do not show up as one of the major limiting attributes at the HUC-4 scale. However, low streamflow is often an issue in areas of agricultural production throughout the Flathead Subbasin, and the most extensive irrigation system is run by the BIA on the Flathead Indian Reservation. The Reservation makes up most of the Lower Flathead watershed. As part of their federal trust responsibility, the BIA established instream flows in 1986 to protect fish on streams impacted by the federal Flathead Irrigation Project. Although these interim flows have proved beneficial to fish, they are considered "minimum" and are currently under evaluation. There are situations where current instream flows are probably not adequate to protect fish, even though low flows did not show up as an issue for the Lower Flathead when the QHA attributes were analyzed at the HUC-4 scale.

Table 4.14. Ranking of key habitat attributes for reservoirs in the Flathead Subbasin for bull trout based on a LQHA analysis. Those with the highest rank scored highest in terms of their condition with respect to bull trout.

Habitat Attribute	Score	Rank
Temperature	0.00	1
Gas saturation	0.00	1
Macrophytes	0.00	1
Substrate condition	0.02	2
Oxygen	0.04	3
Trophic status	0.04	3
Pollutants	0.05	4
Entrainment	0.06	5
Habitat diversity	0.08	6
Shoreline condition	0.12	7
Volumetric turnover rates	0.14	8
Migratory obstruction	0.15	9
Hydraulic regime	0.19	10

Long-term Viability of Populations Based on Habitat Availability and Condition

Table 4.15 shows the status, trend, and risk of stochastic extirpation for bull trout in the Flathead Subbasin. Because data are limited at best for some waters, risk scores should be considered subjective.

Table 4.15. Bull trout subpopulation status, trend and risk of stochastic extirpation. Source: USFWS (1998c).*

Drainage	Subpopulation	Status	Trend	Risk of Stochastic Extirpation
Flathead				
	Flathead Lake	D	D	N
	Whitefish Lake	D	D	N
	Upper Whitefish Lake	U	U	Y
	Upper Stillwater Lake	D	D	N
	Cyclone Lake	U	U	Y
	Frozen Lake	U	U	Y
	Kintla Lake	D	D	Y
	Upper Kintla Lake	U	U	Y
	Cerulean Lake	U	U	Y
	Upper Quartz Lake	U	U	N
	Middle Quartz Lake	U	U	N
	Lower Quartz Lake	U	U	Y
	Akokala Lake	U	U	Y
	Logging Lake	U	U	Y
	Bowman Lake	D	D	Y
	Arrow Lake	E	E	Y
	Trout Lake	U	U	Y
	Lower Isabel Lake	U	U	Y
	Upper Isabel Lake	U	U	Y
	Harrison Lake	U	U	Y
	Lake McDonald	D	D	Y
	Lincoln Lake	D	D	Y
South Fork Flathead				
	Hungry Horse Reservoir	S	S	N
	Big Salmon Lake	D	U	Y
	Doctor Lake	U	U	Y
Swan River				
	Swan Lake	S	I	N
	Lindbergh Lake	D	U	Y
	Holland Lake	D	U	Y
Clark Fork River				
	Middle Clark Fork (includes lower Flathead River)	U	U	N

** Abreviations: For Status: D = Depressed; S = Strong; and U = Unknown. For Trend: D=Decreasing; I=Increasing; S=Stable; and U= Unknown. For Risk of Stochastic Extirpation: Y= Yes; N = No.*

4.1.6 Bull Trout Limiting Factors and Conditions

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.

In our own HUC-by-HUC assessment of all Flathead Subbasin 6th- code HUCs, our technical team concluded that of the habitat attributes considered most important to resident salmonids, the four most limiting for bull trout in streams are riparian condition, fine sediment, channel stability, and habitat diversity, in that order. In lakes, they are migratory obstructions, pollutants, shoreline condition, and hydraulic regime. This phase of the HUC assessment considered only habitat factors (factors such as the presence of nonnative species were evaluated in a second phase of the HUC assessment and were not ranked against the habitat attributes in terms of which is most limiting).

The following paragraphs are adapted from the Draft Bull Trout Recovery Plan and summarize the factors or conditions identified by the USFWS that have led to the decline of bull trout and/or that currently inhibit bull trout populations in the Flathead Subbasin.

Dams

Dams have been one of the most important factors in fragmenting and likely reducing the bull trout population. Large and medium-sized hydroelectric dams have permanently interrupted established bull trout migration routes, eliminating access from major portions of the tributary system to the productive waters of Flathead Lake. Similarly, dams downstream of the subbasin have prevented migration from Lake Pend Oreille upstream into the lower Flathead River and its tributaries. These dams have also impacted the habitat that was left behind by affecting reservoir and lake levels, water temperature, and water quality. Smaller irrigation storage dams have further fragmented some of the previously connected watersheds and made it increasingly difficult for migratory bull trout to thrive.

Forest Practices

Past forestry practices (road construction, log skidding, riparian tree harvest, clear-cutting, and splash dams) are also a major contributing cause of the decline of bull trout in the Flathead River drainage. The effects on habitat of these practices include increased sediment in streams, increased peak flows, hydrograph and thermal modifications, loss of instream woody debris and channel stability, and increased accessibility for anglers and poachers. Although the heaviest timber harvest occurred in the 1960s and 1970s and more progressive and less damaging practices have been implemented, past forest activities will continue to impact bull trout because of the remaining road systems, increased water yields, and increased efficiency of water delivery to the streams that results in changes in the runoff timing. Impaired water quality as a result of silvicultural activities has been identified in 325 kilometers (202 miles) of 17 streams in the upper Flathead River drainage (MDHES 1994). In addition, insufficient funding to maintain the existing road system has resulted in maintenance deficiencies, even on some well-designed roads. Consequently, impacts of the existing road system are compounded.

Grazing

The overall risk to bull trout from livestock grazing in most of the subbasin is low (MBTSG 1995c). Exceptions include the Flathead Indian Reservation and to a lesser extent, the Stillwater and Whitefish River watersheds. Grazing is of particular concern where allotments are located along spawning and rearing streams. Severe site-specific problems occur on some lands, although livestock grazing does not represent a major threat to bull trout recovery in this subbasin.

Agricultural Practices

Impacts to bull trout from agriculture include dewatering, irrigation entrainment, reduced water quality, loss of riparian habitat, and increased water temperature. In portions of the lower Flathead River drainage downstream of Kerr Dam, agricultural impacts may have been the primary cause of the loss of bull trout (MBTSG 1996e). In 1985, the Confederated Salish and Kootenai Tribes established instream flows on streams impacted by the Flathead Agency Irrigation District (FAID). Although stream dewatering is no longer a major problem in this portion of the drainage, agricultural impacts to water quality remain. The Flathead Agency Irrigation District broke the connection between many of the tributary streams and the lower Flathead River (MBTSG 1996e). Many tributary streams also contain dams, including Crow, Mission, Post, and Dry Creeks. All of these streams, except Crow Creek, are known to have been historical bull trout spawning and rearing streams. In total, construction of irrigation diversions, canals, and dams on the tributaries eliminated access to more than 100 kilometers (62 miles) of tributary spawning and rearing habitat in the lower Flathead River watershed (Cross and DosSantos 1988), though some of the watershed may have been unoccupied by bull trout because of natural conditions.

The water management operations of the Flathead Agency Irrigation District are severely limiting to the potential recovery of the local population(s) of bull trout in the Mission Creek complex and the Jocko River. The isolated populations in the three reservoirs on Mission Creek will probably never become secure, but with better management strategies, drawdown limits, and instream flow protection, the chances of persistence would increase (MBTSG 1996e).

Agriculture impacts to water quality in the Flathead Recovery Subunit occur primarily in the lower reaches of the upper Flathead River, Ashley Creek, and the Stillwater River (MBTSG 1995c). Though the latter two streams are not generally occupied by bull trout, they do contribute to the water quality degradation of the lake and river system. The impacts of agriculture on bull trout in this watershed may have been more significant historically than they are at the present time. Current impacts to bull trout from agricultural activities in the Flathead River basin are believed to be low.

Transportation Network

Transportation systems were a major contributor to the decline of bull trout in this recovery unit. Separating the direct effect of the roads and railroads from the development associated with their construction is difficult. Separating the effects of transportation corridors in forested habitat from the legacy effects of forest management is also difficult. Construction methods during the late 19th and early 20th century, primarily channelization and meander cutoffs, caused major impacts on many of these streams—impacts that persist. Such impacts seldom occur with new roads. However, significant problems remain and are associated with passage barriers, sediment production, unstable slopes, improper maintenance, and high road densities. All of these problems impact bull trout and can only be addressed on a site-by-site basis.

Mining

At the present time, mining is not known to be impacting bull trout in the Flathead Subbasin (MBTSG 1995c). However, there is a large coal deposit in the North Fork Flathead River drainage in British Columbia. If the deposit is mined, a potential loss of 10 percent of the spawning stock of Flathead Lake migratory bull trout was estimated (Fraley et al. 1989). Also water quality impacts could be experienced downstream. Similar concerns have been expressed if the deposit is developed for coalbed methane. Because the coal is in Canada, the United States has relatively little control over mine plans, except under the authority of the International Joint Commission. In August, 2004, the British Columbian government put coal-deposit parcels in the Flathead up for auction to oil and gas companies, however the coalbed methane leases failed to attract any bidders.

Residential Development

The impact of residential development will become increasingly important to bull trout recovery in the Flathead Subbasin. In the decade of the 1990s Sanders, Lake and Flathead counties grew 18.0, 26.0, and 25.8 percent respectively (Inter Lake 2001). Growth is particularly evident in watersheds bordered by private lands, such as along the Jocko River and in the Swan River Valley. In the Swan, requests for State 310 permits to alter the bed and/or immediate banks of streams in the drainage are increasing. Private land in the drainage is concentrated along the Swan River and the lower portions of the tributary drainages. These reaches provide critical migratory corridors and rearing habitat. It is likely that some corporate timber holdings in the drainage may be sold in the future. Such a sale could allow development adjacent to major spawning and rearing areas, though the recent development of a Habitat Conservation Plan with Plum Creek Timber Company is designed, in part, to minimize such impacts (USFWS et al. 2000). Some residential development is also ongoing in the tributaries used by spawning bull trout in the North and Middle Fork Flathead River drainages (MBTSG 1995c). Domestic sewage from these developments and changes to stream morphology caused by building in the floodplain could reduce habitat quality in the tributaries.

In addition, an increasing human population has led to increased lake eutrophication because of nutrient enrichment in Flathead Lake and other large natural lakes within the basin (Flathead Basin Commission 1999). Recent evidence indicates that the downward trend in water quality in Flathead Lake may be leveling off, in part because of an aggressive campaign by the Flathead Basin Commission and other private and public interests. Unmanaged growth and increased development pose a serious threat to water quality in many of the lakes in the basin (MDHES 1994).

Golf courses often impact riparian areas, causing bank erosion and reduced water quality. Ski area development is expanding into the headwater areas of Big Creek, an important bull trout spawning stream in the North Fork Flathead River drainage (MBTSG 1995c). Downhill ski areas create permanent clearcuts that have the potential to increase sediment loads and water yields and to change hydrologic patterns.

Fisheries Management

Of all the threats to bull trout recovery, the expanding presence of nonnative species may prove to be the most intractable. While the status of stream habitat for bull trout in many watersheds throughout the Recovery Unit has had an improving trend, the effects of nonnative species introductions, particularly in large lakes, may permanently reduce the capacity of these waters to support bull trout. In particular, expansion of congeneric lake trout and brook trout is of greatest concern for bull trout recovery in the Clark Fork Recovery Unit, of which the Flathead Subbasin is a part.

Brook trout are known to be extensively hybridized with bull trout in Mission Creek (Hansen and DosSantos 1993b) and pose a threat to bull trout in some tributaries of the Middle Fork Flathead River, although hybridization there has not been documented to date. There are no bull trout streams in the Swan River drainage that do not contain resident brook trout populations.

Lake trout were introduced into Flathead Lake in 1905, and with the establishment of *Mysis* shrimp in Flathead Lake, lake trout populations underwent a dramatic expansion. A scientific advisory team convened in 1997 concluded that the lake trout population in the lake has to be reduced by 70 to 90 percent from present levels if bull trout are to return to population levels of the 1980s (McIntyre 1998).

With the increase in the lake trout population, subadult lake trout became common in the river systems connected to Flathead Lake. Their presence has been documented as far upstream as Bear Creek on the Middle Fork Flathead River (160 kilometers (100 miles) upstream of the lake) and beyond the Canadian border on the North Fork Flathead River (183 kilometers (114 miles) upstream of the lake).

Of 27 natural lakes in the Flathead Recovery Subunit known to have contained native populations of bull trout, 11 (41 percent) now contain lake trout (Fredenberg 2000). The introduction of lake trout is suspected as the primary factor contributing to the decline of bull trout in several lakes in Glacier National Park (Fredenberg 2002). Evidence from this study indicates that four of the five bull trout populations studied in Glacier National Park are at high risk of extirpation, due primarily to incompatibility with introduced lake trout populations (Fredenberg 2002).

LINKS

Appendix 87 reports on bull trout populations in Glacier National Park that are at high risk of extirpation due primarily to incompatibility with introduced lake trout populations

Click Here

Brown trout and bull trout may spawn in the same areas, and brown trout may disturb bull trout redds (Pratt and Huston 1993). Brown trout are common in the Jocko River and also occur in the lower Flathead River (MBTSG 1996a). In 1999, a reproducing population of brown trout was documented in the Flathead River basin upstream of Kerr Dam for the first time.

Of the other introduced species established in the Flathead Subbasin, the northern pike is the one of most concern, and it is now widely distributed. A single illegal introduction of pike into Lone Pine Reservoir in the late 1960s led to widespread illegal introductions throughout northwest Montana. Northern pike have also become established in the lower Flathead River. Given the predacious behavior of northern pike, predation and/or competition between this species and bull trout may occur.

The Montana Bull Trout Scientific Group (MBTSG) identified potential effects of land management activities on important bull trout habitat components in Montana (table 4.16). Table 4.17 lists activities considered by the MBTSG to be posing a risk to the restoration of bull trout populations within identified bull

LINKS

Appendix 65 lists the waters in Montana Fish, Wildlife & Park's Region One that have tested positive or have questionable results for fish pathogens. Further queries may be conducted at: http://www.esg.montana.edu/nfhdb/fh1.html

Click Here

trout restoration/conservation areas in the Flathead Subbasin. The MBTSG also rated various habitat risk factors in the subbasin: the major habitat risk factors include: (1) rural residential development especially around Flathead Lake, the North and South forks of the Flathead, and the Swan River; (2) dam operations in the areas affected by Kerr and Hungry Horse Dams; (3) forestry practices throughout the subbasin; and (4) agriculture and grazing in the lower Flathead River drainage. These activities have lowered habitat quality for bull trout and threaten to continue to do so in the future.

One other issue that should be mentioned is that of disease. While not a limiting factor for bull trout in the subbasin, it can be an issue of local concern. Appendix 65 lists the waters in Montana Fish, Wildlife & Park's Region One that have tested positive or have questionable results for fish pathogens.

*Table 4.16. Potential effects of land management activities on important bull trout habitat components in Montana (source: MBTSG 1998). * = potentially affected or indirect effect; ** = high magnitude effect or direct effect.*

	Rural and Indus. Develop.	Mining	Grazing	Agri.	Irrig. Diver-sion	Dams	Timber Harv: Upland	Timber Harv: Ripar.	Secon-dary Roads	Recrea-tion	Trans-porta-tion System	Fire
Cold water, thermal refuges	*		*	*	**	**	*	**	*	*	*	*
High quality pools	*	**	**	*		**	**	**	**	*	**	*
Habitat complexity	**	**	**	**	*	**	*	**	**	*	**	*
Clean substrate	**	**	**	**	*	**	**	**	**	*	**	*
Stable substrate		**		*	*	**	*	*	*		*	*
Ground-water inflow	**	**		**	**	*	*	*	*		*	*
Connect between systems	*	*		*	**	**			**		**	*
Large woody debris	*	*	*	*		*	*	**	*	*	*	*
Adequate stream-flow	*	*	*	*	**	**			*			
Chemical water quality	**	**	*	**	*					*	*	*
Stable vegetated banks	**	*	**	*	*	**	*	**	*	*	**	*

Table 4.17. Activities posing risk to the restoration of bull trout populations within identified bull trout restoration/conservation areas in the Flathead Subbasin (source: MBTSG 1998). HR = High Risk; VHR = Very High Risk.

	Lower Clark Fork (includes lower Flathead)	Flathead (inclues NF, MF, Stllwtr/Whtfsh, and FH lake)	South Fork Flathead	Swan
Rural and Industrial Development		HR		HR
Mining	VHR*			
Grazing				
Agriculture				
Irrigation Diversion				
Dams			VHR	
Forestry (timber harvest and secondary roads)	VHR	VHR	VHR	VHR
Recreation				
Transportation System				
Fire				

**This rating was given because of threats that are posed on the Clarkfork downstream from the Flathead Subbasin.*

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4.2 Westslope Cutthroat Trout

4.2.1 Background

Reasons for Selection as Focal Species

Globally, westslope cutthroat trout (*Oncorhynchus clarki lewisi*), one of thirteen subspecies of cutthroat trout, 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. Indeed, a recent status report estimated that the subspecies currently occupies about 59 percent of its historic 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 Flathead River drainage remains a stronghold for the subspecies, especially the South Fork Flathead River (USFS 1998).

The USFWS, charged with administration of the federal Endangered Species Act (ESA), recently determined that westslope cutthroat trout are not threatened or endangered. In 2003, the agency reevaluated their finding and concluded again that the subspecies does not warrant listing.

Region I of the US Forest Service lists westslope cutthroat trout as a sensitive species. The Montana state ranking 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. Montana Fish, Wildlife & Parks and the Montana Chapter of the American Fisheries Society 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; elimination from Montana would be a significant loss to the gene pool of the species or subspecies. The Confederated Salish and Kootenai Tribes consider westslope cutthroat trout both a sensitive species and an important cultural resource.

In British Columbia, westslope cutthroat trout are blue-listed, that is they are a species considered to be vulnerable, or of special concern because of characteristics that make them particularly sensitive to human activities or natural events (BC Ministry of Sustainable Resources 2003).

Like bull trout, westslope cutthroat trout are often considered an indicator of the health of the aquatic ecosystem. They require high quality, cold water, and they need clean gravel for spawning, and do best in complex habitats, much of which is created by large woody debris.

It appears that many of the areas where westslope cutthroat have been displaced are also areas with a considerable amount of riparian disturbance and

LINKS

State, federal and tribal biologists in Montana have done extensive work on westslope cutthroat trout. Results from these efforts, which have yielded some of the best and most detailed information available for westslope cutthroat trout in the U.S. portion of the Flathead Subbasin, are entered onto the Montana Fisheries Information System (MFISH) database accessible on the internet at: http://nris.state.mt.us/scripts/esrimap.dll?name=MFISH&Cmd=INST.

Click Here

For westslope cutthroat trout information in the Flathead in British Columbia, go to: http://srmwww.gov.bc.ca/aib/

Click Here

For an electronic library of aquatic information (including reports pertaining to westslope cutthroat trout) for the B.C. portion of the subbasin, go to: http://srmwww.gov.bc.ca/appsdata/acat/html/deploy/acat_p_home.html

Click Here

LINKS

The Westslope Cutthroat Trout Conservation website is a reference source for documents relating to the conservation and restoration of the westslope cutthroat. http://www.fwp.state.mt.us/wildthings/westslope/content.asp

Click Here

Data supporting the 2003 Status Review can be downloaded for further analysis at: http://www.streamnet.org/online-data/OutSideDataSets.html

Click Here

instream effects from upland management (USFS 1998). Because they use the entire aquatic system in the subbasin, including Flathead Lake, the river, and tributaries, impacts in any single component is potentially reflected by westslope cutthroat trout populations. Because of this and their conservation rankings, we have selected westslope cutthroat trout as a focal species in this assessment.

Summary of Population Data[8]

In the U.S. portion of the Flathead, westslope cutthroat occur in about 2,609 linear miles of stream habitat. Approximately 66 percent of these stream miles have stocks that are considered abundant (table 4.18). Data from the Interior Columbia Basin Ecosystem Management Project (ICBEMP) indicate westslope cutthroat trout stocks are strong or predicted strong in 55 HUCs, depressed or predicted depressed in 220 HUCs, and absent or predicted absent in the remaining 37 HUCs that collectively constitute the Flathead River drainage (table 4.18).

North Fork Flathead River Watershed

Among the total 444 miles of stream occupied by westslope cutthroat trout stocks, 266 (60 percent) of the stream miles have stocks that are considered abundant; stocks in the remaining 178 (40 percent) miles of stream are considered rare. Data from the ICBEMP indicate westslope cutthroat trout stocks are strong or predicted

Table 4.18. Total number of stream miles and tributaries or stream reaches occupied by westslope cutthroat trout (WCT) in the historic range of the subspecies as of 1998.

Watershed	4th-field HUC No.	No. of 6th Field HUCs	No. of Occupied Miles			Occupied Tribs or Reaches
			Abundant	Rare	Total	
North Fork Flathead River	17010206	37	266	178	444	111
Middle Fork Flathead River	17010207	42	246	225	471	135
Flathead Lake	17010208	33	70	67	137	19
South Fork Flathead River	17010209	73	559	50	609	148
Stillwater River	17010210	32	261	185	446	135
Swan River	17010211	29	126	179	305	103
Lower Flathead River	17010212	67	185	12	197	25
COMBINED FLATHEAD		313	1713	896	2609	676

[8] *Condensed from Status Review for Westslope Cutthroat Trout in the United States, USFWS 1999.*

strong in four HUCs; depressed or predicted depressed in 31 HUCs; and absent or predicted absent in the remaining one HUC that collectively constitute the North Fork Flathead River watershed. Within that portion of the watershed that lies in Glacier National Park, genetically pure westslope cutthroat trout naturally inhabit 10 lakes that have a total surface area of 2,407 acres (Marnell 1988).

Middle Fork Flathead River *Watershed*

Among the total 471 miles of stream occupied by westslope cutthroat trout stocks, 246 (52 percent) of the stream miles have stocks that are considered abundant; stocks in the remaining 225 (48 percent) miles of stream are considered rare. Data from the ICBEMP indicate westslope cutthroat trout stocks are depressed or predicted depressed in 41 HUCs and absent or predicted absent in the remaining one HUC that collectively constitute the Middle Fork Flathead River watershed. Within that portion of the watershed that lies in Glacier National Park, genetically pure westslope cutthroat trout naturally inhabit 10 lakes that have a total surface area of 2,940 acres (Marnell 1988).

LINKS

Maps in Appendix 46 show westslope cutthroat trout status by 6th-code HUC for the Flathead Subbasin as compiled by the USFS Region One Cohesive Strategy Team.

Click Here

South Fork Flathead River Watershed

Among the total 609 miles of stream occupied by westslope cutthroat trout stocks, 559 (92 percent) of the stream miles have stocks that are considered abundant; stocks in the remaining 50 (8 percent) miles of stream are considered rare. Data from the ICBEMP indicate westslope cutthroat trout stocks are strong or predicted strong in 51 HUCs and depressed or predicted depressed in the remaining 22 HUCs that collectively constitute the South Fork Flathead River watershed.

Flathead Lake Watershed

Among the total 137 miles of stream occupied by westslope cutthroat trout stocks, 70 (51 percent) of the stream miles have stocks that are considered abundant; stocks in the remaining 67 (49 percent) miles of stream are considered rare. Data from the ICBEMP indicate westslope cutthroat trout stocks are depressed or predicted depressed in 19 HUCs and absent or predicted absent in the remaining 14 HUCs that collectively constitute the Flathead Lake watershed.

Stillwater River Watershed

Among the total 446 miles of stream occupied by westslope cutthroat trout stocks, 261 (59 percent) of the stream miles have stocks that are considered abundant; stocks in the remaining 185 (41 percent) miles of stream are considered rare. Data from the ICBEMP indicate westslope cutthroat trout stocks are depressed or predicted depressed in 29 HUCs and absent or predicted absent in the remaining three HUCs that collectively constitute the Stillwater River watershed.

Swan River Watershed

Among the total 305 miles of stream occupied by westslope cutthroat trout stocks, 126 (41 percent) of the stream miles have stocks that are considered abundant; stocks in the remaining 179 (59 percent) miles of stream are considered rare. Data from the ICBEMP indicate westslope cutthroat trout stocks are depressed or predicted depressed in the 29 HUCs that constitute the Swan River watershed.

Lower Flathead River Watershed

Among the total 197 miles of stream occupied by westslope cutthroat trout stocks, 185 (94 percent) of the stream miles have stocks that are considered abundant; stocks in the remaining 12 (6 percent) miles of stream are considered rare. Data from the ICBEMP indicate westslope cutthroat trout stocks are depressed or predicted depressed in 49 HUCs and absent or predicted absent in the remaining 18 HUCs that collectively constitute the Lower Flathead River watershed.

Historic Distribution

Behnke (1996) states that the original distribution of westslope cutthroat trout is not known with certainty. It is believed they 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 east of the Divide (Leary et al. 1990). In the Flathead Subbasin, westslope cutthroat trout are believed to have historically occupied all of the streams and lakes to which they had access (USFWS 1999). Shepard et al. (2003) estimates they historically occupied 5,453 miles of stream (table 4.19).

Current Distribution

Westslope cutthroat trout in the Flathead River drainage occur in about 676 tributaries or stream reaches. To date, however, only 3,489 miles (33.9 percent) of the estimated 10,288 miles of historic stream habitat have been surveyed for westslope cutthroat trout. Thus, westslope cutthroat trout could occupy additional stream miles that have not yet been surveyed. Among those 3,489 surveyed stream miles, westslope cutthroat trout have been documented in 2,609 miles of stream habitat (74.8 percent) distributed among 7 watersheds (USFWS 1999) (table 4.20).

LINKS

For MFWP maps showing westslope cutthroat trout distribution and conservation classes in the North, Middle, and South Forks of the Flathead, Swan, and Flathead Lake watersheds, see Appendix 48. Click Here

For maps showing westslope cutthroat trout genetic distribution and status throughout the subbasin, see Appendix 46. Click Here

For maps showing barriers to fish passage, see Appendix 21. Click Here

QHA westslope cutthroat trout spreadsheets contain current and historic distribution by lifestage for HUC-6 watersheds in the U.S. and B.C. portions of the Flathead. These data are a compilation put together by our Technical Team. Go to Appendix 26. Click Here

Table 4.19. Miles of Habitat Historically (circa 1800) Occupied by Westslope Cutthroat Trout in the U.S. Soure: Shepard et al. (2003) .

4th Code HUC Name	Occupied	Unoccupied	Total
North Fork Flathead	506.8	67.9	574.7
Middle Fork Flathead	610.1	88.3	698.5
Flathead Lake	378.7	147.4	526
South Fork Flathead	958.8	320.5	1279.3
Stillwater	510.6	138.3	649
Swan	537.2	103.2	640.4
Lower Flathead	1085.5	0	1085.5

Table 4.20. Miles of habitat currently known to be occupied by westslope cutthroat trout in the U.S. Source: USFWS (1999).

4th Code HUC Name	Stream Miles Occupied
North Fork Flathead[1]	444
Middle Fork Flathead[1]	471
Flathead Lake	137
South Fork Flathead	609
Stillwater	446
Swan	305
Lower Flathead	197

[1]*In addition to the linear habitat accounted for above, westslope cutthroat trout are known to occur naturally in at least 20 lakes in Glacier National Park (10 each in the North Fork and Middle Forks of the Flathead watersheds) that total 5,347 surface acres.*

Status of Westslope Cutthroat Trout Introductions, Artificial Production and Captive Breeding Programs

Westslope cutthroat captive brood stock (M012) is held at Washoe Park State Fish Hatchery in Anaconda, Montana. These fish are not stocked in rivers or streams, but are planted in lakes for recreation. Because they are not stocked in rivers, they have no effect on wild stocks, with the possible exception of planted fish escaping downstream and mixing with wild fish. This is an uncommon event and in most cases would be considered beneficial because the fish have been deemed genetically unchanged from their wild source (which is mainly the South Fork of the Flathead with a few parents from Clark Fork tributaries). When these fish do escape downstream, it is often in areas that already contain rainbows and

LINKS

For current and historic fish stocking records in Montana, go to http://www.fwp.state.mt.us/fishing/stock02.asp

Click Here

For the Creston National Fish Hatchery And Genetic Management Plan go to Appendix 50.

Click Here

For westslope cutthroat trout hatchery brood stock histories, see Appendix 51

Click Here

other introduced stocks, so it only increases (however slightly) the number of westslope cutthroat trout in the system (Brian Marotz, MFWP, pers. comm. 2003).

Creston National Fish Hatchery Produces up to 100,000 three-inch hatchery westslope cutthroat trout to offsite mitigation waters as requested by management agencies. The goal of this program is to mitigate for Hungry Horse Dam hydro-related losses of 415,000 salmonids annually from Flathead Lake by partially offsetting lost angler opportunity and reducing pressure on native stocks. Stocking of small lakes and reservoirs isolated within the interconnected waters of the Flathead Subbasin with 3-to-4-inch, hatchery-produced fish will, after one to two years growth, provide recreational angling opportunities for catchable-sized trout and partially offset the affects of fishing closures and reduced limits on weak but recoverable native populations of westslope cutthroat trout and bull trout remaining in the Flathead Lake and River system (CSKT 2001).

Historic and current harvest[9]

Since the 1950s, fisheries managers in the Flathead River Subbasin have attempted to protect bull trout and westslope cutthroat trout (MBTSG 1995c). Even with these efforts, native populations of these species have declined, and MFWP has increased restrictions on anglers in response. Table 4.21 shows angler days in each of the major subbasin watersheds.

In many westslope cutthroat trout waters in the subbasin, fishing for the westslope cutthroat trout is restricted to catch-and-release. Elsewhere, only limited harvest is allowed. Fishing for westslope cutthroat trout is tightly regulated in Montana and not considered a threat to the subspecies in the Flathead River drainage.

Table 4.21. Estimated 1999 angling pressure on Flathead subbasin waters. Source: MFWP Angling Pressure Survey 1999.

Waterbody	Angler Days
Flathead Lake	47,000 to 53,000
Flathead River above FH Lake	31,223
Middle Fork Flathead River	5,352
North Fork Flathead River	6,590
Hungry Horse Reservoir	7,568
South Fork Flathead River	11,488
Swan Lake	12,716
Swan River	16,319
Lower Flathead River	3,180

[9] *This section is excerpted from USFWS (1999).*

4.2.2 Population Delineation and Characterization

Population Units

The USFWS has found no morphological, physiological, or ecological data for westslope cutthroat trout that indicate unique adaptations of individual stocks or assemblages of stocks anywhere within the historic range of the subspecies (USFWS 1999). Hence, the agency found that at this time there is no compelling evidence to support the recognition of distinct population segments, and they recognize only a single westslope cutthroat trout population.

Life History[10]

Westslope cutthroat trout usually mature at 4 or 5 years of age and spawn entirely in streams, primarily small tributaries. Spawning occurs between March and July, when water temperatures warm to about 10 C (50 °F) (Trotter 1987; Behnke 1992; McIntyre and Rieman 1995). Natal homing, the return of adult fish to spawning areas where they themselves were produced, is believed to occur in westslope cutthroat trout. Individual fish may spawn only in alternate years (Shepard et al. 1984; Liknes and Graham 1988). Fertilized eggs are deposited in stream gravels where the developing embryos incubate for several weeks, with the actual time period inversely related to water temperature. Several days after hatching from the egg, westslope cutthroat trout fry about 2.5 cm (1 inch) long emerge from the gravel and disperse into the stream.

Westslope cutthroat trout fry may grow to maturity in the spawning stream or they may migrate downstream and mature in larger rivers or lakes. Consequently, three westslope cutthroat trout life-history types are recognized (Trotter 1987; Liknes and Graham 1988; Behnke 1992; McIntyre and Rieman 1995): *Resident* fish spend their lives entirely in the natal tributaries; *fluvial* fish spawn in small tributaries but their resulting young migrate downstream to larger rivers where they grow and mature; and *adfluvial* fish spawn in streams but their young migrate downstream to mature in lakes. After spawning in tributaries, adult fluvial and adfluvial westslope cutthroat trout return to the rivers or lakes (Rieman and Apperson 1989; Behnke 1992). All three life-history types commonly occur within the forks of the Flathead River (MFWP and CSKT 2000).

In the Flathead System, adfluvial westslope cutthroat trout generally occur in the Middle and North Forks of the Flathead (MFWP and CSKT 2000). The fluvial life-history form, is relatively low in abundance in the North Fork and in the lower portions of the Middle Fork, but is abundant in the upper Middle Fork

LINKS

For maps showing westslope cutthroat trout genetic distribution and status, go to Appendix 46

Click Here

[10] *Adapted from USFWS Status Review (1999). For additional information, see also Shepard et al. (1984).*

of the Flathead. Resident westslope cutthroat trout are found in tributaries to both the North and Middle Forks (MFWP and CSKT 2000).

Whether these life-history types represent opportunistic behaviors or genetically distinct forms of westslope cutthroat trout is unknown. However, establishment of numerous, self-sustaining stocks of westslope cutthroat trout in streams and lakes outside the historic range of the subspecies as the result of widespread introductions of hatchery westslope cutthroat trout in Washington state, for example, suggests the life-history types represent opportunistic behaviors.

Westslope cutthroat trout feed primarily on macroinvertebrates, particularly immature and mature forms of aquatic insects, terrestrial insects, and, in lakes, zooplankton (Liknes and Graham 1988). These preferences for macroinvertebrates occur at all ages in both streams and lakes. Westslope cutthroat trout rarely feed on other fishes (Liknes and Graham 1988; Behnke 1992).

Growth of individual westslope cutthroat trout, like that of fish of other species, depends largely upon the interaction of food availability and water temperature. Resident westslope cutthroat trout usually do not grow longer than 30 cm (12 inches), presumably because they spend their entire lives in small, cold-water tributaries. In contrast, fluvial and adfluvial westslope cutthroat trout often grow longer than 30 cm (12 inches) and attain weights of 0.9-1.4 kg (2-3 pounds). Such rapid growth results from the warmer, more-productive environments afforded by large rivers, lakes, and reservoirs (Trotter 1987; Behnke 1992).

Genetic Integrity

MFWP reports that samples of 25 fish from the main stem Flathead River showed a high incidence of hybridization between westslope cutthroat trout and rainbow trout. The samples also showed evidence that both genetically pure westslope cutthroat trout and rainbow trout occur. The data suggest the samples contained fish from a number of populations (Deleray et al. 1999).

Shepard et al. (2003) report that among the occupied stream miles surveyed in the Flathead Subbasin, stocks of genetically unaltered westslope cutthroat trout occupy 740 miles; stocks that are less than 10 percent introgressed occupy 293.7 miles; stocks between 25 percent and 10 percent introgressed occupy 58.1 miles; and stocks greater than 25 percent introgressed occupy 56.1 miles. Westslope cutthroat trout stocks inhabiting 1,160 miles of stream are suspected unaltered (with no record of stocking or contaminating species present), and stocks inhabiting 441.7 miles are potentially altered (potentially hybridized with records of contaminating species being stocked or occurring in stream). Hybridized and pure populations coexist in 218.2 stream miles. Table 4.22 gives the break down in miles of occupied stream habitat by watershed.

LINKS

The Montana Trout Genetic Purity Data Set (Data in Excel format) describes the genetic makeup of trout populations from 839 sites in Montana. See Appendix 52.

Click Here

For additional genetic information, see also Appendix 53, the Status Review for Westslope Cutthroat Trout in the United States, September 1999

Click Here

See also the Status Update (Shepard et al. 2003), which is Appendix 54.

Click Here

For MFWP maps showing westslope cutthroat trout distribution and conservation classes in the North, Middle, and South Forks of the Flathead, Swan, and Flathead Lake watersheds, see Appendix 48.

Click Here

For maps showing westslope cutthroat trout genetic distribution and status throughout the subbasin, see Appendix 46.

Click Here

Table 4.22. Genetic Status of Westslope Cutthroat Trout in the Flathead Subbasin (by miles of occupied stream habitat). Source: Shepard et al. 2003.

	Genetically Tested						Tested;	
Basin	Unaltered	< 10%	>10% and <25%	>25%	Suspected Unaltered	Potentially Unaltered	Mixed Stock	Total
North Fork Flathead	108.4	111.4	30.2	30.1	185	4.8	57.6	527.5
Middle Fork Flathead	89.4	25.5	15.5		340.6	130.4		601.4
Flathead Lake	9.3	6.8	3.9		8.7	31.4	83.2	143.3
South Fork Flathead	350.5	87.7		17	468	48.6		971.8
Stillwater	27.5	12		2.9	97.1	49.7		189.2
Swan	4.9	14	8.5	0.5	60.6	176.8	77.4	342.9
Lower Flathead	150.1	36.3		5.6				191.9
Totals	740.1	293.7	58.1	56.1	1160	441.7	218.2	2968

The most recent USFWS finding for westslope cutthroat contains a analysis of the genetic issue in which the agency found that fish that are 80 percent or more pure should be considered pure for ESA purposes. Further, the agency found that those fish are not considered a threat to the westslope subspecies of cutthroat. While this is the published finding of the USFWS, many geneticists and biologists disagree with it and believe that the 80 percent finding is too low.

A great deal of genetic information exists for mountain lakes in the subbasin. Genetic surveys in the North Fork and Middle Fork watersheds showed that 7 of 22 lakes had hybrid trout populations and many of the streams below those 7 lakes also contained hybrid or nonnative trout. MFWP and CSKT believe that emigration of individuals from these hybrid or nonnative populations threaten the persistence of westslope cutthroat trout throughout the Flathead River system (MFWP and CSKT 2000).

LINKS

For the most recent USFWS finding on the genetics of westslope cutthroat trout in which the agency found that fish that are 80 percent or more pure should be considered pure for ESA purposes, go to: http://mountain-prairie.fws.gov/endspp/fish/wct/

Click Here

4.2.3 Population Status

Current Status

Upper Flathead

Gill net surveys conducted in Flathead Lake since the 1980s show that the relative abundance of westslope cutthroat trout has declined. In the early 1980s the subspecies made up, on average, about 33 percent of the catch in floating gill nets. By the mid to late nineties, the average had dropped by more than half, to about 16 percent. The actual number of westslope cutthroat trout caught in floating nets over that same period declined as well, from 2.7 fish/net to 0.7 fish per net (Deleray et al. 1999). A third measure, creel surveys, also indicates a decline. Westslope cutthroat trout harvest went from 5,241 in 1962 to 3,581 in 1981, to 108 in 1992 (although this decline in catch occurred at the same time increasing harvest restrictions were being implemented).

Electrofishing in the Flathead River above Flathead Lake—also suggests that westslope cutthroat trout numbers may have dropped (Deleray et al. 1999). A decreasing trend in an effort to catch (through angling), tag, and release westslope cutthroat trout when combined with the trend shown by Flathead Lake gill net surveys suggests that the adfluvial component of westslope cutthroat trout the Flathead Lake River system has decreased in abundance since the 1990s.

Genetic analysis shows introgression between westslope cutthroat trout and rainbow trout was common, with one section showing 44 percent of the fish sampled were introgressed and another showing 20 percent of the sample was introgressed (Deleray et al. 1999).

Lower Flathead River

Limited capture rates in the lower Flathead River in the mid 1980s made it impossible to estimate the westslope cutthroat trout population (CSKT et al. 1989) (40 fish were captured in 3,000 hours of effort). In 1998, six westslope cutthroat trout were captured in May, and in October five were collected. The relative abundance of the subspecies in the lower Flathead in 1998 was estimated at 0.4 percent to 2.8 percent. Westslope cutthroat trout occur in the Jocko River above Finley Creek and in Jocko River tributaries. Crow and Mission Creek may also contain westslope cutthroat trout. Genetic analysis shows a high level of introgression in these tributaries (FERC 2000).

LINKS

Appendix 46 shows the status of westslope cutthroat trout populations by 6th-code HUC as determined by the USFS Cohesive Strategy Team in 2002.

Click Here

Appendix 55 shows the "risk scores" for Flathead and Kootenai Subbasin conservation populations.

Click Here

Flathead Subbasin

Table 4.23 shows the trend and status for cutthroat trout across all Flathead Subbasin watersheds as determined in the USFWS 1999 Status Review. Appendix 46 shows the status of populations as determined by the USFS Region 1 Cohesive Strategy Team in 2002.

In 2002, Shepard et al. (2003) rated risks to 539 of the 563 designated westslope cutthroat trout conservation populations (across the entire range of the subspecies), segregating the two distinct types of conservation populations, “isolets” and “metapopulations.” They found that in general, more isolet populations were at higher risk due to temporal variability, population size, and isolation than metapopulations, but more isolet populations were at less risk than metapopulations due to genetic introgression, disease, and population

Table 4.23. Total number of stream miles and tributaries or stream reaches occupied by westslope cutthroat trout (WCT) in the historic range of the subspecies. Trend is given as unknown (U), declining (D), or stable (S). Also shown are ICBEMP data that give status of WCT in 6th-code HUCs in the Columbia River basin. Data are given as the number of 6th-code HUCs in which WCT stocks are strong (S), depressed (D), absent (A), predicted strong (PS), predicted depressed (PD), or predicted absent (PA). In the Pend Orielle and Upper Columbia drainages, occupied river miles and tributaries are given as both historic (h) and current (c).

Watershed	No. of 6th Field HUCs	No. of Occupied Miles			Occupied Tribs or Reaches	Trend	ICBEMP Data						
		Abundant	Rare	Total			S	D	A	PS	PD	PA	TOTAL
North Fork Flathead River	37	266	178	444	111	U	4	27	1	0	4	0	36
Middle Fork Flathead River	42	246	225	471	135	U	0	36	1	0	5	0	42
Flathead Lake	33	70	67	137	19	U	0	12	14	0	7	0	33
South Fork Flathead River	73	559	50	609	148	U	38	9	0	13	13	0	73
Stillwater River	32	261	185	446	135	U	0	25	3	0	4	0	32
Swan River	29	126	179	305	103	U	0	26	0	0	3	0	29
Lower Flathead River	67	185	12	197	25	U	0	42	15	0	7	3	67
COMBINED FLATHEAD	313	1713	896	2609	676	U	42	177	34	13	43	3	312

demographics. Composite population risk scores ranged from a low of 4 to a high of 16. Isolets are at relatively high risk from population-type risks, but at much lower risk from genetic and disease risks than metapopulations. Appendix 55 shows the risk scores for Flathead Subbasin conservation populations assessed as part of the Westslope cutthroat trout status review update done in 2002. Figure 4.2 shows a frequency distribution of composite population risk scores for the westslope cutthroat trout populations in the Flathead Subbasin.

Historic Status

Quantitative data on historic westslope cutthroat trout abundance and productivity in the Flathead Subbasin is not available. Shepard et al. (2003) estimates the subspecies historically occupied 5,453 miles of stream (USFWS 1999). It is assumed that historically (prior to European settlement) most of these streams were generally characterized by optimum habitat conditions and therefore supported abundant and productive native fisheries.

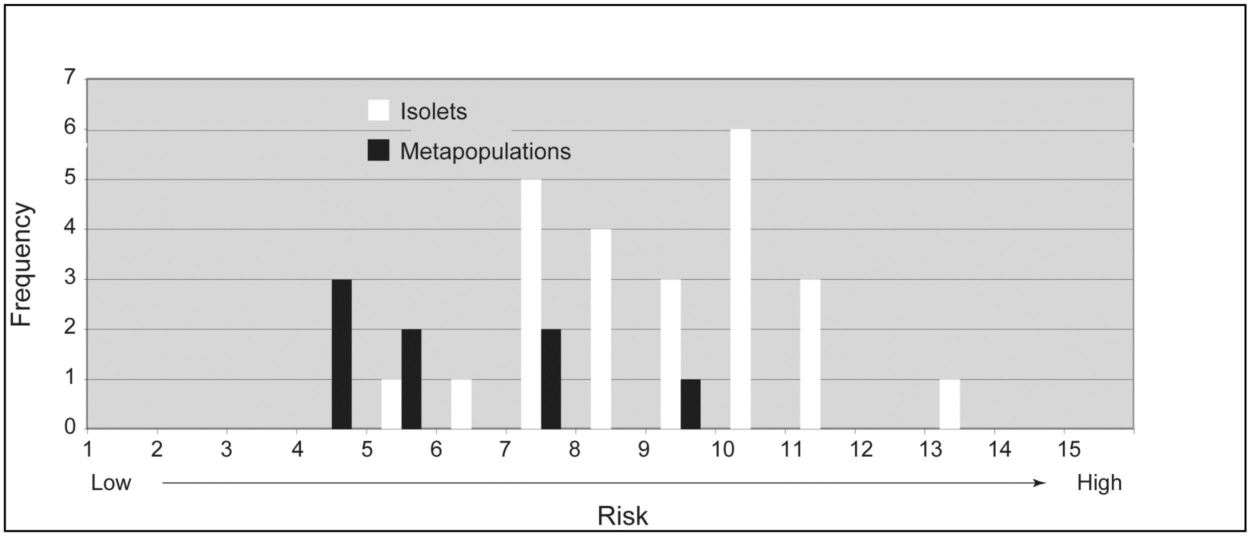

Figure 4.2. Distribution of the number of designated westslope cutthroat trout populations by composite population risk scores and population type for the Flathead Subbasin (excludes genetic and disease risks).

Theoretical Reference Condition[11]

In 1999, MFWP finalized a "Memorandum of Understanding and Conservation Agreement for Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in Montana" (MFWP 1999) signed by representatives of the principal state and federal natural resources management agencies concerned with the protection and management of westslope cutthroat trout. The goal of the agreement is: To ensure the long-term, self-sustaining persistence of the subspecies within each of the five major river drainages they historically inhabited in Montana. To meet this goal, it identifies the following objectives:

1. Protect all genetically pure westslope cutthroat trout populations. All genetically pure populations are to be provided the protection necessary to ensure their long-term persistence. Protection includes expansion of small, isolated populations where possible and maintaining or

[11] *Guidance from the Power Planning Council states that "this [section of the assessment] is a key component of the NMFS and USFWS ESA delisting evaluation, and that for ESA-listed species, these determinations will be made by the appropriate recovery team." For westslope cutthroat trout, which are not listed under ESA, we rely instead on"Memorandum of Understanding and Conservation Agreement for Westslope cutthroat trout (Oncorhynchus clarki lewisi) in Montana."*

developing high quality habitats to prevent extirpation due to small population size or stochastic events. Each tributary that supports westslope cutthroat trout, regardless of its length, constitutes a population.

2. Protect slightly introgressed (less than 10 percent introgressed) populations. Populations where a genetic sample shows greater than a 90 percent westslope cutthroat trout genetic contribution indicate suitable habitat for westslope cutthroat trout and may have genetic value. The protections afforded to pure westslope populations, therefore, will be provided to such populations until land management and fish management agencies make a determination about the role of such habitats and populations for westslope cutthroat trout restoration.

3. Ensure the long-term persistence of the westslope cutthroat trout within their native range. The long-term persistence of westslope cutthroat trout within their native range will be ensured by maintaining at least ten population aggregates distributed throughout the five major river drainages in which they occur, each occupying at least 50 miles of connected habitat. The Flathead River drainage will have at least two geographically separate interconnected populations, and to ensure that these population aggregates persist, they must be isolated from potentially introgressing species, and at least one local population (tributary population within the connected habitat), must persist for more than 10 years (representing 2-3 generations). The interconnected populations within each major river drainage should be geographically separate to help ensure long-term persistence. Every effort should be made to develop interconnected populations that have open connectivity up and down stream throughout at least 50 continuous miles of stream habitats. However, it might be impossible to have upstream connectivity of all headwater habitats of some tributaries due to natural upstream migration barriers. Where these conditions exist, monitoring of persistence must be done above any natural barriers, as well as somewhere else within the connected habitats, to ensure that these segments of the population persist. If isolated headwater segments become extinct, those population segments must be refounded by moving westslope cutthroat trout from below the natural barrier.

4.2.4 Out-of-Subbasin Effects and Assumptions

LINKS

For a more complete discussion of how Mainstem Columbia River operations affect subbasin fisheries, and how those effects might be minimized see Appendix 12.

Click Here

Mainstem Columbia River operations profoundly influence dam operations as far upstream as headwater reservoirs. Dam operations affect environmental conditions in the reservoirs upstream and rivers downstream of Hungry Horse Dam. The abundance, productivity and diversity of fish and wildlife species inhabiting the headwaters of the Columbia River are dependent on their immediate environment that changes with river management. Mainstem Columbia River operations affect westslope cutthroat trout in the following ways (Brian Marotz, MFWP, pers. comm. 2003):

- Unnaturally high flows during summer and winter negatively impact resident fish. The effects can be mitigated by releasing flows at a constant rate, producing constant stable, or slowly declining (unidirectional) flows.

- Summer flow augmentation causes reservoirs to be drafted during the biologically productive summer months. This impacts productivity in the reservoirs.

- Drafting the reservoirs too hard prior to receiving the January 1 inflow forecast places the reservoirs at a disadvantage for reservoir refill. This is especially important during less than average water years.

- Flow fluctuations caused by power, flood control or fish flows create a wide varial zone in the river, which becomes biologically unproductive.

- The planned reservoir-refill date in the NOAA Fisheries BiOp of June 30, will cause the dam to spill in roughly the highest 30 percent of water years. This is because inflows remain above turbine capacity into July on high years. That means the reservoirs fill and have no remaining capacity to control spill. This causes gas super saturation problems.

4.2.5 Environment-Population Relationships

Environmental Factors Particularly Important to Westslope Cutthroat Trout Survival or Key Ecological Correlates (KECs)[12]

Spawning habitat for westslope cutthroat trout occurs in low-gradient stream reaches that have gravel substrate ranging from 2 mm to 75 mm (0.8 to 3 inches)

[12] *This section is condensed from the USFWS (1999).*

in diameter, water depths near 0.2 m (0.7 ft), and mean water velocities from 0.3 to 0.4 m/sec (1 to 1.3 ft/sec) (Liknes 1984; Shepard et al. 1984). Proximity to cover (e.g., overhanging stream banks) is an important component of spawning habitat. 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 (Alabaster and Lloyd 1982; Weaver and Fraley 1993; Waters 1995).

After they emerge from the spawning gravel, fry generally occupy shallow waters near stream banks and other low-velocity areas (e.g., backwaters, side channels) (McIntyre and Rieman 1995) and 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 7-16 °C (45-61 °F) and a diversity of cover (Fraley and Graham 1981; McIntyre and Rieman 1995). Adult westslope cutthroat trout in streams are strongly associated with pools and cover (Shepard et al. 1984; Pratt 1984a; Peters 1988; Ireland 1993; 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 rearing and maturation of adfluvial fish, westslope cutthroat trout are often found at depths where temperatures are less than 16 °C (61 F) (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 22.3, 23.2, 24.0, and 24.1 °C, 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 cannot exploit these cold, high-gradient waters (Griffith 1988; Fausch 1989).

In addition to the above variables — channel form and stability, water temperature; cover; discharge; the presence of loose, clean gravels — the geologic makeup of watersheds has been shown to be an important habitat parameter for westslope cutthroat trout in the subbasin. Fraley and Graham (1981b) found that of five geologic types in the North and Middle Forks of the Flathead, watersheds composed of quartzite and those underlain by a combination of

LINKS

For the website containing descriptions of surface waters included in the state water quality assessment database go to:http://nris.state.mt.us/wis/environet/2002_305bhome.html.

Click Here

Appendix 20 summarizes the information in the state water quality assessment database for Flathead and Lake Counties, excluding the Flathead Reservation and Glacier Park.

Click Here

limestone and argillite/siltite have significantly higher trout densities than those composed of limestone alone, argillite/siltite alone, or shales, sandstone, and limestones. They caution however that geology is not independent of other key habitat variables and must be considered in combination with them.

Environment s Ability to Provide Key Ecological Correlates

As part of our assessment, the Flathead Subbasin Technical Team[13] evaluated all the 6th-code HUCs[14] and selected lakes in the Montana and Canadian portions of the Flathead Subbasin on the basis of eleven stream habitat attributes (Parkin and McConnaha 2003) and thirteen lake habitat attributes considered key to resident salmonids. This was done utilizing a spreadsheet tool developed by Mobrand Biometrics called Qualitative Habitat Assessment (QHA). Mobrand Biometrics and Dr. Paul Anders developed the lacustrine or lake version of QHA, called LQHA. 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) (table 4.24). Those used in LQHA are the ones considered by our Technical Team to be the main habitat drivers in lakes in the subbasin (table 4.25). For each 6th-Code HUC, the technical team used quantitative data (when it existed) and professional knowledge to score each of the attributes for each HUC. We did the same for selected lakes and reservoirs (table 4.26).

Table 4.27 ranks stream habitat attributes for the regulated mainstem. Table 4.28 does the same for a typical or average 6th-code tributary HUC in the Flathead Subbasin for westslope cutthroat trout. Table 4.29 ranks attributes for westslope cutthroat trout at the HUC-4 scale. Table 4.30 makes a similar ranking for subbasin lake/reservoir habitat attributes in reservoirs. The ranking provides an indication of the subbasin's ability to provide the key ecological correlates for westslope cutthroat trout and the habitat attributes that may be the most limiting for westslope cutthroat in the subbasin. It should be noted, however, that these rankings have been generalized for the subbasin and at 4th-code HUC scale. Rankings for individual 6th-code HUCs will vary.

[13] Flathead Subbasin Technical Team members particiapating in the HUC-by-HUC assessment included fisheries biologists and hydrologists from Montana Fish, Wildlife & Parks, US Army Corps of Engineers, US Fish and Wildlife Service, the Flathead National Forest, two provincial Canadian ministries, the Salish and Kootenai Tribes, and a private consulting firm.

[14] In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portion of the subbasin, time limitations prevented the use of 6th-code HUCs. Instead, the Canadian members of the team used analogous watersheds developed during a previous watershed restoration planning exercise in B.C.

LINKS

For more detailed results of the QHA assessment, including attribute scores and HUC rankings, see Appendix 26.

Click Here

Appendix 43 summarizes the baseline condition for bull trout in bull trout drainages in the upper Flathead (these determinations can also be used for assessing conditions for westslope cutthroat trout).

Click Here

Appendix 44 has the results of a GIS-based fisheries vulnerability analysis conducted by the Cohesive Strategy Team of Region 1 of the USFS.

Click Here

For a Geographic Information Systems (GIS)-based, coarse scale analysis of the current condition of native aquatic integrity across an Upper Columbia basin (called the Aquatic Integrity Areas (AIA) model) go to Appendix 45

Click Here

Table 4.24. Habitat attributes used in the QHA analysis of 6th-code HUCs.

Attribute	Brief Definition
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 flow events.
Low Flow	Frequency and amount of low flow events.
Oxygen	Dissolved oxygen in water column and stream substrate
High Temperature	Duration and amount of high summer water temperature that can be limiting to fish survival
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
Obstructions	Barriers to fish passage

Table 4.25. Thirteen habitat attributes used in the Flathead Subbasin Lacustrine or Lake QHA analysis of selected lakes with definitions.

Attribute	Brief Definition
Temperature	Duration and amount of high or low water temperatures that can be limiting to fish survival
Dissolved Oxygen	Dissolved oxygen in water column and stream substrate
Gas Saturation	Percent water is saturated (<100%) or super-saturated (>100%) with Nitrogen gas
Volumetric Turnover Rates	Time required to replace entire reservoir with new water based on rate of its downstream expulsion
Pollutants	Introduction of toxic (acute and chronic) substances into the lake or reservoir
Trophic Status	Level (status) of biological productivity in lake or reservoir
Entrainment	Downstream fish loss through a hydropower dam, other than through a spillway of fish ladder
Migratory Obstacles	Natural and artificial barriers to upstream and/or downstream fish migration
Macrophytes	Emergent and submergent aquatic plant species and community structure in lakes and reservoirs
Hydraulic Regime	Temporal and volumetric characteristics of hydrograph
Shoreline Condition	Physical condition of water-land interface, riparian and varial zones
Habitat Diversity	Relative degree of habitat heterogeneity
Substrate Condition	Physical condition of substrates

Table 4.26. Lakes assessed in the Flathead Subbasin using the LQHA spreadsheet tool.

Lake	Drainage
Upper Stillwater	Stillwater
Whitefish	Stillwater
Lindbergh	Swan
Holland	Swan
Swan	Swan
Flathead	Flathead
Ashley	Flathead
Bitterroot	Lower Flathead
Tally	Flathead
Mcdonald	Lower Flathead
Kintla	North Fork Flathead
Bowman	North Fork Flathead
Quartz	North Fork Flathead
Logging	North Fork Flathead
Harrison	Middle Fork Flathead
McDonald	Middle Fork Flathead
Big Salmon	South Fork Flathead
Hungry Horse	South Fork Flathead

Table 4.27. Ranking of key stream-habitat attributes in the regulated mainstem of the Flathead Subbasin for westslope cutthroat trout based on a QHA analysis.

Habitat Attribute	Score	Rank
Obstructions	0.00	1
Oxygen	0.00	1
Low Temperature	0.05	2
High Temperature	0.08	3
Pollutants	0.10	4
Channel stability	0.15	5
Fine sediment	0.31	6
Low Flow	0.35	7
High Flow	0.38	8
Habitat Diversity	0.63	9
Riparian Condition	0.82	10

Table 4.28. Ranking of key stream-habitat attributes in Flathead Subbasin tributaries for westslope cutthroat trout based on a QHA analysis of 6th-code HUCs.

Habitat Attirbute	Score	Rank
Low Temperature	0.01	1
Oxygen	0.01	1
Pollutants	0.04	2
High Temperature	0.04	2
Obstructions	0.06	3
High Flow	0.08	4
Low Flow	0.09	5
Fine sediment	0.17	6
Habitat Diversity	0.18	7
Channel stability	0.20	8
Riparian Condition	0.26	9

Table 4.29. Ranking of key stream-habitat attributes for the regulated mainstem and at the HUC-4 scale for westslope cutthroat trout based on a QHA analysis of 6th-codeHUCs. Those with the highest rank (1 being highest) scored highest in terms of their condition with respect to westslope cutthroat trout. The higher the QHA score, the more degraded the attribute for the species. The most limiting attributes are highlighted in yellow. Note that the QHA scores for the regulated mainstem and some HUC-4 watersheds are significantly higher than for others HUC-4 watersheds (the Lower Flathead and Stillwater, for example). Also note that Low Flow and High Flow are attributes that showed up as QHA limiting factors for westslope cutthroat trout in a few 4th-code HUCs. Except for regulated mainstem, these flows are due to natural watershed conditions that restoration projects cannot effectively address.

	Regulated Mainstem		North Fork Flathead		Middle Fork Flathead		South Fork Flathead		Swan River		Lower Flathead		Flathead Lake		Stillwater	
Habitat Attribute	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Channel stability	0.15	5	0.06	2	0.16	7	0.09	5	0.17	6	0.46	9	0.35	7	0.44	8
Fine sediment	0.31	6	0.17	4	0.02	3	0.06	4	0.18	7	0.40	8	0.26	4	0.44	8
Habitat Diversity	0.63	9	0.20	6	0.10	6	0.02	3	0.11	5	0.50	10	0.34	6	0.34	7
High Flow	0.38	8	0.08	3	0.00	1	0.01	2	0.05	3	0.27	7	0.08	3	0.21	6
High Temperature	0.08	3	0.00	1	0.00	1	0.00	1	0.04	2	0.15	4	0.06	2	0.13	3
Low Flow	0.35	7	0.08	3	0.03	4	0.01	2	0.04	2	0.26	6	0.31	5	0.18	5
Low Temperature	0.05	2	0.00	1	0.00	1	0.00	1	0.00	1	0.06	3	0.00	1	0.00	1
Obstructions	0.00	1	0.00	1	0.01	2	0.01	2	0.08	4	0.23	5	-0.03	1	0.11	2
Oxygen	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1
Pollutants	0.10	4	0.00	1	0.00	1	0.00	1	0.05	3	0.05	2	0.31	5	0.16	4
Riparian Condition	0.82	10	0.19	5	0.05	5	0.12	6	0.23	8	0.69	11	0.55	8	0.49	9

Because this analysis ranks attributes at the HUC-4 scale, it generalizes conditions across multiple HUC-6 watersheds. Certain attributes not considered limiting at the HUC-4 scale may be limiting within one or more specific HUC-6 watersheds. For example, in the Lower Flathead low flows do not show up as one of the major limiting attributes at the HUC-4 scale. However, low streamflow is often an issue in areas of agricultural production throughout the Flathead Subbasin, and the most extensive irrigation system is run by the BIA on the Flathead Indian Reservation. The Reservation makes up most of the Lower Flathead watershed. As part of their federal trust responsibility, the BIA established instream flows in 1986 to protect fish on streams impacted by the federal Flathead Irrigation Project. Although these interim flows have proved beneficial to fish, they are considered "minimum" and are currently under evaluation. There are situations where current instream flows are probably not adequate to protect fish, even though low flows did not show up as an issue for the Lower Flathead when the QHA attributes were analyzed at the HUC-4 scale.

Table 4.30. Ranking of key lake-habitat attributes in the Flathead Subbasin for westslope cutthroat trout based on a LQHA analysis of reservoirs.

Habitat Attribute	Score	Rank
Temperature	0.00	1
Gas saturation	0.00	1
Trophic status	0.04	2
Oxygen	0.04	2
Substrate condition	0.05	3
Pollutants	0.05	3
Entrainment	0.07	4
Volumetric turnover rates	0.14	5
Migratory obstruction	0.15	6
Macrophytes	0.17	7
Habitat diversity	0.20	8
Hydraulic regime	0.40	9
Shoreline condition	0.53	10

Based on this analysis, of the eleven stream-habitat attributes considered key to resident salmonids, the four most limiting to westslope cutthroat trout in the regulated mainstem are riparian condition, habitat diversity, altered hydrograph, and fine sediment. In tributaries (when averaged across all the HUCs in the subbasin) they are riparian condition, channel stability, habitat diversity, and fine sediment, in that order.

Of the thirteen lake-habitat attributes considered key to resident salmonids in lakes and reservoirs, the most limiting to westslope cutthroat trout (when averaged across all the reservoirs assessed) are shoreline condition, hydraulic regime, habitat diversity, and macrophytes.

Long-term Viability of Westslope Cutthroat Trout Populations Based on Habitat Availability and Condition

In 2000, the USFWS, charged with administration of the Endangered Species Act (ESA), determined that the listing of westslope cutthroat trout as a threatened species under the ESA was not warranted, due to the species wide distribution, available habitat in public lands and conservation and management efforts underway by state and federal agencies. Under the Endangered Species Act, threatened means a species is likely to become endangered within the foreseeable future. In 2003, the agency finished reevaluating that finding and found again the listing was not warranted.

Since the initial finding by the USFWS, Shepard et al. (2003), in their report on the status of the subspecies in the United States, found that westslope cutthroat trout "currently occupy significant portions of, and are well distributed across, their historical range." Their assessment also found that "the data suggest genetically unaltered westslope cutthroat trout occupy at least 13 percent and possibly up to 35 percent of currently occupied habitats and 8 to 20 percent of historical habitats." MFWP estimates that westslope cutthroat trout now occupy only 27 percent of their historic range in Montana, and genetically pure populations occupy only 3 percent of their historic range. In the Flathead Subbasin, Shepard et al. (2003) found genetically unaltered westslope cutthroat trout occupy 16 to 51 percent of their historical habitats (the second number includes habitats occupied by genetically unaltered, suspected unaltered, and potentially unaltered westslope cutthroat trout).

In addition, signers of the state of Montana's Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana (MOA), stated that they believed implementation of the agreement and achievement of its goals and objectives "should ensure the long-term viability of westslope cutthroat trout in the state of Montana." Signers included representatives from American Wildlands, Montana Chapter of the American Fisheries Society, Montana Department of Natural Resources and Conservation

(DNRC), Montana Farm Bureau, Montana Fish, Wildlife & Parks (MFWP), Montana Stockgrowers Association, Montana Trout Unlimited, Montana Wildlife Federation, Natural Resource Conservation Service (NRCS), private landowners, U.S. Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), and U.S. Forest Service (USFS). At an interagency meeting (December 1999), participants prioritized river drainages in Montana for westslope cutthroat trout conservation and restoration. At this meeting, the North, Middle, and South forks of the Flathead River were categorized as priority one statewide (MFWP and CSKT 2000).

Based on the conclusion of these analyses, the MOA, and the conservation priority agencies have placed on westslope cutthroat trout in the subbasin, we believe that proper conservation, restoration, and mitigation actions will secure the long-term viability of westslope cutthroat trout in the Flathead Subbasin.

4.2.6 Westslope Cutthroat Trout Limiting Factors and Conditions

Guidance from the NWPPC 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.

The Montana Chapter of the American Fisheries Society (MTAFS) identified the following four factors as the primary reasons for the decline of westslope cutthroat trout in Montana: over exploitation, genetic introgression and competition from nonnative fish species, and habitat degradation (MTAFS website). The Flathead Subbasin Summary (2000) describes these four limiting factors as they relate to native fish in the subbasin. In their Flathead Lake and River Fisheries Co-Management Plan (2000) MFWP and CSKT identified the same four factors as the MTAFS, but went on to conclude that the greatest threat to westslope cutthroat trout persistence in the Flathead Subbasin is hybridization with nonnative rainbow trout and Yellowstone cutthroat trout. The co-management plan also notes that the presence of Mysis in the system has benefited lake trout and lake whitefish, and that as these introduced species increased in abundance, westslope cutthroat trout have declined in abundance.

In our own HUC-by-HUC assessment of all Flathead Subbasin 6th-code HUCs, our technical team concluded that of the habitat attributes considered most important to resident salmonids, the four most limiting for westslope cutthroat trout in Flathead Subbasin streams are riparian condition, channel stability, habitat diversity, and fine sediment, in that order. In lakes, the most limiting attributes are shoreline condition, migratory obstructions, and hydraulic regime. This phase of the HUC assessment considered only habitat factors (factors such as the presence of nonnative species were evaluated in a second phase of the

HUC assessment and were not ranked against the habitat attributes in terms of which is most limiting).

Shepard and others (2003) asked fishery professionals to assess whether various land, water, and/or fish management activities affected each designated westslope cutthroat trout conservation population. Table 4.31 is the result of this survey and lists the known impacts to conservation populations and miles of stream presently impacted within the Flathead Subbasin by 4th-code HUC.

As part of their Status Review for Westslope Cutthroat Trout in the United States (USFWS 1999), the USFWS assessed limiting factors and threats to westslope cutthroat trout. The following paragraphs are condensed and adapted from that review and summarize the threat posed by various potential limiting factors for westslope cutthroat trout in the Flathead Subbasin.

Timber management is the dominant land use in the Flathead River drainage, where an extensive road system to support forestry practices and other forest uses exists. In addition, rural residential development is increasing, particularly in the Flathead Lake area; resulting domestic sewage and human-caused changes to stream morphology are considered threats to water quality (MBTSG 1995d). The Montana Department of Environmental Quality (MTDEQ) lists 17 streams in the Flathead River drainage as being water-quality impaired as the result of forestry practices and 16 streams impaired by agricultural practices; additional impairments result from other land-use practices (MTDEQ 1998; Appendix Table 5). Many of these streams are water quality impaired by more than one activity. Information on the possible occurrence of westslope cutthroat trout in these streams is presently unavailable, however.

Angler harvest of westslope cutthroat trout is closely regulated in Montana and not considered a threat to the subspecies in the Flathead River drainage. In many westslope cutthroat trout waters in the drainage, fishing for westslope cutthroat trout is restricted to catch-and-release. Elsewhere in the drainage, only limited harvest of westslope cutthroat trout is allowed.

Whirling disease has been detected in trout in the Swan River watershed of the Flathead River drainage and a few other tributaries (Gustafson 1996; Montana Whirling Disease Task Force Website 2003). Where westslope cutthroat trout coexist with both the protozoan that causes the disease and the protozoan's intermediate host, whirling disease poses a threat to westslope cutthroat trout. However, extensive research is being conducted to determine the distribution of whirling disease in Montana, the susceptibility of westslope cutthroat trout (a close relative of rainbow trout) to whirling disease, and possible control measures. Research suggests that westslope cutthroat trout in headwater streams will not be affected by whirling disease because these streams are not suitable for colonization by the intermediate host for the whirling disease organism. Moreover, current research suggests that,

Table 431. Known impacts to conservation populations and miles of stream presently impacted within the Flathead Subbasin.

4th Code HUC	Management Impact	Miles Presently Impacted
North Fork Flathead	Angling	21.4
North Fork Flathead	Roads	21.4
North Fork Flathead	Timber Harvest	21.4
Middle Fork Flathead	Timber Harvest	217.5
Flathead River to and including Flathead Lake	Hydroelectric, water storage, and/or flood control	80.7
Flathead River to and including Flathead Lake	Range (livestock grazing)	9.5
Flathead River to and including Flathead Lake	Roads	90.2
Flathead River to and including Flathead Lake	Stocking	80.7
Flathead River to and including Flathead Lake	Timber Harvest	90.2
South Fork Flathead	Roads	410.3
South Fork Flathead	Stocking	842.8
South Fork Flathead	Timber Harvest	410.3
Stillwater River	Angling	51
Stillwater River	Roads	56
Stillwater River	Timber Harvest	56
Swan River	Angling	17.7
Swan River	Dewatering	2.7
Swan River	Other, specifiy in comments	32.3
Swan River	Recreation (non-angling)	22.6
Swan River	Roads	82.6
Swan River	Stocking	61.6
Swan River	Timber Harvest	85.5

LINKS

Appendix 65 lists the waters in Montana Fish, Wildlife & Park's Region One that have tested positive or have questionable results for fish pathogens.

Click Here

although the whirling disease organism may be present in streams, low levels of the organism are unlikely to result in deleterious infections in fish, including cutthroat trout. Consequently, whirling disease is not considered an important threat to most extant westslope cutthroat trout stocks in the Flathead River drainage. Appendix 65 (see links column) lists the waters in Montana Fish, Wildlife & Park's Region One that have tested positive or have questionable results for fish pathogens.

Predation on westslope cutthroat trout by nonnative predatory fishes poses a threat to westslope cutthroat trout in a few localized areas. In the Flathead Lake basin, there are 13 introduced, nonnative species of fish with which westslope cutthroat trout must coexist (MBTSG 1995d). Among these is lake trout, Salvelinus *namaycush*, which has become the dominant species in Flathead Lake. Juvenile lake trout have also been found in major tributaries to the lake (MBTSG 1995d). Hungry Horse Dam protects native fishes in the South Fork Flathead River watershed, the most intact native fish assemblage in western Montana, by preventing the upstream movement of nonnative fishes, particularly lake trout, into the watershed (MBTSG 1995e). Bigfork Dam has benefitted the Swan River watershed because the dam prevents the upstream movement of nonnative fishes, particularly lake trout, into the Swan drainage (MBTSG 1996a). Over 100 illegal fish introductions have been documented in northwest Montana during the past 20 years (MBTSG 1995e). MFWP does not stock nonnative predatory fishes into waters harboring genetically pure westslope cutthroat trout and aggressively prosecutes anyone caught illegally transferring live fish or attempting to do so.

Existing regulatory mechanisms failed to prevent the more than 100 illegal fish introductions that have been documented in northwest Montana during the past 20 years. There are no other evident, inherent inadequacies in existing federal, state or local regulatory mechanisms that affect westslope cutthroat trout in the drainage. However, effective implementation of the various regulatory mechanisms that potentially affect westslope cutthroat trout depends largely upon the appropriation of adequate funding and, ultimately, commitment on the part of the management or regulatory agencies to fulfill their respective responsibilities. Where these responsibilities are not being fulfilled, westslope cutthroat trout may be threatened by ongoing or planned, adverse changes in their habitat or by chronic, adverse effects that remain unabated.

Although authorized stocking of nonnative fish species has not occurred for more than two decades, the nonnative fishes that became established probably constitute the greatest contemporary threat to the maintenance and restoration of westslope cutthroat trout in the drainage. Nonnative fish species that have become established in the drainage include lake trout, kokanee salmon, northern pike, and largemouth bass *Micropterus salmoides* (MBTSG 1996a).

In the South Fork of the Flathead, MFWP file records indicate that as early as 1957 fish managers had identified sources of rainbow trout and Yellowstone cutthroat trout in the Graves Creek drainage, and as early as 1965 they had identified unknown sources of rainbow trout in the Big Salmon drainage and were concerned with the potential impacts that hybridization could have on the westslope cutthroat trout populations throughout the South Fork Flathead River drainage (MFWP 1965; MFWP 1957). There is little historical information detailing the stocking of rainbow trout in these areas. However, based on the practices of the times, it is believed that fish stocking in these drainages was unauthorized, or unrecorded during public fish distribution programs. Public distribution of fish actually began to be an issue as early as the late 1890s, when the railroad connected the Flathead Subbasin with the Eastern U.S. The U.S. Bureau of Sport Fisheries had rail cars specifically designed to transport fish, and the Great Northern railroad had an active program of providing fish for stocking of public and private waters, especially in Glacier National Park.

Westslope cutthroat trout conservation in Montana became more active around 1980, and in 1983 MFWP commissioned a status review of westslope cutthroat trout west of the continental divide in which the South Fork Flathead River drainage was described as the largest and most secure stronghold for the species in Montana (Liknes 1984). The status review described the primary threat to the South Fork Flathead populations as hybridization with non-native trouts. This threat was defined as especially predictable in drainages with a lake in the headwaters. Many of the lakes had been historically stocked with non-native trout that have since been escaping downstream. By 1988 (Liknes and Graham 1988), the westslope cutthroat trout was believed to exist in only 2.5 percent of its historic range. In 1999, Montana Fish, Wildlife & Parks (MFWP) began a program, which is ongoing, aimed at conserving the genetically pure populations of westslope cutthroat trout in the South Fork Flathead River drainage. The objective of this program is to eliminate all of the non-native and hybrid trout that threaten the genetically pure westslope cutthroat populations in the South Fork Flathead (for a description of the program, see Appendix 74).

Table 4.32, from USFWS (1999) shows the threats to westslope cutthroat trout by 4th-code HUC for the Flathead Subbasin.

LINKS

For more information on the South Fork Flathead Watershed Westslope Cutthroat Trout Conservation Program, also known as the Mountain Lakes Program, go to Appendix 74.

Click Here

Table 4.32. Threats to westslope cutthroat trout throughout the historic range of the subspecies. Data are given as the number of water bodies considered water-quality impaired by that particular land-use activity. Harvest is given as catch and release only (C & R), restricted (R), low (L), moderate (M), or extensive (E). Nonnative fish are given as brook trout (BKT) and rainbow trout (RBT). Source: USFWS 1999.

Watershed	North Fork Flathead River	Middle Fork Flathead River	Flathead Lake	South Fork Flathead River	Stillwater River	Swan River	Lower Flathead River
Dams				1			1
Forestry	6	4	1	1	5		
Agriculture			3		3		10
Water Withdrawls				1	2		3
Roads					1		1
Channelization	1		3				
Mining							
Natural Sources	2	2			2		3
Water Quality	6	4	5		7		10
Harvest	R	R	R	R	R		R
Non-native Fish	BKT RBT	BKT RBT	BKT RBT	BKT RBT	BKT RBT	BKT RBT	BKT RBT

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4.3 Target Species

The Flathead Subbasin is a large subbasin and encompasses an enormous diversity of habitats, which in turn, are home to a large array of birds, mammals, amphibians, and reptiles. In all an estimated 374 terrestrial species[13] (IBIS 2003). (Appendix 57 gives the predicted distributions of terrestrial vertebrate species in Montana in acres and by percent distribution by land stewardship.)

While the concept of using one or two focal species to characterize habitats subbasin-wide may be appropriate for an aquatic system (which involves just a single biome), it does not work for the terrestrial system of a subbasin as large as the Flathead, which is composed of multiple and diverse biomes.

To help us answer the questions set forth in the Technical Guide for Subbasin Planners (NWPCC 2001), our Technical Team has taken a multi-species approach. We have selected a group of species that we are calling target species (table 4.33). These target species were selected because: (1) they have been designated as a Federal endangered or threatened species or have been otherwise designated a priority species for conservation action; (2) they play an important ecological role in the subbasin such as a functional specialist or a critical functional link species; (3) they possess economic or cultural significance to the people of the Flathead Subbasin; and/or (4) collectively they represent a cross-section of the wildlife community. Because of the number of wildlife species that we are targeting, we have chosen, in interest of saving space and generating a more user-friendly document, to provide the bulk of the information about each of these species, including information on biological needs and limiting factors, in the form of electronic links in Appendix 27. Most of the links summarize what is known about the species across its entire range or at least its range in Montana. For most target species detailed, subbasin-scale information does not exist.

While Appendix 27 provides a generalized overview of wildlife species, the heart of our terrestrial assessment is focused on the condition of habitats, specifically the target biomes within each 4th-field HUC. We developed and employed a spreadsheet tool called Terrestrial Biome Assessment (TBA) that, like QHA, the aquatic assessment tool, utilizes existing data and the knowledge of professional biologists who have worked in the subbasin for many years to assess the current condition of subbasin terrestrial habitats. The results are presented in Appendix 73. We have supplemented this biome analysis with data from IBIS to assess subbasin-wide conditions (for example, the change in acres—historic vs current—of wildlife habitats and habitat guilds across the subbasin).

[13] *This does not include extirpated or accidental species. This number is for the U.S. portion of the subbasin. A similar analysis for the Canadian portion yielded an estimate of 363 species.*

LINKS

The IBIS-USA website has done further analysis that are generally descriptive in nature. These can be viewed at the following URLs:

http://www.nwhi.org/ibis/subbasin/ecos2.asp

Click Here

http://www.nwhi.org/ibis/subbasin/uscan2.asp

Click Here

http://www.nwhi.org/ibis/subbasin/subs2.asp

Click Here

Appendix 57 gives the predicted distributions of terrestrial vertebrate species in Montana and Idaho in acres and by percent distribution by land stewardship.

Click Here

Table 4.33. Terrestrial target species.

MAMMALS	IBIS STATUS	BIRDS (CONT.)	IBIS STATUS	BIRDS (CONT.)	IBIS STATUS
American Beaver	*CFLS*	Black Swift	*FS*	Merlin	*FS*
American Pika	*CFLS*	Black Tern	*CFLS*	Northern Goshawk	
Big Brown Bat	*CFLS*	Black-backed Woodpecker		Northern Pygmy-owl	*FS*
Black Bear	*CFLS*	Black-chinned Hummingbird	*CFLS*	Olive-sided Flycatcher	
Bushy-tailed Woodrat	*CFLS*	Boreal Owl	*FS*	Peregrine Falcon	*FS*
Deer Mouse	*CFLS*	Brewer s Sparrow		Pileated Woodpecker	
Fisher	*CFLS*	Brown Creeper		Red-eyed Vireo	
Golden-mantled Grnd Squirrel	*CFLS*	Brown-headed Cowbird	*CFLS*	Red-naped Sapsucker	
Grizzly Bear	*CFLS*	Calliope Hummingbird		Ruffed Grouse	
Lynx	*FS*	Canada Goose	*CFLS*	Rufous Hummingbird	*CFLS*
Mink	*CFLS*	Columbian Sharp-tailed Grouse		Snowy Owl	*FS*
Montane Vole	*CFLS*	Common Loon		Three-toed Woodpecker	
Moose	*CFLS*	Common Nighthawk	*FS*	Trumpeter Swan	
Mule Deer	*CFLS*	Cordilleran Flycatcher		Tundra Swan	*CFLS*
Northern Bog Lemming	*FS*	Flammulated Owl		Turkey Vulture	*FS*
Northern Pocket Gopher	*CFLS*	Grasshopper Sparrow		Vaux s swift	
Nuttall's Cottontail	*CFLS*	Great Blue Heron	*CFLS*	Veery	
Raccoon	*CFLS*	Great Horned Owl	*CFLS*	Williamson's Sapsucker	*CFLS*
Red Squirrel	*CFLS*	Gyrfalcon	*FS*	Willow Flycatcher	
River Otter		Hammond s Flycatcher		Winter Wren	
Rocky Mountain Elk	*CFLS*	Harlequin Duck	*FS*	**AMPHIBIANS**	
Snowshoe Hare	*CFLS*	Hooded Merganser		Boreal Toad	
Wolverine	*FS*	Horned Grebe		Long-toed Salamander	*CFLS*
BIRDS		House Finch	*CFLS*	Northern Leopard Frog	
American Crow	*CFLS*	Lazuli Bunting		Spotted Frog	
Bald Eagle		Lewis s woodpecker			
Barrow s Goldeneye		Long-billed Curlew			

[1]FS = Functional specialist, species that have only one or a very few number of key ecological functions. Functional specialist species could be highly vulnerable to changes in their environment (such as loss of carrion causing declines or loss of carrion-feeder functional specialists) and thus might be good candidates for focal species.

[2]CFLS = Critical functional link species, species that are the only ones that perform a specific ecological function in a community. Their removal would signal loss of that function in that community. Thus, critical functional link species are critical to maintaining the full functionality of a system. See Appendix 65 (see links column) for the critical functions associated with each of these species.

LINKS

See Appendix 36 for a list of the key ecological functions (KEFs) associated with the biomes.

Click Here

Results of the IBIS analysis are presented in the *Fish and Wildlife Communities* section of this document and at the IBIS website (see Links column). Finally, in our assessment of the terrestrial ecosystem, our Technical Team reviewed results of the Nature Conservancy's SITES model and used that information to complement the results of our own biome assessment.

4.3.1 Terrestrial Limiting Factors and Conditions

Guidance from the NWPCC defines limiting factors as those factors or conditions that have led to the decline of target species and/or that currently inhibit populations and ecological processes and functions relative to their potential. Because the term *limiting factor* has another meaning to most biologists (i.e., the abiotic condition that most controls the growth of a species) and because this analysis involves multiple species, our terrestrial technical team chose to use term *impact* when describing the factors or conditions that have led to the general decline of target species.

As part of our Terrestrial Biome Assessment (TBA), the terrestrial technical team identified the primary, secondary, and tertiary impacts on the target species associated with each subunit analyzed. Table 4.34 lists the impacts in each of those categories that biologists identified most often in the regulated mainstem and across the rest of the subunits.

LINKS

Appendix 27 provides more information and links for each of the target species.

Click Here

For the results of the Terrestrial Biome Assessment (TBA), go to Appendix 73.

Click Here

Table 4.34. Primary, secondary, and tertiary impacts on the target species associated with each subunit analyzed.

	Primary Impacts (number of subunits)	Secondary Impacts (number of subunits)	Tertiary Impacts (number of subunits)
Regulated Mainstem			
Riparian	Altered Hydrograph		
Wetland	Altered Hydrograph		
Rest of the Subbasin			
Mesic Forest	Fire Exclusion (6) Forest Management (6) Human Developments (4)	Non-Native Species (5) Roads (5) Forest Fragmentation (3)	Recreation Use (6) Non-Native Species (4) Fire Exclusion (2)
Grassland	Forest Encroachment (9) Land Conversion (9)	Non-Native Species (8) Forest Encroachment (5) Overgrazing (4)	Non-Native Species (5)
Riparian	Land Conversion (13) Altered Hydrograph (11)	Human/wildlife Conflicts (10) Land Conversion (8) Non-Native Species (7)	Non-Native Species (16) Human/wildlife Conflicts (5)
Wetland	Land Conversion (9) Forest Management (5)	Human/wildlife Conflicts (10) Land Conversion (8) Non-Native Species (7)	Non-Native Species (16) Human/wildlife Conflicts (5)
Xeric Forest	Fire Exclusion (9) Encroachment (6)	Forest Fragmentation (6) Human/wildlife Conflicts (4)	Non-Native Species (3) Overgrazing (3)

** Forest management impacts in the context of this section are defined as negative impacts on target wildlife species stemming from forest management practices that cause changes in thermal cover, hiding cover, large snage density, down woody debris, early seral forage habitat, and the level of habitat fragmentation. Changes to any one of these parameters may have negative or postive affects, depending on the wildlife species at issue.*

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5 HUC/Unit Classification

5.1 Aquatic Systems

5.1.1 Methods

To help us classify 6th-code HUCs within the subbasin according to the degree to which each area has been modified and its potential for restoration, we used a spreadsheet tool called Qualitative Habitat Assessment (QHA). Dr. Chip McConnaha of Mobrand Biometrics and Drew Parkin, a private consultant contracted at the time with the Northwest Power and Conservation Council, designed and built QHA specifically in response to requests from the Flathead and Kootenai Subbasin Coordinators. Developed principally for resident salmonids in stream environments, QHA provides a means of capturing, in a systematic and consistent way, aquatic-habitat information. It is a mechanism for objectively and transparently combining opinions from multiple scientists (in the case of the Flathead, twenty biologists and hydrologists). Dr. Paul Anders and Dr. McConnaha, also constructed a lacustrine or lake version of QHA, called LQHA. It works like the stream version, but uses habitat attributes appropriate to lentic environments. We used LQHA to assess selected lakes within the subbasin (table 5.1) (lakes that the Technical Team could foresee doing BPA-related management actions on the future). Both tools use a hypothesis developed by our Technical Team to characterize the relationship between a fish population and its habitat. Both provide an indication of the relative restoration and protection value for each HUC-6 or lake with respect to a focal species. Both also yield a ranking of the condition of habitat attributes for each focal species. QHA also allows users to document the decision process and describe the level of confidence users have in their various ratings.

Several biological and management-oriented modifiers were subsequently added to QHA to further inform the habitat-based rankings. These include: genetic purity, presence of nonnative species, and fish pathogens.

QHA, with its modifiers, relies on a combination of data and the expert knowledge of people intimately familiar with the streams being rated. QHA does not result in a detailed assessment of any waterbody. Rather, it is a tool for capturing data and professional knowledge about streams and organizing that information in such a way as to show *how watersheds and habitat attributes within a subbasin compare to each other*.

While QHA relies on a similar conceptual framework as the Ecosystem Diagnosis and Treatment (EDT) model, there are significant differences. Most significantly, EDT is a model that produces a series of numerical products to estimate productivity, abundance, and related factors that predict how well habitat supports fish. EDT is intended to result in a detailed assessment of a stream or group of

LINKS

For a more detailed description of QHA and how it works, go to Appendix 62.

Click Here

QHA habitat attribute scores are in Appendix 26.

Click Here

Appendix 83 explains why the Flathead Technical Team chose to use QHA rather than EDT as our primary aquatic assessment tool.

Click Here

Appendix 71 shows the HUCs used in the QHA analysis.

Click Here

Table 5.1. Lakes assessed in the Flathead Subbasin using the Lacustrine QHA spreadsheet tool.

Lake	Drainage
Upper Stillwater	Stillwater
Whitefish	Stillwater
Lindbergh	Swan
Holland	Swan
Swan	Swan
Flathead	Flathead
Ashley	Flathead
Bitterroot	Lower Flathead
Tally	Flathead
Mcdonald	Lower Flathead
Kintla	North Fork Flathead
Bowman	North Fork Flathead
Quartz	North Fork Flathead
Logging	North Fork Flathead
Harrison	Middle Fork Flathead
McDonald	Middle Fork Flathead
Big Salmon	South Fork Flathead
Hungry Horse	South Fork Flathead

watersheds—how many fish they can support and what specific habitat factors are limiting the population. QHA, on the other hand, simply provides the user with *a relative ranking of the streams and habitat attributes in a subbasin* based on the characteristics being evaluated—for example, the aquatic habitat for resident salmonids in Camp Creek is significantly more degraded than that of Bear Creek or riparian condition is more limiting for a given focal species than temperature.

At the end of May, 2003, technical team members from the Flathead Subbasin held a four-day meeting in Whitefish, Montana to conduct our HUC-6-by-HUC-6 aquatic assessment using QHA[1]. Fisheries biologists, hydrologists, data managers and GIS professionals from Montana Fish, Wildlife & Parks, US Army Corps of Engineers, US Fish and Wildlife Service, the Flathead National Forest, the B.C. Ministry of Sustainable Resource Management, the B.C. Ministry of Water, Land, and Air Protection, the Salish and Kootenai Tribes, and a private consulting firm evaluated habitat parameters on all the 6th-code HUCs in the Flathead Subbasin, including those within the Canadian portion. Later, other non-habitat modifiers (genetic purity, presence of nonnatives, pathogens) were added to QHA and additional factors such as ESA status, physiographic vulnerability, landownership, and cultural values were considered, and streams at the HUC-6 scale and selected lakes were then grouped into classification schemes adapted

[1] In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portion of the subbasin, time limitations prevented the use of 6th-code HUCs. Instead, the Canadian members of the team used analogous watersheds developed during a previous watershed restoration planning exercise in B.C.

from *Upstream* (National Research Council 1996) (tables 5.2 and 5.3). The technical team then reviewed the resulting classification using professional knowledge and judgement and comparing it to other recent assessments that utilized different methodologies. When appropriate, team members reclassified streams or lakes and documented the reasons. The two analytical methods, QHA (as the expert system) and expert opinion gave us our final stream and lake classification. (This was particularly true with LQHA, which the Technical Team determined to have limited value in assessing lake/reservoir limiting factors and in generating a lake/reservoir classification. The team based most of the lake/reservoir classification on: (1) the level of degradation of the watershed (including, but not emphasizing the lake basin itself); (2) the natural capability of these waters (some lakes have few or no live streams attached and others are on-stream reservoirs); and (3) species interactions (non-native species).

An important advantage of the stream version of QHA is that it allows for assessments at multiple scales as recommended by the Independent Scientific Advisory Board (ISAB) in their *Review of Strategies for Recovering Tributary Habitat* (2003). Specifically we are able to view habitat conditions, life history needs, and limiting factors at the HUC-6, HUC-4, and subbasin scales. These analyses appear throughout this assessment.

Classification Strategy

When viewing the restoration scores from QHA, it is important to keep in mind that the term restoration in the QHA spreadsheet tool actually means the extent to which a stream is degraded. The formula QHA uses is:

Restoration Score = Reference - Current x Lifestage Weight

So in QHA, the higher the restoration score, the more degraded the stream and the more important it is to the focal species. But in most cases, near-term restoration opportunities are not the most degraded streams. Restoration potential measured as biological gain per unit of investment, is not a linear function of the difference between the reference and current conditions. It is a dome shaped function (figure 5.1), limited at the small-impact end by the fact that present high quality conditions cannot be improved much, and limited at the high-impact end by intractable ecological complications and irreversible constraints (such as introduced species) that cap what can be regained through restoration actions (Dr. Chris Frissell, pers. comm. 2003). In other words, going from D to B or A in figure 5.1, if possible at all, requires enormous capital investment and often very long periods of time. On the other hand, going from C to B or A is often

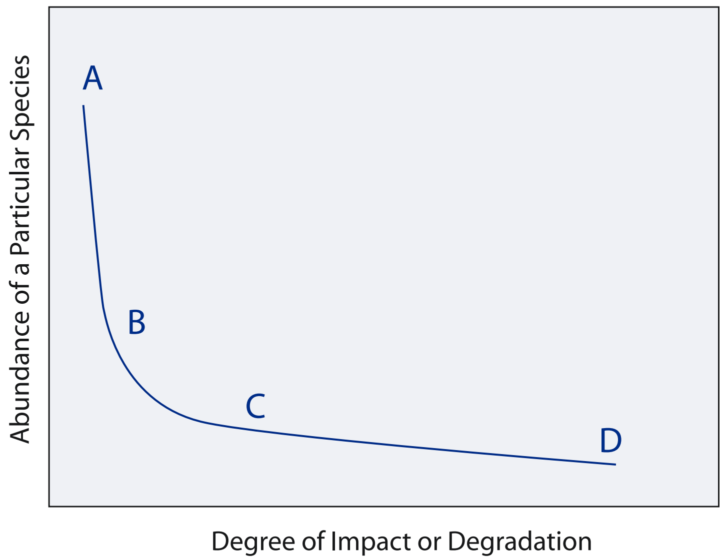

Figure 5.1. Relationship between degree of degradation and productivity.

quite possible and requires much less in the way of investments of capital and time.

Therefore, our Technical Team has generally made our near-term opportunities for restoration those waterbodies that have a moderate to high value for a given focal species and that have been only slightly to moderately degraded. These are primarily our Class 2 Waters (table 5.2 and 5.3). For those cases where a waterbody is severely degraded, but its restoration is considered key to an ESA-listed-species' recovery or the recovery of a species of concern, we have created a separate class, Class 2.5, which we also consider near-term restoration opportunities. Tables 5.2 and 5.3 describe these and the other classes. Figure 5.2 shows the desired path of reaches within each class with regard to restoration and protection.

Table 5.2. Protection/restoration aquatic classification system used to classify streams and lakes in the Flathead Subbasin (adapted from the scheme presented Upstream *by the National Research Council (1996)).*

Stream Aquatic Classification
Class 1 Waters **Most intact stream habitats; high protection value** Bear the closest resemblance to waters unaltered by modern human activities, contain a complete set of native biota, and have a high degree of natural protection. **Management Goal:** Keep as pristine as possible, recognizing that some biotic change is inevitable or necessary. Conduct restoration as necessary to perpetuate values.
Class 2 Waters **Low to moderate degree of degradation; high to moderate protection value** Low to moderate degree of modification by human activity. Contain mainly native organisms and have reasonable potential to be restored to Class 1. **Management Goal:** Restore degraded areas, maintain natural diversity, and prevent further degradation.
Class 2.5 Waters **High restoration priority driven by ESA needs or the needs of species of concern** Habitat heavily modified by human activity; may contain many nonnative species and may require significant investment of time and money to be restored, but are restoration priorities because of their value to ESA-listed species. **Management Goal** Manage for protection of listed species, prevent further degradation and restore degraded habitat to extent possible.
Class 3 Waters **Moderate to high degree of degradation; low protection value** Appear natural, but their biotic communities have been significantly and possibly irreversibly altered. Difficult to restore to Class 1 given current technology, but can be refuges for native species or migration corridors for adfluvial species. Vulnerable to change and current condition cannot be relied upon for long-term preservation of species. **Management Goal:** Prevent further degradation. Restore areas as opportunities arise. Maintain supplemental populations and gene pools, sources of organisms to stock restored waters, and wild areas that can sustain fairly heavy public use.
Class 3.5 Waters **High degree of degradation; low protection value** Highly altered waters that do not appear natural, and their biotic communities have been irreversibly altered. Very unlikely ever to be restored to Class 1 given current technology, but can be refuges for native species or migration corridors for adfluvial species. Cannot be relied upon for long-term preservation of species. **Management Goal:** Maintain value as migration corridor and, to extent possible, utilize for recreational fishery to relieve pressure on native populations. Prevent further degradation. Consider restoration projects only if cost effective and benefits can be clearly demonstrated.

Table 5.3. Protection/restoration aquatic classification system used to classify lakes in the Flathead Subbasin. Adapted from National Research Council (1996).

Lake Aquatic Classification
Class 1 Waters **Most intact lake habitats; high protection value** Lake habitat and native species complex (biota) both nearly unaltered and both with a high degree of protection. Large enough system with well-connected stream habitat to maintain viable native species population stronghold for the foreseeable future. **Management Goal:** Keep pristine, avoid invasion of nonnative species as highest priority. Conduct restoration as necessary to perpetuate values.
Class 2 Waters **Low to moderate degree of degradation; high to moderate protection value** Lake habitat relatively intact but may have some limited impacts due to human development. Mostly native biota, or with sufficient habitat quality in lake and interconnected stream system for restoration to Class 1 status if nonnative species issues can be mitigated. **Management Goal:** Restore degraded areas, maintain native biota (genetic reserve) at sufficient level to avoid further degradation and allow future recovery.
Class 2.5 Waters **High restoration priority driven by ESA needs or the needs of species of concern** Habitat may be heavily altered or native salmonid complexes may be extensively compromised by non-native and may require considerable investment to maintain or improve on the status quo. These systems are a high priority for long-term maintenance or restoration due to the size, scope, or position of the watershed and its interconnected stream system and because of their overall importance to ESA-listed species or species of concern. **Management Goal:** Protect viable native gene pool and prevent further erosion and degradation of either aquatic habitat or native species complexes. Restore degraded habitat to extent possible.
Class 3 Waters **Moderate to high degree of degradation; low protection value** May appear natural, but interconnected spawning and rearing habitat and/or the aquatic communities in these lakes have been significantly and potentially irreversibly altered. Difficult to restore to Class 1 given current technology. Current condition cannot be relied upon for long-term preservation of native species. **Management Goal:** Potential to be useful in the future as supplemental habitat for native populations or gene pools if restored, though highest current value is likely for supporting public use. Preclude any fish stocking or other uses that will directly impact native species in interconnected offsite waters. Prevent further habitat degradation. Restore areas as opportunities arise.
Class 3.5 Waters **Low restoration potential, low protection value.** Highly altered habitat and/or restricted interconnected spawning and rearing habitat. Dominant nonnative species component. Very problematic for support of native species beyond potential function as a migratory corridor (in some cases). **Management Goal:** Maintain as a recreational fishery while protecting any values that support limited use by native species. Preclude any fish stocking or other uses that will directly impact native species in interconnected offsite waters. Consider restoration projects only if cost effective and benefits can be clearly demonstrated.

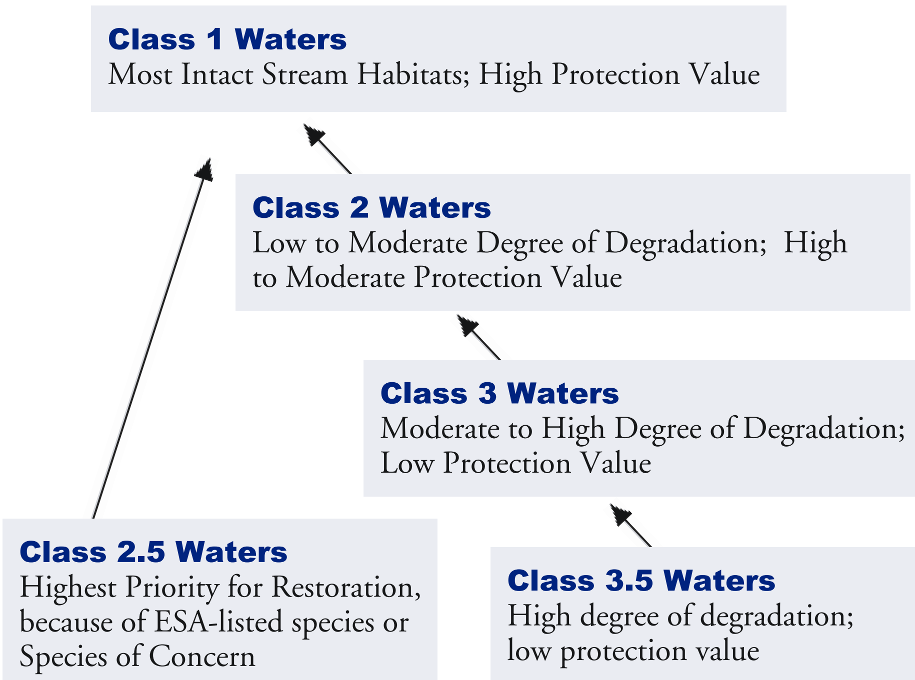

Figure 5.2. The desired path of reaches within each class with reguard to restoration and protection. Class 3.5 waters have low protection value and a high level of degradation, but with passive restoration and improved management, they may improve enough to become Class 3 waters.

5.1.2 HUC-6 Classifications

Tables 5.4 through 5.8 show the results of our Technical Team's HUC-6 watershed classification for bull trout. Tables 5.9 through 5.13 show the same for westslope cutthroat trout. It should be noted that the Technical Team views this classification or ranking as dynamic, and if conditions change for any given watershed (for example, if a major forest fire that changes aquatic habitat conditions should occur), that watershed may be re-scored and reclassified. Also, the Technical Team only scored selected lakes in the subbasin.

The Technical Team determined that in the Flathead Subbasin, LQHA had limited value in assessing lake/reservoir limiting factors and in generating a lake/reservoir prioritization. We therefore based our lake/reservoir prioritization on: (1) the level of degradation of the watershed (including, but not emphasizing the lake basin itself); (2) the natural capability of these waters (some lakes have few or no live streams attached and others are on-stream reservoirs); and (3) species interactions (non-native species). In the future, as additional information becomes available or as circumstances change, other lakes may be added to the various classes.

It should be noted that the Confederated Salish and Kootenai Tribes and Montana Fish, Wildlife & Parks consider all waters, lands, and native species in the subbasin worthy of restoration and protection.

Table 5.4. Class 1 waters for bull trout.

Class 1 Bull Trout Waters	
North Fork Flathead Streams	
Bowman Creek	North Fork Flathead River 4
Kintla Creek 1	Quartz Creek 1
Kintla Creek 2	Quartz Creek 2
Logging Creek	Trail Creek
North Fork Flathead River 2	Upper East Flathead (Canada)
North Fork Flathead River 3	Upper West Flathead (Canada)
North Fork Flathead Lakes	
Quartz Lake	
Middle Fork Flathead Streams	
Bowl Creek	Middle Fork Flathead River 7
Clack \ Calbick	MIddle Fork Flathead River 8
Dolly Varden Creek	Middle Fork Flathead River 9
Harrison Creek	Morrison Creek
Lincoln Creek	Nyack Creek 1
Long Creek	Nyack Creek 2
McDonald Creek 2	Ole Creek
Middle Fk. FHR Valley 2	Park Creek
Middle Fork Flathead River 3	Schafer Creek
Middle Fork Flathead River 4	Strawberry Creek
Middle Fork Flathead River 5	Trail Creek 1
South Fork Flathead Streams	
Babcock Creek	South Fork Flathead River 2
Big Salmon Creek 2	South Fork Flathead River 3
Bunker Creek	South Fork Flathead River 4
Danaher Creek 1	South Fork Flathead River 5
Danaher Creek 2	South Fork Flathead River 6
Gordon Creek 1	South Fork Flathead River 7
Gordon Creek 2	Sullivan Creek 1
Little Salmon Creek	White River 2
Rapid Creek	Youngs Creek 1
South Fork Flathead River 1	Youngs Creek 2
South Fork Flathead Lakes	
Big Salmon Lake	
Swan River Streams	
Cedar Creek	Lost Creek
Elk Creek	Piper Creek
Holland Creek	Swan River 1
Lower Flathead Streams	
Mission Creek 1	Post Creek 1

Table 5.5. Class 2 waters for bull trout.

Class 2 Bull Trout Waters	
North Fork Flathead Streams	
Big Creek 1	Howell Creek (Canada)
Big Creek 2	North Fork Flathead River 1
Coal Creek 1	Red Meadow Creek
Coal Creek 2	Shorty Creek
Cyclone Creek	Sage and Kishinena Creeks (Canada)
Hallowat Creek	South Fork Coal Creek
Hay Creek	Whale Creek 2
North Fork Flathead Lakes	
Bowman Lake	Logging Lake
Kintla Lake	
Middle Fork Flathead Streams	
Bear Creek	McDonald Lk./Middle Fk. FHR Valley
Granite Creek	Middle Fk. FHR Valley 1
Middle Fork Flathead Lakes	
Lake McDonald	Harrison Lake
South Fork Flathead Streams	
Clark Creek	Spotted Bear River 3
Felix Creek	Sullivan Creek 2
Lower Twin Creek	Wheeler Creek
Spotted Bear River 2	Wounded Buck Creek
South Fork Flathead Lakes	
Wildcat	Margaret
Clayton	Sunburst
Blackfoot	Woodward
Black	Necklace lakes (4)
Handkerchief	Lena
Upper 3 Eagles	Lick
Lower 3 Eagles	Koessler
Pilgrim	George
Bighawk	Pyramid
Stillwater River Streams	
Stillwater River 1	West Fork Swift Creek
Stillwater River Valley A	
Swan River Streams	
Cold Creek	Swan Lake
Glacier Creek	Swan River 2
Goat Creek	Swan River 3
Jim Creek	Swan River Valley
Lion Creek	Woodward Creek
Soup Creek	
Swan River Lakes	
Lindbergh Lake	
Lower Flathead Streams	
Jocko River Valley	South Fork Jocko River
North Fork Jocko River	Middle Fork Jocko River

Table 5.6. Class 2.5 waters for bull trout.

Class 2.5 Bull Trout Waters	
South Fork Flathead Lakes	
Hungry Horse Reservoir	
Swan River Lakes	
Swan Lake	Holland Lake
Flathead Lake Streams	
Dayton Creek	
Flathead Lake Lakes	
Flathead Lake	
Lower Flathead Streams	
Dry Creek	Valley Creek 1
Mission Valley	
Lower Flathead Lakes	
McDonald Reservoir	

Table 5.7. Class 3 waters for bull trout.

Class 3 Bull Trout Waters	
North Fork Flathead Streams	
Canyon Creek	
South Fork Flathead Streams	
South Fork Flathead River 9	
Stillwater River Streams	
East Fork Swift Creek	Logan Creek 2
Flathead Lake/Upper FHR Valley	Stillwater River Valley E
Stillwater River Lakes	
Tally Lake	Whitefish Lake
Upper Stillwater Lake	
Flathead Lake Lakes	
Ashley Lake	
Lower Flathead Streams	
Lower FHR Valley	
Lower Flathead Lakes	
Lake Mary Ronan	Little Bitterroot Lake

Table 5.8. Class 3.5 waters for bull trout.

Class 3.5 Bull Trout Waters	
Stillwater River Streams	
Good Creek 3	Stillwater River Valley C
Logan Creek 2	Stillwater River Valley D
Stillwater River Valley B	Stillwater River Valley F
Swan River Streams	
Big Fork	
Flathead Lake Streams	
Boulder Creek	Yellow Bay Creek
Polson	
Flathead Lake Lakes	
Echo Lake	
Lower Flathead Streams	
Camas Creek 3	Pistol Creek
Crow Creek 1	Post Creek 2
Finley Creek 1	Revais Creek
Jocko River 1	Seepay Creek
Magpie Creek	Valley Creek 2
Lower Flathead Lakes	
Kicking Horse Reservoir	Ninepipes Reservoir

Table 5.9. Class 1 waters for westslope cutthroat trout.

Class 1 Westslope Cutthroat Trout Waters	
North Fork Flathead Streams	
Akokala Creek	North Fork Flathead River 4
Anaconda Creek	Quartz Creek 1
Bowman Creek	Quartz Creek 2
Camas Creek	Trail Creek
Dutch Creek	Upper East Flahead (Canada)
Kintla Creek 2	Upper West Flahead (Canada)
Logging Creek	Whale Creek 1
North Fork Flathead River 2	Yakinikak Creek
North Fork Flathead River 3	
North Fork Flathead Lakes	
Quartz Lake	
Middle Fork Flathead Streams	
Bowl Creek	Middle Fork Flathead River 4
Clack \ Calbick	Middle Fork Flathead River 5
Coal Creek	Middle Fork Flathead River 7
Cox Creek	MIddle Fork Flathead River 8
Dickey Creek	Middle Fork Flathead River 9
Dolly Varden Creek	Morrison Creek
Harrison Creek	Nyack Creek 2
Howe Creek 1	Ole Creek
Howe Creek 2	Paola
Lake Creek	Park Creek
Lincoln Creek	Schafer Creek
Long Creek	Strawberry Creek
McDonald Creek 2	Trail Creek 1
Middle Fk. FHR Valley 2	Twentyfive Mile Creek
Middle Fork Flathead River 3	
South Fork Flathead Streams	
Aeneas Creek	Gordon Creek 1
Babcock Creek	Murray Creek
Bartlett Creek	Rapid Creek
Basin Creek	South Fork Flathead River 1
Big Salmon Creek 1	South Fork Flathead River 2
Big Salmon Creek 2	South Fork Flathead River 3
Black Bear Creek	South Fork Flathead River 4
Bunker Creek	South Fork Flathead River 5
Clayton Creek	South Fork Flathead River 6
Danaher Creek 1	South Fork Logan Creek
Danaher Creek 2	South Fork White River
Dean Creek	Spotted Bear River 1
Doris Creek	

Table 5.9 (cont.). Class 1 waters for westslope cutthroat trout.

Class 1 Westslope Cutthroat Trout Waters	
South Fork Flathead Streams (cont.)	
Gordon Creek 2	Tent Creek
Gorge Creek	White River 2
Hollbrook Creek	Youngs Creek 1
Little Salmon Creek	Youngs Creek 2
MidCreek	
South Fork Flathead Lakes	
Big Salmon Lake	
Stillwater River Streams	
Martin Creek	
Swan River Streams	
Elk Creek	Piper Creek
Holland Creek	Swan River 1
Lion Creek	
Lower Flathead Streams	
Crow Creek 1	Post Creek 1
Mud Creek	Post Creek 2

Table 5.10. Class 2 waters for westslope cutthroat trout.

Class 2 Westslope Cutthroat Trout Waters	
North Fork Flathead Streams	
North Fork Flathead River 1	Canyon Creek
Tepee Creek	Coal Creek 1
Hallowat Creek	South Fork Coal Creek
Shorty Creek	Big Creek 1
Whale Creek 2	Big Creek 2
Moose Creek	Coal Creek 2
Red Meadow Creek	Cyclone Creek
Hay Creek	
North Fork Flathead Lakes	
Bowman Lake	Logging Lake
Kintla Lake	
Middle Fork Flathead Streams	
Granite Creek	Middle Fk. FHR Valley 1
McDonald Lk./Middle Fk. FHR Valley	Bear Creek
Middle Fork Flathead Lakes	
Lake McDonald	Harrison Lake
South Fork Flathead Streams	
Clark Creek	Spotted Bear River 3
Deadhorse Creek	Wheeler Creek
Sullivan Creek 1	Felix Creek
Silvertip Creek	Emery Creek
Sullivan Creek 2	Hungry Horse Creek
Wounded Buck Creek	Twin Creek
Lower Twin Creek	Spotted Bear River 2
South Fork Flathead River 7	
South Fork Flathead Lakes	
Wildcat	Margaret
Clayton	Sunburst
Blackfoot	Woodward
Black	Necklace lakes (4)
Handkerchief	Lena
Upper 3 Eagles	Lick
Lower 3 Eagles	Koessler
Pilgrim	George
Bighawk	Pyramid

Table 5.10 (cont.). Class 2 waters for westslope cutthroat trout.

Class 2 Westslope Cutthroat Trout Waters	
Stillwater River Streams	
West Fork Swift Creek	Stillwater River Valley A
Swift Creek 2	Good Creek 1
Stillwater River 1	Stillwater River Valley B
Swan River Streams	
Lost Creek	Swan River 3
Cedar Creek	Glacier Creek
Goat Creek	Soup Creek
Condon Creek	Jim Creek
Cold Creek	Swan Lake
Swan River Valley	Woodward Creek
Swan River 2	
Swan River Lakes	
Lindbergh Lake	
Flathead Lake Streams	
Yellow Bay Creek	Big Fork
Truman Creek	Patrick Creek
Lower Flathead Streams	
Mission Creek 1	Little Bitterroot Lk. Valley
Finley Creek 1	Jocko River 1
Seepay Creek	Revais Creek
Magpie Creek	South Fork Jocko River

Table 5.11. Class 2.5 waters for westslope cutthroat trout.

Class 2.5 Westslope Cutthroat Trout Waters	
South Fork Flathead Lakes	
Hungry Horse Reservoir	
Swan River Lakes	
Swan Lake	Holland Lake
Stillwater River Streams	
Sheppard Creek	
Flathead Lake Streams	
Ronan Creek	Dayton Creek
Polson	
Flathead Lake Lakes	
Flathead Lake	
Lower Flathead Streams	
Mill Creek	Jocko River Valley
Valley Creek 2	Valley Creek 1
Lower Flathead Lakes	
McDonald Reservoir	

Table 5.12. Class 3 waters for westslope cutthroat trout.

Class 3 Westslope Cutthroat Trout Waters	
South Fork Flathead Streams	
South Fork Flathead River 9	
Stillwater River Streams	
East Fork Swift Creek	Stillwater River Valley E
Griffin Creek 2	Stillwater River Valley G
Logan Creek 2	White Fish River 3
Squaw Meadows Creek	
Stillwater River Lakes	
Tally Lake	Whitefish Lake
Upper Stillwater Lake	
Flathead Lake Lakes	
Ashley Lake	
Lower Flathead Streams	
Camas Creek 1	Lower FHR Valley
Cottonwood Creek	Middle Fork Jocko River
Dry Creek	Mission Valley
Dry Fork Creek	North Fork Jocko River
Finley Creek 2	Pistol Creek
Garden Creek	Sullivan Creek
Hot Springs Creek	
Lower Flathead Lakes	
Lake Mary Ronan	Little Bitterroot Lake

Table 5.13. Class 3.5 waters for westslope cutthroat trout.

Class 3.5 Westslope Cutthroat Trout Waters	
Stillwater River Streams	
Evers Creek	Stillwater River Valley C
Good Creek 3	Stillwater River Valley D
Logan Creek 1	Stillwater River Valley F
Stillwater River 2	Porcupine
Flathead Lake Streams	
Boulder Creek	Stoner Creek
Flathead Lake Lakes	
Echo Lake	
Lower Flathead Streams	
Camas Creek 3	Little Biterroot River 3
Camas Prairie Valley	Little Bitterroot River 2
Cromweel Creek	Little Bitterroot Valley
Jocko River 2	Spring Creek 1
Lower Flathead Lakes	
Kicking Horse Reservoir	Pablo Reservoir
Ninepipes Reservoir	

5.2 Terrestrial Systems

5.2.1 Methods

LINKS

For the results of the Terrestrial Biome Assessment (TBA), go to Appendix 73.

Click Here

To help us classify terrestrial subunits according to the degree to which each has been modified and its potential for restoration, Technical Team members[2] from the Kootenai and Flathead Subbasins led by Dr. Mike Panian developed a spreadsheet tool similar to the Aquatic QHA tool. The Terrestrial Biome Assessment (TBA) combines data and the expert knowledge of people intimately familiar with the areas being rated to qualitatively score the degree of impact or change from presettlement conditions. Unlike QHA, TBA is biome-based; the impacts assessed vary by biome and there is one worksheet for each of our target biomes: xeric forest, mesic forest, wetlands, grassland/shrub, and riparian.

TBA is not a model, and it does not result in a detailed assessment of any geographical area. Rather, it is a tool for capturing data and professional opinion about general wildlife habitats and organizing that information in such a way as to show how the current conditions of subunits within a biome and within the subbasin as a whole compare to each other.

[2] Technical Team members included wildlife biologists and GIS professionals from the state of Montana, Forest Service, Canada, Salish and Kootenai Tribes, Kootenai Tribe of Idaho, and US Fish and Wildlife Service.

After the scores were entered, attributes were weighted and scores were normalized to a scale of 1 to 10. This resulted in a relative ranking of areas within each biome and of the biomes themselves based upon habitat condition. Other indices, such as the presence of listed and target species from point location datasets, general and specific KEF indices and other measures from IBIS were then added and weighted to yield a classification or grouping of subunits based on degree of impact or percent of optimum (table 5.14).

5.2.2 Subunit Classifications

Tables 5.15 through 5.19 list the subunits in each of the three groups in the Flathead Subbasin. It should be noted that the Confederated Salish and Kootenai Tribes and Montana Fish, Wildlife & Parks consider all waters, lands, and native species in the subbasin worthy of restoration and protection.

Table 5.14. Protection/restoration classification of terrestrial biome subunits in the Flathead Subbasin.

Terrestrial Classification
Class 1 Subunits **Most intact wildlife habitats; high protection value** **Habitat Scores 60 to 85 Percent of Optimum** These areas are generally the most intact wildlife habitats within a given biome. Because they are the most intact, they typically contain many areas worthy of protection. But because they are only 60 to 85 percent of optimum, they also encompass areas that have a high priority for restoration. **Management Goal:** Protect to keep as intact as possible while restoring areas to enhance the subunit's biological value.
Class 2 Subunits **Moderate degree of degradation; high to moderate protection value** **Habitat Scores 40 to 60 Percent of Optimum** Relative to other subunits in the biome, these subunits have generally been moderately impacted. A given subunit may have areas within it that are worthy of protection, but most are in need of restoration. **Management Goal:** Restore areas to enhance the subunit's biological value while protecting any intact areas that remain.
Class 2.5 Subunits **High restoration priority driven by ESA needs or the needs of species of concern** **Habitat Scores less than 40 Percent of Optimum** Habitats heavily modified by human activity or exclusion of natural disturbances; may contain non-native species and may require significant investments of time and money to be restored, but are restoration priorities because of value to ESA-listed species. **Management Goal:** Manage for protection of listed species, prevent further degradation and restore degraded habitat to extent possible.
Class 3 Subunits **High degree of degradation; low protection value** **Habitat Scores less than 40 Percent of Optimum** These subunits are generally the most impacted or degraded wildlife habitats within a given biome. They may encompass areas that are economically feasible to restore and that should be restored because they are contiguous to adjacent habitats that are more intact, but generally, they are a lower priority for restoration and protection because of the cost and time required to achieve moderate gains and benefits. **Management Goal:** Prevent further degradation. Restore degraded habitats only when cost effective and clear benefits can be shown.

Table 5.15. Riparian Biome subunit classification.

Riparian Biome **Unit**	**Subunit**	**Percent of Optimum**
Class 1: 60 to 85 Percent of Optimum		
SFFR-wild	All South Fk-Wilderness valley and non-valley riparian	**68%**
MFFR-np	Other Middle Fk-GNP non-valley riparian	**66%**
Mission-val	Other Mission-Wilderness +, non-valley riparian	**66%**
MFFR-wild	All Middle Fk-Wilderness valley and non-valley riparian	**66%**
NFFR-np	All North Fk-GNP valley and non-valley riparian	**65%**
SFFR-for	Other South Fk-USFS non-valley riparian	**65%**
NFFR-cfor	All North Fk-west CFS	**64%**
NFFR-cnp	All North Fk-east CNP	**63%**
LFHR-val	Other Lower Flathead River non-valley riparian	**63%**
NFFR-for	Other North Fk-USFS non-valley riparian	**62%**
LBR-val	Other Lower L. Bitterroot non-valley riparian	**61%**
Swan-for	Other Swan-Wilderness +, non-valley riparian	**60%**
Jocko-val	Other Jocko River watershed non-valley riparian	**60%**
Class 2: 40 to 60 Percent of Optimum		
NFFR-for	North Fk-USFS valley riparian	**59%**
UFHR-val	Other UFHR non-valley riparian	**59%**
Stlwtr-for	All Upper Stillwater valley and non-valley riparian	**58%**
Swan-for	Swan-Wilderness +, upper valley riparian	**57%**
MFFR-np	Middle Fk-GNP valley riparian (Nyak)	**56%**
SFFR-for	Other South Fk-USFS valley riparian, above Hungry Horse Dam	**56%**
Mission-val	Crow Ck watershed, valley riparian	**56%**
Stlwtr-val	Other Lower Stillwater/Whitefish non-valley riparian	**54%**
Swan-for	Swan-Wilderness +, lower valley riparian	**53%**
LBR-val	Flathead River valley riparian, Kerr dam to White-earth Ck	**53%**
Jocko-val	Jocko River valley riparian	**52%**
Mission-val	Mission and Post Ck watersheds, valley riparian	**51%**
LBR-for	All Upper L. Bitterroot valley and non-valley riparian	**50%**
Mission-val	Flathead River valley riparian, White-earth Ck to Jocko	**47%**
Stlwtr-val	Lower Stillwater River valley riparian	**46%**
FHL-for	All Flathead Lake valley and non-valley riparian	**45%**
LFHR-val	Lower Flathead River valley riparian, Jocko to confluence	**45%**
LBR-val	Lower L. Bitterroot River valley riparian	**41%**
Class 3: Less than 40 Percent of Optimum		
UFHR-val	Upper Flathead River valley riparian, 3Fks to Columbia Falls	**38%**
Stlwtr-val	Whitefish River valley riparian	**37%**
UFHR-val	Upper Flathead River valley riparian, Columbia Falls to Kalispell	**37%**
UFHR-val	Kalispell valley riparian, Kalispell to Flathead Lk.	**34%**
SFFR-for	South Fk-USFS valley riparian, below Hungry Horse dam	**32%**

Table 5.16. Wetland Biome subunit classification.

Wetland Biome **Unit**	**Subunit**	**Percent of Optimum**
Class 1: 60 to 85 Percent of Optimum		
NFFR-np	All North Fk-GNP valley and non-valley wetlands	**66%**
MFFR-np	All Middle Fk-GNP valley and non-valley wetlands	**66%**
MFFR-wild	All Middle Fk-Wilderness valley and non-valley wetlands	**60%**
NFFR-for	All North Fk- USFS valley and non-valley wetlands	**60%**
Class 2: 40 to 60 Percent of Optimum		
SFFR-wild	All South Fk-Wilderness valley and non-valley wetlands	**57%**
Stlwtr-for	All Upper Stillwater wetlands	**56%**
NFFR-cfor	All North Fk-west CFS	**54%**
NFFR-cnp	All North Fk-east CNP	**54%**
Mission-val	Other Mission-Wilderness + , non-valley wetlands	**54%**
Swan-for	All Swan-Wilderness + , valley and non-valley wetlands	**52%**
LBR-for	All Upper L. Bitterroot valley and non-valley wetlands	**50%**
FHL-for	All wetlands on and around Flathead Lake	**47%**
LFHR-val	All Lower Flathead River wetlands, Jocko to confluence	**45%**
UFHR-val	Other non-valley wetlands in the Kalispell Valley unit	**45%**
Ashley-for	All wetlands in the Ashley Ck watershed	**44%**
SFFR-for	All South Fk-USFS valley and non-valley wetlands	**42%**
UFHR-val	Kalispell Valley wetlands in HUC6 0107, S of Mill Ck	**42%**
Class 3: Less than 40 Percent of Optimum		
Mission-val	Mission Valley and LFHR wetlands, White-earth Ck To Jocko	**39%**
UFHR-val	Kalispell Valley wetlands N of UFHR/ Mill Ck confluence	**35%**
Jocko-val	All Jocko River watershed valley and non-valley wetlands	**35%**
LBR-val	All Lower L. Bitterroot valley and non-valley wetlands	**34%**
Stlwtr-val	All Lower Stillwater/Whitefish valley and non-valley wetlands	**31%**

Table 5.17. Grassland/Shrub Biome subunit classification.

Grassland/Shrub Biome Unit	Subunit	Percent of Optimum
Class 1: 60 to 85 Percent of Optimum		
SFFR-wild	South Fk-Wilderness	**61%**
MFFR-np	Middle Fk-GNP	**61%**
NFFR-np	North Fk-GNP	**60%**
MFFR-wild	Middle Fk-Wilderness	**58%**
Stlwtr-for	Upper Stillwater	**56%**
NFFR-for	North Fk-USFS	**56%**
Class 2: 40 to 60 Percent of Optimum		
SFFR-for	South Fk-USFS	**51%**
LBR-val	Lower L. Bitterroot	**49%**
LFHR-val	Lower Flathead River	**49%**
Swan-for	Swan-Wilderness +	**49%**
Mission-val	Mission-Wilderness +	**47%**
LBR-for	Upper L. Bitterroot	**46%**
Jocko-val	Jocko River watershed	**44%**
FHL-for	Flathead Lake	**43%**
Ashley-for	Ashley Ck watershed	**43%**
Stlwtr-val	Lower Stillwater/Whitefish	**42%**
UFHR-val	Kalispell Valley	**39%**

Table 5.18. Xeric Forest Biome subunit classification.

Xeric Forest Biome Unit	Subunit	Percent of Optimum
Group 2: 40 to 60 Percent of Optimum		
SFFR-wild	South Fk-Wilderness	**59%**
MFFR-np	Middle Fk-GNP	**59%**
NFFR-np	North Fk-GNP	**58%**
MFFR-wild	Middle Fk-Wilderness	**58%**
SFFR-for	South Fk-USFS	**54%**
Stlwtr-for	Upper Stillwater	**53%**
Swan-for	Swan-Wilderness +	**52%**
NFFR-for	North Fk-USFS	**51%**
Stlwtr-val	Lower Whitefish/Stillwater	**51%**
Mission-val	Misson-Wilderness +	**50%**
FHL-for	Flathead Lake	**48%**
LBR-val	Lower L. Bitteroot	**47%**
LBR-for	Upper L. Bitterroot	**47%**
LFHR-val	Lower Flathead River	**47%**
Jocko-val	Jocko River watershed	**47%**
UFHR-val	Kalispell Valley	**46%**
Ashley-for	Ashley Ck watershed	**45%**

Table 5.19. Mesic Mixed Conifer Biome subunit classification.

Mesic Mixed Conifer Biome Unit	 Subunit	Percent of Optimum
Class 1: 60 to 85 Percent of Optimum		
NFFR-np	North Fk-GNP	**83%**
SFFR-wild	South Fk-Wilderness	**82%**
MFFR-np	Middle Fk-GNP	**81%**
Mission-val	Mission-Wilderness +	**81%**
MFFR-wild	Middle Fk-Wilderness	**80%**
LFHR-val	Lower Flathead River	**75%**
Jocko-val	Jocko River watershed	**75%**
NFFR-cnp	North Fk-east CNP	**74%**
SFFR-for	South Fk-USFS	**73%**
NFFR-cfor	North Fk-west CFS	**72%**
NFFR-for	North Fk-USFS	**71%**
Swan-for	Swan-Wilderness +	**68%**
LBR-val	Lower L. Bitterroot	**67%**
Stlwtr-for	Upper Stillwater	**66%**
Stlwtr-val	Lower Stillwater/Whitefish	**65%**
LBR-for	Upper L. Bitterroot	**65%**
FHL-for	Flathead Lake	**63%**
UFHR-val	Kalispell Valley	**62%**
Ashley-for	Ashley Ck watershed	**60%**

6 Interpretation and Synthesis

6.1 Key Findings

In this phase of the assessment the findings from the HUC-6 and HUC-4 evaluations and the biome, community, and single-species assessments are brought together to form a more holistic view of the subbasin's biological and environmental resources. 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.

6.1.1 Status of Subbasin Environment

ICBEMP Ecological Integrity Ratings

In an integrated scientific assessment for ecosystem management in the Interior Columbia Basin, Quigley and others (1996) classified subbasins into forest and rangeland clusters defined by common characteristics and similar current ecological conditions. The variables found most useful to explain and characterize the clusters were used to develop relative integrity estimates (meaning Columbia River subbasins were rated relative to each other). The integrity estimates assumed that high levels of ecological integrity indicate that evolutionary and ecological processes are being maintained, as are functions and processes dependent on multiple ecological domains and evolutionary timeframes and viable populations of native and desired non-native species. These processes and functions were evaluated in a relative sense within the Columbia Basin, so that those areas exhibiting the most elements of a system were rated as high, and those with the fewest elements were rated low. The basic components that went into the ecological integrity rating include the forest, range, and aquatic systems and a hydrologic system that overlays the landscape as a whole. Table 6.1 shows the results of this assessment for the seven watersheds within the Flathead Subbasin. With respect to ecosystem components, forest and aquatic ranked lowest (moderate), hydrology ranked highest. With respect to HUC-4 watersheds, the Lower Flathead, Flathead Lake, and Stillwater watersheds ranked lowest, the South Fork of the Flathead highest. The composite rank for the Flathead Subbasin was 1.9, which is 63 percent of the highest score possible. These assessment scores have value because they provide a general indication of how the integrity of various ecological components of the Flathead Subbasin compare to that of other subbasins in the Columbia River basin.

Aquatic System QHA Scores

Quality of Habitat

As part of this assessment, the Flathead Subbasin Aquatic Technical Team used QHA to evaluate all the 6th-code HUCs in the Montana and Canadian portions

Table 6.1. Interior Columbia Basin Ecosystem Management Project (ICBEMP) Integrity ratings for watersheds within the Flathead Subbasin.

Watershed	Forest	Aquatic	Hydrology	Watershed Composite
Swan	Low (1)	Moderate (2)	High (3)	**Moderate (2)**
North Fork Flathead	High (3)	Moderate (2)	High (3)	**High (2.7)**
Middle Fork Flathead	High (3)	Moderate (2)	High (3)	**High (2.7)**
South Fork Flathead	High (3)	High (3)	High (3)	**High (3)**
Stillwater	Low (1)	Low (1)	Moderate (2)	**Low (1.3)**
Flathead Lake	Low (1)	Low (1)	Moderate (2)	**Low (1.3)**
Lower Flathead	Low (1)	Low (1)	Low (1)	**Low (1)**
Biome Composite	**Moderate (1.8)**	**Moderate (1.7)**	**Moderate (2.4)**	**Moderate (1.9)**

Forest Integrity: *Measures of forest integrity include such elements as: (1) consistency of tree stocking levels with long-term disturbances typical for the forest vegetation present; (2) the amount and distribution of non-native species; (3) the amount of snags and down woody material present; (4) disruptions to the hydrologic regimes; (5) the absence or presence of wildfire and its effect on the composition and patterns of forest types; and, (6) changes in fire severity and frequency from historical (early 1800s) to the present.*
Aquatic Integrity: *An aquatic system that exhibits high integrity has a mosaic of well-connected, high-quality water and habitats that support a diverse assemblage of native and desired non-native species, the full expression of potential life histories and dispersal mechanisms, and the genetic diversity necessary for long-term persistence and adaptation in a variable environment. This definition is consistent with, and driven by, the goal to sustain biotic diversity and maintain ecological processes. Subbasins exhibiting the greatest level of these characteristics were rated high, those exhibiting the least were rated low, with medium ratings in between.*
Hydrologic Integrity: *Measures of hydrologic integrity include such elements as: (1) disturbance to water flow; (2) bare soil and disturbances to soil structure; (3) riparian vegetation; (4) sensitivity of stream banks and hill slopes to disturbance; (5) cycling of nutrients, energy, and chemicals; (6) surface and sub-surface flows; (7) stream-specific measurements such as gradient, stream bed substrate, full bank width, and depth; and, (8) recovery potential following disturbance.*

LINKS

Appendix 26 is the QHA and LQHA spreadsheet files.

Click Here

Appendix 62, the QHA User's Guide has background information on the QHA spreadsheet tool.

Click Here

of the Flathead Subbasin[1] on the basis of eleven habitat attributes for streams and thirteen habitat attributes for lakes. The attributes used in QHA are generally thought to be the main habitat drivers of resident salmonid production and sustainability in streams (Parkin and McConnaha 2003). Tables 6.2 and 6.3 give the average, subbasin-wide scores for the eleven stream attributes (for tributaries and the regulated mainstem) and thirteen lake/reservoir attributes (for reservoirs), respectively. Unlike the habitat-attribute ranking used to determine limiting factors, these scores are independent of the lifestage weight and do not take into consideration how a specific focal species uses the habitat. They simply represent the current condition of the habitat relative to the normative or reference condition on a scale of 0 to 4 (where 0 = 0% of normative; 1 = 25% of normative; 2 = 50% of normative; 3 = 75% of normative; and 4 = 100% of normative). Normative

[1] In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portion of the subbasin, time limitations prevented the use of 6th-code HUCs. Instead, the Canadian members of the team used analogous watersheds developed during a previous watershed restoration planning exercise in B.C.

Table 6.2. Average scores for eleven stream-habitat attributes[1] for tributaries and the regulated mainstem.

	Tributaries		Regulated Mainstem	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**
Channel stability	2.97	8	3.00	4
Fine Sediment	3.11	6	2.50	6
Habitat Diversity	3.27	5	1.67	8
High Flow	3.59	3	2.33	7
High Temperature	3.56	3	2.67	5
Low Flow	3.46	4	2.67	5
Low Temperature	3.87	1	3.67	2
Obstructions	3.04	7	4.00	1
Oxygen	3.87	1	4.00	1
Pollutants	3.80	2	3.50	3
Riparian Condition	2.97	8	0.83	9
Average Score	3.41		2.80	
% of Optimum	85%		70%	

[1]*Attribute definitions are given in table 4.9.*

conditions are defined as ideal conditions for a similar stream in this ecological province. The scores provide an indication of the subbasin's aquatic habitat's ability to provide the key ecological correlates for resident salmonids in general. It should be noted, however, that these rankings have been generalized for the subbasin. Rankings for individual 6th-code HUCs may vary.

For tributaries, the average of the eleven habitat attribute scores gives an overall score for subbasin aquatic stream habitat of 3.4, which means that based on the QHA habitat assessment and with equal weight assigned to each attribute, overall the subbasin is currently operating at about 85 percent of optimum. For the regulated mainstem, the average score is 2.8 or 70 percent of optimum. The tributary score is considerably higher than the ICBEMP rating, but the ICBEMP rating included non-habitat attributes such as genetic purity and the presence of nonnatives, whereas QHA looked only at habitat. The habitat attributes currently functioning at the lowest levels in tributaries are channel stability and riparian condition, followed by obstructions and fine sediment. These rankings are generalized for 4th-code HUCs; rankings for individual 6th-code HUCs may vary. In the regulated mainstem, the attributes currently functioning at the lowest levels are riparian condition, habitat diversity, flows (the hydrograph), and fine sediment.

Our QHA analysis also revealed that HUC-4 watersheds are operating at quite different levels (table 6.4). The Lower Flathead watershed, for example, is

Table 6.3. Average scores for thirteen habitat attributes[1] in selected subbasin lakes and reservoirs.

	Lakes		Reservoirs	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**
Entrainment	4.00	1	3.67	3
Gas saturation	4.00	1	4.00	1
Habitat diversity	3.97	2	2.50	7
Hydaulic regime	3.90	3	2.33	8
Macrophytes	4.00	1	2.67	6
Migratory obstruction	3.53	6	3.33	4
Oxygen	3.87	4	3.83	2
Pollutants	3.53	6	3.67	3
Shoreline condition	3.43	7	1.83	9
Substrate condition	4.00	1	3.67	3
Temperature	4.00	1	4.00	1
Trophic status	3.83	5	3.83	2
Volumetric turnover rates	4.00	1	3.17	5
Average Score	3.85		3.27	
% of Optimum	96%		82%	

[1]*Attribute definitions are given in table 4.10.*

operating at just 65 percent of optimum, the Stillwater River watershed at 75 percent of optimum, and the Flathead Lake watershed at 78 percent of optimum.

For lakes, the average of the thirteen attribute scores (without consideration to how they are used by any given focal species) gives an overall score of 3.85, which means that based on the LQHA assessment, overall the subbasin aquatic lake habitat is currently operating at about 96 percent of optimum. The overall score for reservoirs is 3.27, which is 82 percent of optimum. Again, QHA looks only at habitat. Based on the QHA scoring, the habitat attributes currently functioning at the lowest levels in reservoirs are shoreline condition, hydraulic regime, habitat diversity, and macrophytes. In lakes, all habitat attributes scored relatively high.

Threat Posed by Non-natives

The other chief factor in the subbasin environment that affects the biological performance of focal species is the presence of nonnative species.

The draft Bull Trout Recovery Plan states that "of all the threats to bull trout recovery, the expanding presence of nonnative species may prove to be the most intractable. While the status of stream habitat for bull trout in many watersheds throughout the Recovery Unit has had an improving trend, the effects of non-native species introductions, particularly in large lakes, may permanently reduce the capacity of these waters to support bull trout. In particular, expansion of congeneric lake trout and brook trout is of greatest concern for bull trout recovery in the Clark Fork Recovery Unit [of which the Flathead Subbasin is a

Table 6.4. Average attribute scores for the regulated mainstem and for each HUC-4 watershed.

	Regulated Mainstem		NF Flathead		MF Flathead		SF Flathead		Swan River		L. Flathead		Flathead LK.		Stillwater R.	
Attribute	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Channel stability	3.00	4	3.03	9	2.90	8	3.65	6	3.37	7	2.21	9	3.00	7	2.45	9
Fine sediment	2.50	6	3.30	7	3.80	5	3.78	5	3.26	8	2.21	9	2.80	9	2.07	11
Habitat Diversity	1.67	8	3.28	8	3.66	6	3.93	4	3.61	6	2.26	8	3.13	4	2.66	8
High Flow	2.33	7	3.67	3	4.00	1	3.95	3	3.76	4	2.74	5	3.56	2	3.21	5
High Temperature	2.67	5	3.72	2	3.98	2	3.95	3	3.74	5	3.07	4	3.06	6	3.02	7
Low Flow	2.67	5	3.47	5	3.88	3	3.95	3	3.79	3	2.57	6	3.00	7	3.36	3
Low Temperature	3.67	2	4.00	1	4.00	1	3.98	2	4.00	1	3.45	3	3.65	1	4.00	1
Obstructions	4.00	1	3.50	4	3.46	7	3.01	8	2.97	10	2.52	7	2.83	8	3.12	6
Oxygen	4.00	1	4.00	1	4.00	1	4.00	1	4.00	1	3.77	2	3.46	3	3.75	2
Pollutants	3.50	3	4.00	1	4.00	1	4.00	1	3.87	2	3.89	1	3.11	5	3.32	4
Riparian Condition	0.83	9	3.34	6	3.83	4	3.57	7	3.21	9	1.54	10	2.70	10	2.13	10
Average Score	2.80		3.57		3.77		3.80		3.60		2.75		3.12		3.01	
% of Optimum	70%		89%		94%		95%		90%		69%		78%		75%	

part].” Our analysis showed brook trout are present in 29 percent of bull trout HUC-6 watersheds. Lake trout, which are a major competitor for bull trout, and the impacts of which can be further exacerbated as a result of the presence of introduced lake whitefish and *Mysis* shrimp, are present in approximately another 32 percent of the watersheds. Northern pike and brown trout pose a threat to bull trout in 11 and 3 percent, of watersheds. All together, we found that the known threat from non-native species is high in 53 of the 119 bull trout watersheds, moderate in 11, and low in 55. So with respect to non-native species, our QHA analysis showed that subbasin watersheds at the HUC-6 scale are functioning at about 67 percent of optimum for bull trout[2]. In the 15 lakes with bull trout that we assessed using LQHA, we found that the known threat from non-native species is high in 8 lakes, moderate in 2, and low in 5. Hence, the lakes assessed are functioning at about 60 percent of optimum for bull trout.

In their Flathead Lake and River Fisheries Co-Management Plan (2000) MFWP and CSKT conclude that the greatest threat to westslope cutthroat trout persistence in the Flathead Subbasin is hybridization with non-native rainbow trout and Yellowstone cutthroat trout. Brook trout, which compete with westslope cutthroat trout, also pose a serious threat. Our analysis showed that rainbow

[2] *We assigned a score of 1 to watersheds where the threat was high, a score of 2 to those where the threat was moderate, and a score of 3 where the threat was low. The average score was 2.0. If 3 is the optimum, then subbasin streams are functioning at about 67 percent of optimum for bull trout with respect to the threat posed by non-native species.*

LINKS

Appendix 54 is the Status Review Update by Shepard et al. (2003).

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trout are present in 24 percent of westslope cutthroat trout HUC-6 watersheds, and brook trout are present in another 27 percent. In all, non-natives deemed by our technical team to pose a significant threat to westslope cutthroat trout (a list of 12 species and hybrids, which includes rainbow trout and brook trout; see Appendix 26) are present in 51 percent of subbasin HUC-6 watersheds that support westslope cutthroat trout. Our QHA analysis showed that the known threat to westslope cutthroat trout from non-native species is high in 97 of the 191 westlope cutthroat trout watersheds and low in 94. So with respect to non-native species, subbasin watersheds at the HUC-6 scale are functioning at about 66 percent of optimum for westslope cutthroat trout. In the 16 lakes with westslope cutthroat trout that we assessed using LQHA, we found that the known threat from non-native species is high in 11 lakes and low in 5. Hence, with respect to non-natives, the lakes assessed are functioning at about 54 percent of optimum for westslope cutthroat trout.

Shepard and others (2003) report that 48 percent of historically occupied westslope cutthroat trout habitat in the Flathead Subbasin and 74 percent currently occupied habitat has genetically unaltered socks, stocks that are less than 10 percent introgressed, or are suspected to contains stocks that are genetically unaltered. Another 10 percent of historically occupied habitat and 15 percent of currently occupied habitat contains stocks that are potentially unaltered (table 6.5). Based on these numbers, our technical team concludes that from a purely genetics standpoint, westslope cutthroat trout are, at best, operating at about 48 percent to 57 percent of optimum.

Table 6.5. Genetic Status of Westslope Cutthroat Trout by percent of historically and currently occupied habitat (in stream miles) in the Flathead Subbasain. Source: Shepard et al. 2003.

Status	% Historic Distribution (stream miles)	% Current Distribution (stream miles)
Genetically Unaltered	16%	25%
<10% introgressed	6%	10%
Suspected Unaltered	25%	39%
Total (Genetically Unaltered + < 10% introgressed + Suspected Unaltered)	**48%**	**74%**
Potentially Unaltered	10%	15%
Grand Total (Genetically Unaltered + < 10% introgressed + Suspected Unaltered + Potentially Unaltered)	**57%**	**89%**

Terrestrial System TBA Scores

As part of our assessment, the Flathead Subbasin Terrestrial Technical Team used a spreadsheet tool to evaluate units and subunits within target biomes in the Montana and Canadian portions of the Flathead Subbasin. This Terrestrial Biome Assessment (TBA) relies on a combination of data and the expert knowledge of people intimately familiar with the areas being rated. The habitat impact variables used in TBA differ by biome and were selected because they provide a measure of habitat quality for a wide range of species, including target species. Table 6.6 gives the average, subbasin-wide scores (as percentage of an optimum condition) for each biome. Table 6.7 lists biome scores for each subunit as well as the overall subunit scores. The scores provide an indication of habitat quality for terrestrial species in each subunit. Table 6.7 also shows the biomes that occur in each subunit. Figure 6.1 shows graphically how the 4th-code HUCs compare to each other. The average of the subunit scores gives an overall score for the subbasin's terrestrial environment of 55 percent. Based on the TBA scoring, the biome currently functioning at the lowest level is the wetland biome. The biome currently functioning at the highest level is the mesic conifer forest.

LINKS

For the results of the Terrestrial Biome Assessment (TBA), go to Appendix 73.

Click Here

Table 6.6. The TBA scores (as percentage of a optimum condition) for each biome.

Biome	Percent of Optimum
Mesic Coniferous Forest	72%
Riparian	54%
Xeric Forest	51%
Grassland Shrub	50%
Wetland	48%

Table 6.7. TBA Scores as a percent of optimum for Flathead Subunits.

Unit/Subunit	Biome	Percent of Optimum
NFFR-cfor		
All North Fk-west CFS	Wetlands	**54%**
All North Fk-west CFS	Riparian	**64%**
North Fk-west CFS	Mesic mixed conifer	**72%**
All North Fk-east CNP	Wetlands	**54%**
All North Fk-east CNP	Riparian	**63%**
North Fk-east CNP	Mesic mixed conifer	**74%**
Average for Unit		**63%**
NFFR-for		
All North Fk- USFS valley and non-valley wetlands	Wetlands	**60%**
North Fk-USFS valley riparian	Riparian	**59%**
Other North Fk-USFS non-valley riparian	Riparian	**62%**
North Fk-USFS	Grassland/shrub	**56%**
North Fk-USFS	Xeric	**51%**
North Fk-USFS	Mesic mixed conifer	**71%**
Average for Unit		**60%**
NFFR-np		
All North Fk-GNP valley and non-valley wetlands	Wetlands	**66%**
All North Fk-GNP valley and non-valley riparian	Riparian	**65%**
North Fk-GNP	Grassland/shrub	**60%**
North Fk-GNP	Xeric	**58%**
North Fk-GNP	Mesic mixed conifer	**83%**
Average for Unit		**67%**
MFFR-np		
All Middle Fk-GNP valley and non-valley wetlands	Wetlands	**66%**
Middle Fk-GNP valley riparian (Nyak)	Riparian	**56%**
Other Middle Fk-GNP non-valley riparian	Riparian	**66%**
Middle Fk-GNP	Grassland/shrub	**61%**
Middle Fk-GNP	Xeric	**59%**
Middle Fk-GNP	Mesic mixed conifer	**81%**
Average for Unit		**65%**
MFFR-wild		
All Middle Fk-Wilderness valley and non-valley wetlands	Wetlands	**60%**
All Middle Fk-Wilderness valley and non-valley riparian	Riparian	**66%**
Middle Fk-Wilderness	Grassland/shrub	**58%**
Middle Fk-Wilderness	Xeric	**58%**
Middle Fk-Wilderness	Mesic mixed conifer	**80%**
Average for Unit		**64%**

Table 6.7 (cont.). TBA Scores as a percent of optimum for Flathead Subunits.

Unit/Subunit	Biome	Percent of Optimum
Ashley-for		
All Ashley Ck watershed riparian	Riparian	**39%**
All wetlands in the Ashley Ck watershed	Wetlands	**44%**
Ashley Ck watershed	Grassland/shrub	**43%**
Ashley Ck watershed	Xeric	**45%**
Ashley Ck watershed	Mesic mixed conifer	**60%**
Average for Unit		**46%**
FHL-for		
All Flathead Lake valley and non-valley riparian	Riparian	**45%**
Flathead Lake	Xeric	**48%**
Flathead Lake	Grassland/shrub	**43%**
All wetlands on and around Flathead Lake	Wetlands	**47%**
Flathead Lake	Mesic mixed conifer	**63%**
Average for Unit		**49%**
SFFR-for		
All South Fk-USFS valley and non-valley wetlands	Wetlands	**42%**
South Fk-USFS valley riparian, below Hungry Horse dam	Riparian	**32%**
Other South Fk-USFS valley riparian, above Hungry Horse Dam	Riparian	**56%**
Other South Fk-USFS non-valley riparian	Riparian	**65%**
South Fk-USFS	Grassland/shrub	**51%**
South Fk-USFS	Xeric	**54%**
South Fk-USFS	Mesic mixed conifer	**73%**
Average for Unit		**53%**
SFFR-wild		
All South Fk-Wilderness valley and non-valley wetlands	Wetlands	**57%**
All South Fk-Wilderness valley and non-valley riparian	Riparian	**68%**
South Fk-Wilderness	Grassland/shrub	**61%**
South Fk-Wilderness	Xeric	**59%**
South Fk-Wilderness	Mesic mixed conifer	**82%**
Average for Unit		**65%**

Table 6.7 (cont.). TBA Scores as a percent of optimum for Flathead Subunits.

Unit/Subunit	Biome	Percent of Optimum
Stlwtr-for		
All Upper Stillwater wetlands	Wetlands	**56%**
All Upper Stillwater valley and non-valley riparian	Riparian	**58%**
Upper Stillwater	Grassland/shrub	**56%**
Upper Stillwater	Xeric	**53%**
Upper Stillwater	Mesic mixed conifer	**66%**
Average for Unit		**58%**
Stlwtr-val		
All Lower Stillwater/Whitefish valley and non-valley wetlands	Wetlands	**31%**
Whitefish River valley riparian	Riparian	**37%**
Lower Stillwater River valley riparian	Riparian	**46%**
Other Lower Stillwater/Whitefish non-valley riparian	Riparian	**54%**
Lower Stillwater/Whitefish	Grassland/shrub	**42%**
Lower Whitefish/Stillwater	Xeric	**51%**
Lower Stillwater/Whitefish	Mesic mixed conifer	**65%**
Average for Unit		**47%**
UFHR-val		
Kalispell Valley wetlands N of UFHR/ Mill Ck confluence	Wetlands	**35%**
Kalispell Valley wetlands in HUC6 0107, S of Mill Ck	Wetlands	**42%**
Other non-valley wetlands in the Kalispell Valley unit	Wetlands	**45%**
Kalispell valley riparian, Kalispell to Flathead Lk.	Riparian	**34%**
Upper Flathead River valley riparian, Columbia Falls to Kalispell	Riparian	**37%**
Upper Flathead River valley riparian, 3Fks to Columbia Falls	Riparian	**38%**
Other UFHR non-valley riparian	Riparian	**59%**
Kalispell Valley	Grassland/shrub	**39%**
Kalispell Valley	Xeric	**46%**
Kalispell Valley	Mesic mixed conifer	**62%**
Average for Unit		**44%**

Table 6.7 (cont.). TBA Scores as a percent of optimum for Flathead Subunits.

Unit/Subunit	Biome	Percent of Optimum
Swan-for		
All Swan-Wilderness + , valley and non-valley wetlands	Wetlands	**52%**
Swan-Wilderness +, lower valley riparian	Riparian	**53%**
Swan-Wilderness +, upper valley riparian	Riparian	**57%**
Other Swan-Wilderness +, non-valley riparian	Riparian	**60%**
Swan-Wilderness +	Grassland/shrub	**49%**
Swan-Wilderness +	Xeric	**52%**
Swan-Wilderness +	Mesic mixed conifer	**68%**
Average for Unit		**56%**
LBR-for		
All Upper L. Bitterroot valley and non-valley wetlands	Wetlands	**50%**
All Upper L. Bitterroot valley and non-valley riparian	Riparian	**50%**
Upper L. Bitterroot	Xeric	**47%**
Upper L. Bitterroot	Grassland/shrub	**46%**
Upper L. Bitterroot	Mesic mixed conife	**65%**
Average for Unit		**52%**
LBR-val		
All Lower L. Bitterroot valley and non-valley wetlands	Wetlands	**34%**
Lower L. Bitterroot River valley riparian	Riparian	**41%**
Flathead River valley riparian, Kerr dam to White-earth Ck	Riparian	**53%**
Other Lower L. Bitterroot non-valley riparian	Riparian	**61%**
Lower L. Bitteroot	Xeric	**47%**
Lower L. Bitterroot	Grassland/shrub	**49%**
Lower L. Bitterroot	Mesic mixed conifer	**67%**
Average for Unit		**50%**
Mission-val		
Mission Valley and LFHR wetlands, White-earth Ck To Jocko	Wetlands	**39%**
Other Mission-Wilderness + , non-valley wetlands	Wetlands	**54%**
Mission and Post Ck watersheds, valley riparian	Riparian	**51%**

Table 6.7 (cont.). TBA Scores as a percent of optimum for Flathead Subunits.

Unit/Subunit	Biome	Percent of Optimum
Mission-val (cont.)		
Crow Ck watershed, valley riparian	Riparian	**56%**
Other Mission-Wilderness +, non-valley riparian	Riparian	**66%**
Flathead River valley riparian, White-earth Ck to Jocko	Riparian	**47%**
Misson-Wilderness +	Xeric	**50%**
Mission-Wilderness +	Grassland/shrub	**47%**
Mission-Wilderness +	Mesic mixed conifer	**81%**
Average for Unit		**54%**
Jocko-val		
All Jocko River watershed valley and non-valley wetlands	Wetlands	**35%**
Jocko River valley riparian	Riparian	**52%**
Other Jocko River watershed non-valley riparian	Riparian	**60%**
Jocko River watershed	Xeric	**47%**
Jocko River watershed	Grassland/shrub	**44%**
Jocko River watershed	Mesic mixed conifer	**75%**
Average for Unit		**52%**
LFHR-val		
All Lower Flathead River wetlands, Jocko to confluence	Wetlands	**45%**
Other Lower Flathead River non-valley riparian	Riparian	**63%**
Lower Flathead River valley riparian, Jocko to confluence	Riparian	**45%**
Lower Flathead River	Xeric	**47%**
Lower Flathead River	Grassland/shrub	**49%**
Lower Flathead River	Mesic mixed conifer	**75%**
Average for Unit		**54%**

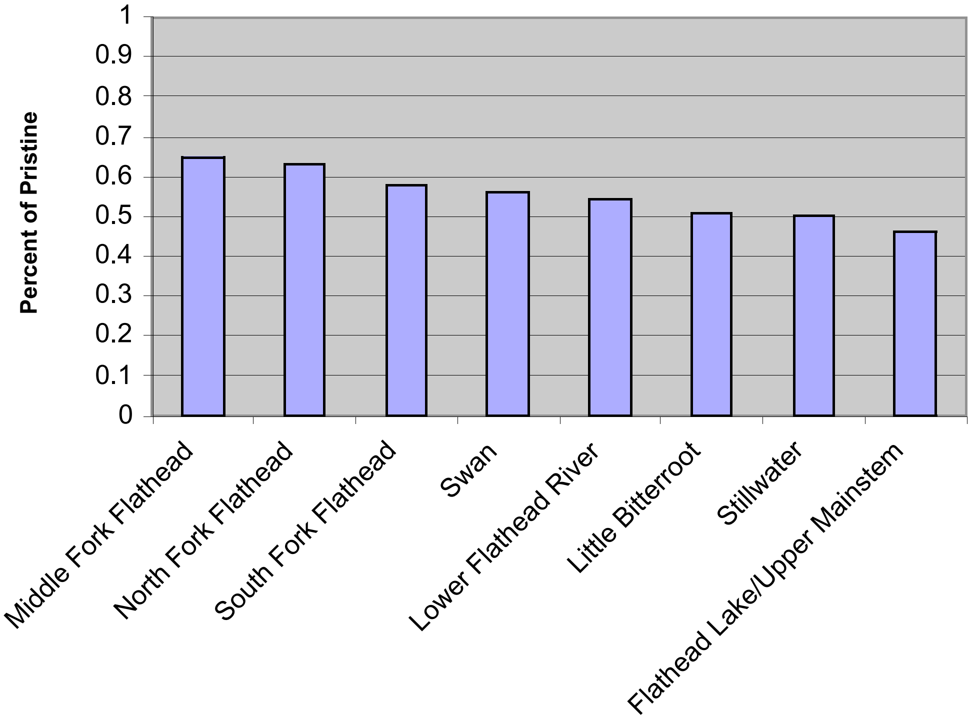

Figure 6.1. TBA 4th-Code HUC ranks for the Flathead Subbasin.

6.1.2 Status of Species

Many wildlife and aquatic species have seen range and population reductions since non-Indian settlement, some drastic. A few well known examples include grizzly bears, wolves, lynx, wolverines, trumpeter swans, leopard frogs, bull trout and westslope cutthroat trout. Appendices 14, 15, and 16 list species of concern within the US portion of the Flathead, the Canadian portion of the Flathead, and the Mountain Columbia Province, respectively.

The Montana Natural Heritage Program uses a number of factors—the number, size, and distribution of known populations, trends (if known), habitat sensitivity, and life history factors that make species especially vulnerable—to assign and rank species of concern. Table 6.8 shows the number of species within the U.S. portion of the Flathead Subbasin (94 percent of the subbasin) that have been assigned to each rank category. Table 6.9 shows the number of species in the Flathead Subbasin in each group by Endangered Species Act status category. Figure 6.2 shows the percent of species at risk per total species for our targeted biomes using several different species of concern indices for US and Canadian portions of the Flathead and Kootenai Subbasins.

There are currently 185 Montana Natural Heritage Program species of concern in the Flathead Subbasin, about three-quarters of which are plants. Of these, 92 are considered critically imperilled, just under 90 percent of that number being plants. Across the Flathead and Kootenai Subbasins, the grassland biome is the biome with the highest occurrence of these species of concern, although the herbaceous wetland

Table 6.8. The number of Montana Heritage Program Species of Concern within the U.S. portion of the Flathead Subbasin.

State Rank[1]	bird	fish	insect	mammal	mollusk	plant	Grand Total
S1		1	3		6	82	92
S1?			1				1
S1S2			2				2
S1S2B	1						1
S1S3			1		1		2
S2		1	2	1		39	43
S2B	5						5
S2S3				1	1	3	5
S3	2			4		7	13
S3B	4						4
S3B,S3N	1						1
S3S4	1						1
SH						7	7
SNR		1					1
SU		1				2	3
SX						1	1
Grand Total	**14**	**4**	**9**	**6**	**8**	**141**	**185**

[1]Rank Definitions:

- S1 — *Critically imperiled because of extreme rarity, or because of some factor of its biology making it especially vulnerable to extirpation.*
- S2 — *Imperiled because of rarity, or because of other factors demonstrably making it very vulnerable to extinction throughout its range.*
- S3 — *Vulnerable because of rarity, or found in a restricted range even though it may be abundant at some of its locations.*
- S4 — *Apparently secure, though it may be quite rare in parts of its range, especially at the periphery.*
- S5 — *Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.*
- S#S# — *When two rankings appear side by side, for example "S2S3", it indicates some uncertainty about the ranking status.*
- SU — *Possibly in peril but status uncertain; more information needed.*
- SH — *Historical, known only from records over 50 years ago; may be rediscovered.*
- SNR — *State not ranked.*
- SX — *Believed to be extinct; historical records only.*
- ? — *Inexact or uncertain.*
- B — *A state rank modifier indicating breeding status for a migratory species. Example: S1B, SZN = breeding occurrences for the species are ranked S1 (critically imperiled) in the state; non-breeding occurrences are not ranked in the state.*

biome has the highest number of species considered in decline, decreasing, or extirpated. It is closely followed by the grassland and riparian/wetland biomes.

Table 6.9. Number of species in the subbasin in each group by Endangered Species Act Status Categories.

ESA Status[1]	bird	fish	mammal	plant	Grand Total
LT		1		2	3
PS			1	1	2
PS:LE	1				1
PS:LE,LT,XN			1		1
PS:LT			1		1
PS:LT,PDL	1				1
PS:LT,XN			1		1
SENSITIVE	5		2	48	55
SPECIAL STATUS	3	1			4
WATCH				7	7
Y:				2	2
Grand Total	**10**	**2**	**6**	**60**	**78**

[1]U. S. Fish And Wildlife Service Endangered Species Act Status

LE Listed endangered.

LT Listed threatened.

PE Proposed endangered.

PT Proposed threatened.

C Candidate: Substantial information exists in U.S. Fish and Wildlife files on biological vulnerability to support proposals to list as threatened or endangered.

NL Not listed or no designation (see below).

XN Non-essential experimental population.

(PS) Indicates "partial status" - status in only a portion of the species' range. Typically indicated in a "full" species record where an infraspecific taxon or population, that has a record in the database, has U.S. ESA status, but the entire species does not.

(PS:value) Indicates "partial status" - status in only a portion of the species' range. The value of that status appears in parentheses because the entity with status is not recognized as a valid taxon by Central Sciences (usually a population defined by geopolitical boundaries or defined administratively, such as experimental populations).

A species can have more than one federal designation if the species' status varies within its range. In these instances, the Montana designation is listed first. Example: LELT = species is listed as endangered in Montana; elsewhere in its range it is listed as threatened.

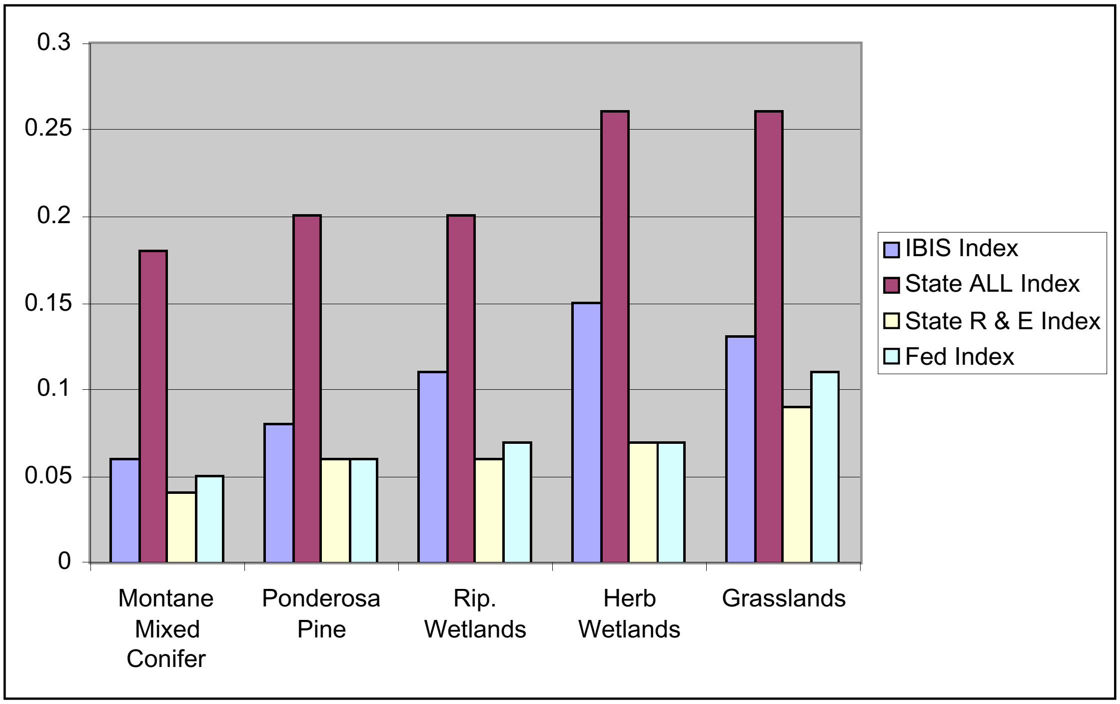

Figure 6.2. The percent of species at risk per total species in targeted biomes in the Flathead and Kootenai Subbasins[1].

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[1] *Total Species: Derived from IBIS-Canada*
IBIS status: *Derived from a column in IBIS-Canada that indicates whether a species is in decline, decreasing extirpated, stable, or increasing. This column is from IBIS-USA and has been edited to be more accurate for Canada.*
State ALL: *From IBIS-USA for the sub basin planning and derived from the Montana and Idaho Natural Heritage programs lists as well as BC's red and blue list designation. Includes Blue and "Species of concern."*
State R and E: *From IBIS-USA for the sub basin planning and derived from the Montana and Idaho Natural Heritage programs lists. Includes only "Red" and Endangered" species.*
Federal: *From IBIS-USA sub basin planning and derived from Federal lists from Canada and the US.*
IBIS Index: *the* ***IBIS status*** *species/total species in IBIS-Canada.*
State All Index: the ***State ALL*** *species/total species in IBIS-Canada.*
Fed_Index: *the* ***Federal*** *species/total species in IBIS-Canada.*

6.1.3 Biological Performance of Focal Species in Relation to the Environment

Bull Trout

Table 6.10 shows the results of a Flathead National Forest baseline assessment of the current condition of bull trout populations in the Flathead, upstream of Flathead Lake (USFS 2000; USFS 2000a; and Gardner 2000). That analysis shows that subpopulation size and growth and survival are both functioning at about 62 percent of optimum. Life history diversity is operating at about 79 percent of optimum, and persistence and genetic integrity at 73 percent of optimum. When all four parameters are considered together with equal weight, bull trout in this part of the subbasin are operating at about 70 percent of optimum[3]. These percentages do not include the populations on the Flathead Indian Reservation, an area with the lowest habitat condition scores. On the Lower Flathead River on the Reservation, bull trout are at very low densities. The Jocko River and Mission Creek are the only tributaries to the Lower Flathead River known to contain bull trout, and the status of those populations is not known.

LINKS

Appendix 43 summarizes the baseline condition for bull trout in bull trout drainages in the upper Flathead (upsteam of Flathead Lake).

Click Here

Westslope Cutthroat Trout

One measure of the status of westslope cutthroat trout is how much of their historical habitat is still occupied by genetically pure populations. Shepard and others (2003) report that genetically unaltered or suspected unaltered populations occupy only 41 percent of historically occupied habitat in the Flathead Subbasin.

For the full biological assessments that produced the baseline reports by Flathead National Forest see Appendices 23, 24, and 25

Click Here

Table 6.10. Biological performance of bull trout subpopulations in the Flathead Subbasin upstream of Flathead Lake.

Performance Measure	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Subpopulation Size	14	1	18
Growth and Survival	14	1	18
Life History Diversity	14	17	1
Persistence and Genetic Integrity	14	12	6

[3] *We assigned a score of 1 to subpopulations that were functioning at an unacceptable risk, a score of 2 to those were functioning at risk, and a score of 3 to those that were functioning appropriately. The composite score for all four parameters is 2.1. If the optimum is 3, the species is functioning at about 69 percent of optimum with respect to these four measures.*

LINKS

Appendix 54 is the Status Review Update by Shepard et al. (2003).

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Shepard and others (2003) also assessed demographic and stochastic population risks for those existing westslope cutthroat trout conservation populations using criteria established by Rieman et al. (1993). All of the conservation populations in the subbasin were rated except for 24 that were located within the Flathead Indian Reservation. Shepard's team considered four separate types of risk: temporal variability, population size, population productivity, and isolation (Appendices 54 and 55). These four main factors were assessed individually and then weighted and summed to derive a final composite risk factor. Weightings were assigned to each risk factor. Weighted composite risk scores ranged from 4 to 16 and were then ranked into four low to high risk categories by placing them in four nearly equal-sized bins (4 to < 7; 7 to < 10; 10 to <13; and 13 to 16) (Shepard et al. 2003).

We averaged these risk scores across all the populations assessed within the Flathead Subbasin and found that when calculated by the number of populations, westslope cutthroat trout isolet populations are operating at 71 percent of optimum with respect to these risk factors (the lowest risk category being the optimum). Metapopulations are operating at about 87 percent of optimum. When calculated by stream miles occupied by each population, we found islotes were operating at about 75 percent of optimum and metapopulations at 82 percent of optimum. These percentages do not include the populations on the Flathead Indian Reservation, an area with the lowest habitat condition scores.

One species that was not selected as a focal species in this assessment, deserves mention. Pygmy whitefish are a relatively uncommon native lacustrine species that we know very little about, but they could be an important indicator species. There is no trend information for the species, but some biologists suspect that this native species has been dramatically affected by all the changing trophic dynamics and species assemblages in Flathead Subbasin lakes. There is also anecdotal evidence that mountain whitefish numbers have also been dramatically reduced (Wade Fredenberg, USFWS, pers. comm. 2004).

6.1.4 Key Factors Impeding Optimal Ecological Functioning and Biological Performance

Aquatic System

Limiting factors vary by species and area. Tables 6.11 and 6.12 list the key factors identified through the use of QHA as the most limiting for aquatic focal species in the Flathead Subbasin. These limiting factors have been generalized for the subbasin and for 4th-code HUCs. Rankings for individual 6th-code HUCs may vary.

Table 6.11. Major habitat-related and biological limiting factors for bull trout in subbasin streams and lakes. Low Flow, High Flow, and Oxygen are attributes that showed up as QHA limiting factors for bull trout in a few 4th-code HUCs, but these are natural watershed conditions that restoration projects cannot effectively address. This analysis is based on our QHA assessment, USFWS (2002), USFS (2000), USFS (2000a), Gardner (2000), and professional knowledge. Limiting factors (habitat attributes) are defined in tables 4.9 and 4.10.

Waterbody Type and Area	Primary Bull Trout Limiting Factors				
Streams	**Habitat-Related**				**Biological**
Subbasin-wide	Channel Stability	Fine Sediment	Riaprian Condition	Habitat Diversity	Non-native Species
Regulated Mainstem	Riparian Condition	Habitat Diversity	Altered Hydrograh	Fine Sediment	Non-native Species
North Fork Flathead	Fine Sediment	Habitat Diversity	Riparian Condition	Channel Stability	Non-native Species
Middle Fork Flathead	Channel Stability	Habitat Diversity	Riparian Condition	Fine Sediment	Non-native Species
South Fork Flathead	Riparian Condition	Channel Stability	Fine Sediment	Habitat Diversity[1]	Non-native Species
Swan River	Riparian Condition	Fine Sediment	Channel Stability	Habitat Diversity	Non-native Species
Stillwater River	Fine Sediment	Channel Stability	Riparian Condition	Habitat Diversity	Non-native Species
Lower Flathead	Riparian Condition	Fine Sediment	Habitat Diversity	Channel Stability	Non-native Species
Reservoirs	**Habitat-Related**				**Biological**
Subbasin-wide	Hydraulic Regime	Migratory Obstr.	Volum. Turnover	Shoreline Condition	Non-native Species

[1]Habitat Diversity and Obstructions score equally in the South Fork QHA analysis.

Table 6.12. Major habitat-related and biological limiting factors for westslope cutthroat trout in subbasin streams and and lakes. Low Flow, High Flow, and Oxygen are attributes that showed up as QHA limiting factors for westslope cutthroat trout in a few 4th-code HUCs, but these are natural watershed conditions that restoration projects cannot effectively address. This analysis is based on our QHA assessment, USFWS (2002), USFS (2000), USFS (2000a), Gardner (2000), USFWS (1999) and Shepard and others (2003), and professional knowledge. Limiting factors (habitat attributes) are defined in tables 4.9 and 4.10.

Waterbody Type and Area	Primary Westslope Cutthroat Trout Limiting Factors				
Streams	**Habitat-Related**				**Biological**
Subbasin-wide	Riparian Condition	Channel Stability	Habitat Diversity	Fine Sediment	Non-native Spp & Introgression
Regulated Mainstem	Riparian Condition	Habitat Diversity	Altered Hydrograh	Fine Sediment	Non-native Spp & Introgression
North Fork Flathead	Habitat Diversity	Riparian Condition	Fine Sediment	Channel Stability	Non-native Spp & Introgression
Middle Fork Flathead	Channel Stability	Habitat Diversity	Riparian Condition	Fine Sediment	Non-native Spp & Introgression
South Fork Flathead	Riparian Condition	Channel Stability	Fine Sediment	Habitat Diversity	Non-native Spp & Introgression
Swan River	Riparian Condition	Fine Sediment	Channel Stability	Habitat Diversity	Non-native Spp & Introgression
Stillwater River	Riparian Condition	Fine Sediment	Channel Stability	Habitat Diversity	Non-native Spp & Introgression
Flathead Lake	Riparian Condition	Channel Stability	Habitat Diversity	Fine Sediment	Non-native Spp & Introgression
Lower Flathead	Riparian Condition	Habitat Diversity	Channel Stability	Fine Sediment	Non-native Spp & Introgression
Reservoirs	**Habitat-Related**				**Biological**
Subbasin-wide	Shoreline Condition	Hydraulic Regime	Habitat Diversity	Macrophytes	Non-native Spp & Introgression

Terrestrial System

As with the aquatic biome, terrestrial-biome limiting factors vary by species and biome. Because we considered a large number of species in our terrestrial assessment, we identified the human impacts that are inhibiting populations of target species and ecological processes and functions. Those are listed in table 6.13 (not necessarily in order of importance). These impacts have been generalized for the entire subbasin. The primary impacts within individual subunits may vary.

Table 6.13. Human impacts that are inhibiting populations of target species and major terrestrial ecological processes and functions.

Regulated Mainstem					
Riparian	Altered Hydrograph				
Wetland	Altered Hydrograph				
Rest of the Subbasin					
Mesic Forest	Fire Exclusion	Forest Management	Roads	Non-native Species	
Grassland/Shrub	Forest Encroachment	Land Conversion	Non-native Species	Overgrazing	
Riparian	Land Conversion	Altered Hydrograph	Human/wildlife Conflicts	Non-native Species	Altered Vegetation
Wetland	Land Conversion	Forest Management	Human/wildlife Conflicts	Non-native Species	Altered Hydrograph
Xeric Forest	Fire Exclusion	Encroachment	Forest Fragmentation	Human/wildlife Conflicts	

** Forest management in this context is defined as negative impacts on target wildlife species stemming from forest management practices that cause changes in thermal cover, hiding cover, large snag density, down woody debris, early seral forage habitat, and the level of habitat fragmentation. Note that changes in any one of these parameters may be negative or positive, depending on the wildlife species at issue.*

6.2 Subbasin Working Hypothesis

6.2.1 Aquatic System

For the aquatic system at the subbasin scale, we developed the following four-part working hypothesis:

1. The presence of non-native species and introgression are the primary factors limiting productivity of focal species on a subbasin scale.[4]

2. On a subbasin scale, the primary habitat factors limiting focal species in the regulated mainstem are riparian condition, habitat diversity, altered hydrograph, and fine sediment.[5]

3. On a subbasin scale, the primary habitat factors limiting focal species in tributaries are: riparian condition, fine sediment, channel stability, and habitat diversity.[5]

4. When considered on a subbasin scale, the primary habitat factors limiting focal species in reservoirs are hydraulic regime, shoreline condition, migratory obstructions, volumetric turnover rates, habitat diversity, and macrophytes.

These hypotheses are based on our QHA spreadsheet analysis, CSKT and MFWP (2000), USFWS (2002), USFWS (1999), other published reports and studies, and professional knowledge. With regard to the determination of habitat factors, we assumed different habitat attributes and life stages should carry different weights. Those stream-habitat assumptions for bull trout and westslope cutthroat trout are shown in table 6.14. Lake-habitat assumptions are shown in table 6.15.

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[4] *The draft Bull Trout Recovery Plan states that "of all the threats to bull trout recovery, the expanding presence of nonnative species may prove to be the most intractable. While the status of stream habitat for bull trout … has had an improving trend, the effects of nonnative species introductions, particularly in large lakes, may permanently reduce the capacity of these waters to support bull trout. From USFWS (1999): "Nonnative fishes … probably constitute the greatest contemporary threat to the maintenance and restoration of westslope cutthroat trout in the [Flathead] drainage." In their Flathead Lake and River Fisheries Co-Management Plan (2000) MFWP and CSKT (2000) concluded the greatest threat to westslope cutthroat trout persistence in the Flathead Subbasin is hybridization with nonnative rainbow trout and Yellowstone cutthroat trout.*

[5] *See the description of QHA results in the section on aquatic focal species.*

Table 6.14. Assumptions made with respect to bull trout and westslope cutthroat trout and their use of stream habitats. These took the form of weights assigned to different life stages and habitat attributes. Life stage weights range between 1 and 3, habitat attribute weights between 1 and 2.

Stream habitat utilization life stages	Life Stage Weight (1-3)	Riparian Condition	Channel Stability	Habitat Diversity	Fine Sediment	High Flow	Low Flow	Oxygen	Low Temp	High Temp	Pollu-tants	Obstructions
Bull Trout												
Spawning and incubation	3	1.0	2.0	1.0	2.0	2.0	2.0	2.0	0.5	2.0	2.0	0.0
Rearing (growth and feeding)	3	2.0	2.0	2.0	2.0	1.0	2.0	2.0	0.0	2.0	2.0	1.0
Migration	2	0.5	0.5	0.5	0.5	0.5	2.0	2.0	0.0	2.0	2.0	2.0
Westslope Cutthroat Trout												
Spawning and incubation	3	2.0	2.0	2.0	2.0	1.5	2.0	2.0	0.0	1.0	2.0	0.0
Rearing (growth and feeding)	3	2.0	2.0	2.0	2.0	1.5	1.0	2.0	2.0	2.0	2.0	1.5
Migration	1	0.5	0.5	1.0	0.0	0.5	2.0	2.0	0.0	1.0	2.0	2.0

Life stage weights were assigned on the basis of the duration of the life stage and its potential vulnerability to physical habitat conditions for the focal species.

Attribute weights rank the importance the Technical Team ascribed to the attribute with regard to the life stage of the focal species.

Table 6.15. Assumptions made with respect to bull trout and westslope cutthroat trout and their use of lake habitats. These took the form of weights assigned to different life stages and habitat attributes. Life stage weights range between 1 and 3, habitat attribute weights between 1 and 2.

Stream habitat utilization life stages	Life Stage Weight (1-3)	Temperature	Oxygen	Gas saturation	Volumetric turnover rates	Pollutants	Trophic status	Entrainment	Migratory obstruction	Macrophytes	Hydraulic regime	Shoreline condition	Habitat diversity	Substrate condition
Bull Trout														
Spawning and incubation	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Young of the Year	1	2.0	2.0	2.0	0.0	1.0	1.5	2.0	0.0	0.0	2.0	2.0	2.0	2.0
Juvenile	4	2.0	2.0	1.0	1.5	1.0	2.0	2.0	2.0	0.0	1.0	0.5	0.5	0.5
Adult	4	2.0	2.0	0.5	1.5	1.5	2.0	1.5	2.0	0.0	1.0	0.5	0.5	0.5
Westslope Cutthroat Trout														
Spawning and incubation	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Young of the Year	1	2.0	2.0	2.0	0.0	1.0	1.5	2.0	0.0	1.0	2.0	2.0	2.0	2.0
Juvenile	4	2.0	2.0	1.0	1.5	1.0	2.0	2.0	2.0	1.0	2.0	2.0	1.0	1.0
Adult	4	2.0	2.0	0.5	1.5	1.5	2.0	1.5	2.0	1.0	2.0	2.0	1.0	1.0

6.2.2 Terrestrial System

For the terrestrial system at the subbasin scale, we have developed the following working hypotheses:

1. On a subbasin scale, the chief impacts limiting wildlife populations in the Mesic Forest Biome are fire exclusion, forest management, roads, and non-native species (noxious weeds). (Forest management in the context of this section is defined as the negative impacts on target wildlife species stemming from forest management practices that cause changes to thermal cover, hiding cover, large snag density, down woody debris, early seral forage habitat, and the level of habitat fragmentation. Note that changes in any one of these parameters may be negative or positive, depending on the wildlife species at issue.

2. On a subbasin scale, the chief impacts limiting wildlife populations in the Grassland/Shrub Biome are forest encroachment, land conversion, non-native species, and overgrazing.

3. On a subbasin scale, the chief impacts limiting wildlife populations in the Riparian Biome are land conversion, altered hydrographs, human-wildlife conflicts, non-native species and altered vegetation.

4. On the regulated mainstem, the chief impact limiting wildlife populations in the Riparian Biome is an altered hydrograph.

5. On a subbasin scale, the chief impacts limiting wildlife populations in the Wetland Biome are land conversion, forest management, human-wildlife conflicts, non-native species, and altered hydrographs.

6. On the regulated mainstem, the chief impact limiting wildlife populations in the Wetland Biome is an altered hydrograph.

7. On a subbasin scale, the chief limiting factors limiting wildlife populations in the Xeric (Ponderosa Pine) Forest Biome, are fire exclusion, encroachment, forest fragmentation, and human-wildlife conflicts.

These hypotheses are based on our TBA spreadsheet analysis and various published and unpublished reports and studies, and professional knowledge.

6.3 Reference Conditions

6.3.1 Aquatic and Terrestial

Focal and target species populations have not been modeled on a subbasin scale for the various reference conditions referenced in the assessment outline presented in the Technical Guide for Subbasin Planners (NWPCC 2001). Consequently, the Technical Team could not make quantitative estimates. Instead, we made qualitative estimates based upon the results of this assessment, and these are presented in table 6.16 along with a measure of the confidence the team has in each of the predictions.

Table 6.16. Estimate of species abundance and productivity under various reference conditions (current, potential, and future/no new action)[1].

Species	Bull Trout	Westslope Cutthroat Trout	Target Wildlife Species[3]
Relation of Current Populations to Historic Condition	60% of Historic	30% of Historic	50 to 70% of Historic
Estimate of Species Abundance and Productivity under Potential Reference Condition	80 to 90% of Optimum	90% to 95% of Optimum	70 to 80% of Optimum
Estimate of Species Abundance and Productivity under Future/No Action Reference Condition	0 to 20% of Optimum	<20% of Optimum	30 to 50% of Optimum
Confidence of Preditions[2]	1	1	1

[1] *The historic condition refers to the state of the environment at the time of European settlement, or 1850. Potential condition is defined as the desired end state or optimal condition for this subbasin in the year 2050 (similar to the historic condition but it also considers cultural modifications that are not reversible such as urbanization). Future/no new action condition is the state of the environment in 2050 assuming that current trends and current management continues. Optimum abundance and productivity means abundance and productivity of populations at time of European settlement or 1850.*

[2] *Confidence Scores: 0 = Unknown, 1 = Speculative, expert opinion without real data or modeling results, 2 = Expert opinion with some supporting data or modeling results, 3 = Well documented with data or modeling results.*

[3] *Estimates should vary by species, however insufficient data exsists to make predictions of this nature on a species-by-species basis. The estimates presented here are general and a composite reference for all target species based on best professional judgement of our Technical Team.*

6.4 Near-term Opportunities

The following list of near-term opportunities is based on our QHA and TBA results. For aquatic opportunities, we have lumped the Class 1 waters for both focal species to get near-term protection opportunities. Similarly, we lumped all the Class 2 and 2.5 waters for both focal species to get the near-term restoration opportunities. If a body of water occurred in Class 1 for one focal species and Class 2 for another, it was grouped here as a Class 2 water.

Maps showing near-term opportunities (Class 1, Class 2, and Class 2.5 aquatic 6th-code HUCs and terrestrial subunits) as well as an overlay of these aquatic and terrestrial protection and restoration areas are presented after the tables.

This list of near-term opportunities does not take into consideration socioeconomic concerns. The Flathead Subbasin Planning Team will use the public review and management planning process to determine which opportunities are socially, economically, and politically feasible. This list does not imply that streams and subunits not listed are not worthy of restoration. The Confederated Salish and Kootenai Tribes and Montana Fish, Wildlife & Parks consider all waters, lands, and native species in the subbasin worthy of restoration and protection.

6.4.1 Aquatic

Class 1 Watersheds

LINKS

Appendix 26 is the QHA and LQHA spreadsheet files.

Click Here

Table 6.17. Class 1 watersheds.

Class 1 Waters	
North Fork Flathead Streams	
Akokala Creek	North Fork Flathead River 3
Anaconda Creek	North Fork Flathead River 4
Bowman Creek	Quartz Creek 1
Camas Creek	Quartz Creek 2
Dutch Creek	Trail Creek
Kintla Creek 1	Upper East Flahead (Canada)
Kintla Creek 2	Upper West Flahead (Canada)
Logging Creek	Whale Creek 1
North Fork Flathead River 2	Yakinikak Creek
North Fork Flathead Lakes	
Quartz	
Middle Fork Flathead Streams	
Bowl Creek	Middle Fork Flathead River 4
Clack \ Calbick	Middle Fork Flathead River 5
Coal Creek	Middle Fork Flathead River 7
Cox Creek	MIddle Fork Flathead River 8
Dickey Creek	Middle Fork Flathead River 9
Dolly Varden Creek	Morrison Creek
Harrison Creek	Nyack Creek 1
Howe Creek 1	Nyack Creek 2
Howe Creek 2	Ole Creek
Lake Creek	Paola
Lincoln Creek	Park Creek
Long Creek	Schafer Creek
McDonald Creek 2	Strawberry Creek
Middle Fk. FHR Valley 2	Trail Creek 1
Middle Fork Flathead River 3	Twentyfive Mile Creek
South Fork Flathead Streams	
Aeneas Creek	Danaher Creek 2
Babcock Creek	Murray Creek
Bartlett Creek	Rapid Creek
Basin Creek	South Fork Flathead River 1
Big Salmon Creek 1	South Fork Flathead River 2
Big Salmon Creek 2	South Fork Flathead River 3
Black Bear Creek	South Fork Flathead River 4
Bunker Creek	South Fork Flathead River 5
Clayton Creek	South Fork Flathead River 6
Danaher Creek 1	

Class 1 Watersheds (cont.)

Table 6.17 (cont.). Class 1 watersheds.

Class 1 Waters (cont.)	
South Fork Flathead Streams (cont.)	
Dean Creek	South Fork Logan Creek
Doris Creek	South Fork White River
Gordon Creek 1	Spotted Bear River 1
Gordon Creek 2	Tent Creek
Gorge Creek	White River 2
Hollbrook Creek	Youngs Creek 1
Little Salmon Creek	Youngs Creek 2
MidCreek	
South Fork Flathead Lakes	
Big Salmon Lake	
Stillwater River Streams	
Martin Creek	
Swan River Streams	
Elk Creek	Piper Creek
Holland Creek	Swan River 1
Lion Creek	
Lower Flathead Streams	
Crow Creek 1	Post Creek 1
Mud Creek	Post Creek 2

Class 2 Watersheds

Table 6.18. Class 2 and 2.5 watersheds.

Class 2 and 2.5 Waters	
North Fork Flathead Streams	
Big Creek 1	Moose Creek
Big Creek 2	North Fork Flathead River 1
Canyon Creek	Red Meadow Creek
Coal Creek 1	Sage and Kishinena Creeks (Canada)
Coal Creek 2	Shorty Creek
Cyclone Creek	South Fork Coal Creek
Hallowat Creek	Tepee Creek
Hay Creek	Whale Creek 2
Howell Creek (Canada)	
North Fork Flathead Lakes	
Bowman	Logging Lake
Kintla Lake	
Middle Fork Flathead Streams	
McDonald Lk./Middle Fk. FHR Valle	Middle Fk. FHR Valley 1
Granite Creek	Bear Creek
Middle Fork Flathead Lakes	
Lake McDonald	Harrison Lake
South Fork Flathead Streams	
Clark Creek	Spotted Bear River 3
Deadhorse Creek	Wheeler Creek
Sullivan Creek 1	Felix Creek
Silvertip Creek	Emery Creek
Sullivan Creek 2	Hungry Horse Creek
Wounded Buck Creek	Twin Creek
Lower Twin Creek	Spotted Bear River 2
South Fork Flathead River 7	
South Fork Flathead Lakes	
Wildcat	Margaret
Clayton	Sunburst
Blackfoot	Woodward
Black	Necklace lakes (4)
Handkerchief	Lena
Upper 3 Eagles	Lick
Lower 3 Eagles	Koessler
Pilgrim	George
Bighawk	Pyramid
Hungry Horse Reservoir	

Class 2 Watersheds (cont.)

Table 6.18 (cont.). Class 2 and 2.5 watersheds.

Class 2 and 2.5 Waters (cont.)	
Stillwater River Streams	
Good Creek 1	Stillwater River Valley A
Sheppard Creek	Stillwater River Valley B
Swift Creek 2	West Fork Swift Creek
Stillwater River 1	
Swan River Streams	
Lost Creek	Swan River 3
Cedar Creek	Glacier Creek
Goat Creek	Soup Creek
Condon Creek	Jim Creek
Cold Creek	Swan Lake
Swan River Valley	Woodward Creek
Swan River 2	
Swan River Lakes	
Holland Lake	Swan Lake
Lindbergh Lake	
Flathead Lake Streams	
Big Fork	Polson
Dayton Creek	Truman Creek
Ronan Creek	Yellow Bay Creek
Patrick Creek	
Flathead Lake Lakes	
Flathead Lake	
Lower Flathead Streams	
Dry Creek	Mission Creek 1
Finley Creek 1	Mission Valley
Jocko River 1	North Fork Jocko River
Jocko River Valley	Revais Creek
Jocko River Valley	Seepay Creek
Little Bitterroot Lk. Valley	South Fork Jocko River
Magpie Creek	Valley Creek 1
Middle Fork Jocko River	Valley Creek 2
Mill Creek	
Lower Flathead Lakes	
McDonald Reservoir	

HUCs and Lakes that can Serve as Reference Sites for Future Monitoring

As part of the assessment, the NWPCC asked the Technical Team to identify areas within the subbasin and that might serve as reference sites for future monitoring. Table 6.19 presents the streams that can serve as reference sites for bull trout and westslope cutthroat trout in the Flathead Subbasin.

Table 6.19. HUC-6 watersheds and lakes that could serve as reference sites.

Reference Sites for Future Monitoring	
North Fork	**South Fork (cont.)**
North Fork Flathead River 2	South Fork Flathead River 5
Whale Creek	South Fork Flathead River 6
Akokala Creek	Park Creek
Moose Creek	Bear Creek
Trail Creek	Any trib in the Bob Marshall Wilderness
Red Meadow Creek	Youngs Creek 2
Colt Creek	Big Salmon Lake
Sage CreeK	**Swan River**
Kishenehn Creek	Elk Creek
Starvation Creek	Holland Creek
Ford Creek	Lion Creek
Quartz Lake	Swan River 1
Middle Fork	**Lower Flathead**
Challenge Creek	Finley Creek 1
Ole Creek	Mission Creek 1
Long Creek	Mud Creek
McDonald Creek 2	Post Creek 1
Middle Fork Flathead River 3	Post Creek 2
Middle Fork Flathead River 4	Little Meadow Creek
Middle Fork Flathead River 5	**Flathead lake**
Middle Fork Flathead River 7	Elmo
MIddle Fork Flathead River 8	Elmo
Middle Fork Flathead River 9	Flathead Lake Trib 1
South Fork	Flathead River 2
Babcock Creek	Spring Creek
Bent Creek	**Stillwater**
Quintonkin Creek	Stillwater River Valley A
Danaher Creek	Stillwater River Valley C
Rapid Creek	Logan Creek 3
South Fork Flathead River 1	Squaw Meadows Creek
South Fork Flathead River 2	Stillwater River 1
South Fork Flathead River 3	West Fork Swift Creek
South Fork Flathead River 4	

LINKS

For the results of the Terrestrial Biome Assessment (TBA), go to Appendix 73.

Click Here

6.4.2 Terrestrial

Class 1 Subunits (60 to 85 percent of optimum) by Biome

Table 6.20. Class 1 subunits by biome.

Grassland/Shrub Biome	
SFFR-wild	South Fk-Wilderness
MFFR-np	Middle Fk-GNP
NFFR-np	North Fk-GNP
MFFR-wild	Middle Fk-Wilderness
Stlwtr-for	Upper Stillwater
NFFR-for	North Fk-USFS
Mesic Conifer Forest Biome	
NFFR-np	North Fk-GNP
SFFR-wild	South Fk-Wilderness
MFFR-np	Middle Fk-GNP
Mission-val	Mission-Wilderness +
MFFR-wild	Middle Fk-Wilderness
LFHR-val	Lower Flathead River
Jocko-val	Jocko River watershed
NFFR-cnp	North Fk-east CNP
SFFR-for	South Fk-USFS
NFFR-cfor	North Fk-west CFS
NFFR-for	North Fk-USFS
Swan-for	Swan-Wilderness +
LBR-val	Lower L. Bitterroot
Stlwtr-for	Upper Stillwater
Stlwtr-val	Lower Stillwater/Whitefish
LBR-for	Upper L. Bitterroot
FHL-for	Flathead Lake
UFHR-val	Kalispell Valley
Ashley-for	Ashley Ck watershed
Riparian Biome	
SFFR-wild	All South Fk-Wilderness valley and non-valley riparian
MFFR-np	Other Middle Fk-GNP non-valley riparian
Mission-val	Other Mission-Wilderness +, non-valley riparian
MFFR-wild	All Middle Fk-Wilderness valley and non-valley riparian
NFFR-np	All North Fk-GNP valley and non-valley riparian
SFFR-for	Other South Fk-USFS non-valley riparian
NFFR-cfor	All North Fk-west CFS
NFFR-cnp	All North Fk-east CNP
LFHR-val	Other Lower Flathead River non-valley riparian
NFFR-for	Other North Fk-USFS non-valley riparian
LBR-val	Other Lower L. Bitterroot non-valley riparian
Swan-for	Other Swan-Wilderness +, non-valley riparian
Jocko-val	Other Jocko River watershed non-valley riparian
Wetland Biome	
NFFR-np	All North Fk-GNP valley and non-valley wetlands
MFFR-np	All Middle Fk-GNP valley and non-valley wetlands
MFFR-wild	All Middle Fk-Wilderness valley and non-valley wetlands
NFFR-for	All North Fk- USFS valley and non-valley wetlands

Class 2 Subunits (40 to 60 percent of optimum) by Biome

Table 6.21. Class 2 subunits by biome.

Grassland/Shrub Biome	
SFFR-for	South Fk-USFS
LBR-val	Lower L. Bitterroot
LFHR-val	Lower Flathead River
Swan-for	Swan-Wilderness +
Mission-val	Mission-Wilderness +
LBR-for	Upper L. Bitterroot
Jocko-val	Jocko River watershed
FHL-for	Flathead Lake
Ashley-for	Ashley Ck watershed
Stlwtr-val	Lower Stillwater/Whitefish
UFHR-val	Kalispell Valley
Riparian Biome	
NFFR-for	North Fk-USFS valley riparian
UFHR-val	Other UFHR non-valley riparian
Stlwtr-for	All Upper Stillwater valley and non-valley riparian
Swan-for	Swan-Wilderness +, upper valley riparian
MFFR-np	Middle Fk-GNP valley riparian (Nyak)
SFFR-for	Other South Fk-USFS valley riparian, above Hungry Horse
Mission-val	Crow Ck watershed, valley riparian
Stlwtr-val	Other Lower Stillwater/Whitefish non-valley riparian
Swan-for	Swan-Wilderness +, lower valley riparian
LBR-val	Flathead River valley riparian, Kerr dam to White-earth Ck
Jocko-val	Jocko River valley riparian
Mission-val	Mission and Post Ck watersheds, valley riparian
LBR-for	All Upper L. Bitterroot valley and non-valley riparian
Mission-val	Flathead River valley riparian, White-earth Ck to Jocko
Stlwtr-val	Lower Stillwater River valley riparian
FHL-for	All Flathead Lake valley and non-valley riparian
LFHR-val	Lower Flathead River valley riparian, Jocko to confluence
LBR-val	Lower L. Bitterroot River valley riparian
Wetland Biome	
SFFR-wild	All South Fk-Wilderness valley and non-valley wetlands
Stlwtr-for	All Upper Stillwater wetlands
NFFR-cfor	All North Fk-west CFS
NFFR-cnp	All North Fk-east CNP
Mission-val	Other Mission-Wilderness + , non-valley wetlands
Swan-for	All Swan-Wilderness + , valley and non-valley wetlands
LBR-for	All Upper L. Bitterroot valley and non-valley wetlands
FHL-for	All wetlands on and around Flathead Lake
LFHR-val	All Lower Flathead River wetlands, Jocko to confluence
UFHR-val	Other non-valley wetlands in the Kalispell Valley unit
Ashley-for	All wetlands in the Ashley Ck watershed
SFFR-for	All South Fk-USFS valley and non-valley wetlands
UFHR-val	Kalispell Valley wetlands in HUC6 0107, S of Mill Ck

Class 2 Subunits (40 to 60 percent of optimum) by Biome (cont.)

Table 6.21 (cont.). Class 2 subunits by biome.

Xeric Forest Biome	
SFFR-wild	South Fk-Wilderness
MFFR-np	Middle Fk-GNP
NFFR-np	North Fk-GNP
MFFR-wild	Middle Fk-Wilderness
SFFR-for	South Fk-USFS
Stlwtr-for	Upper Stillwater
Swan-for	Swan-Wilderness +
NFFR-for	North Fk-USFS
Stlwtr-val	Lower Whitefish/Stillwater
Mission-val	Misson-Wilderness +
FHL-for	Flathead Lake
LBR-val	Lower L. Bitteroot
LBR-for	Upper L. Bitterroot
LFHR-val	Lower Flathead River
Jocko-val	Jocko River watershed
UFHR-val	Kalispell Valley
Ashley-for	Ashley Ck watershed

6.5 Strategies

The Flathead Subbasin Planning Team developed a list of appropriate strategies for accomplishing objectives as part of the Management Plan. Those strategies are based upon the results of this assessment and suggestions and comments received from the Flathead Subbasin Technical Team, Working Group, and the public.

6.6 Maps Showing Near-term Opportunities

LINKS

For high resolution near-term opportunity maps, go to Appendix 97.

Click Here

The pages that follow present low resolution maps of: (1) aquatic near-term opportunities, (2) terrestrial near-term opportunties, and (3) overlays of aquatic and terrestrial near-term opportunities. For each of the three groups, a subbsin-scale map is followed by a series of seven HUC-4 scale maps (North Fork, Middle Fork, South Fork, Stillwater, Flathead Lake, Swan, Lower Flathaead). These same maps in a higher resolution format are included as Appendix 97.

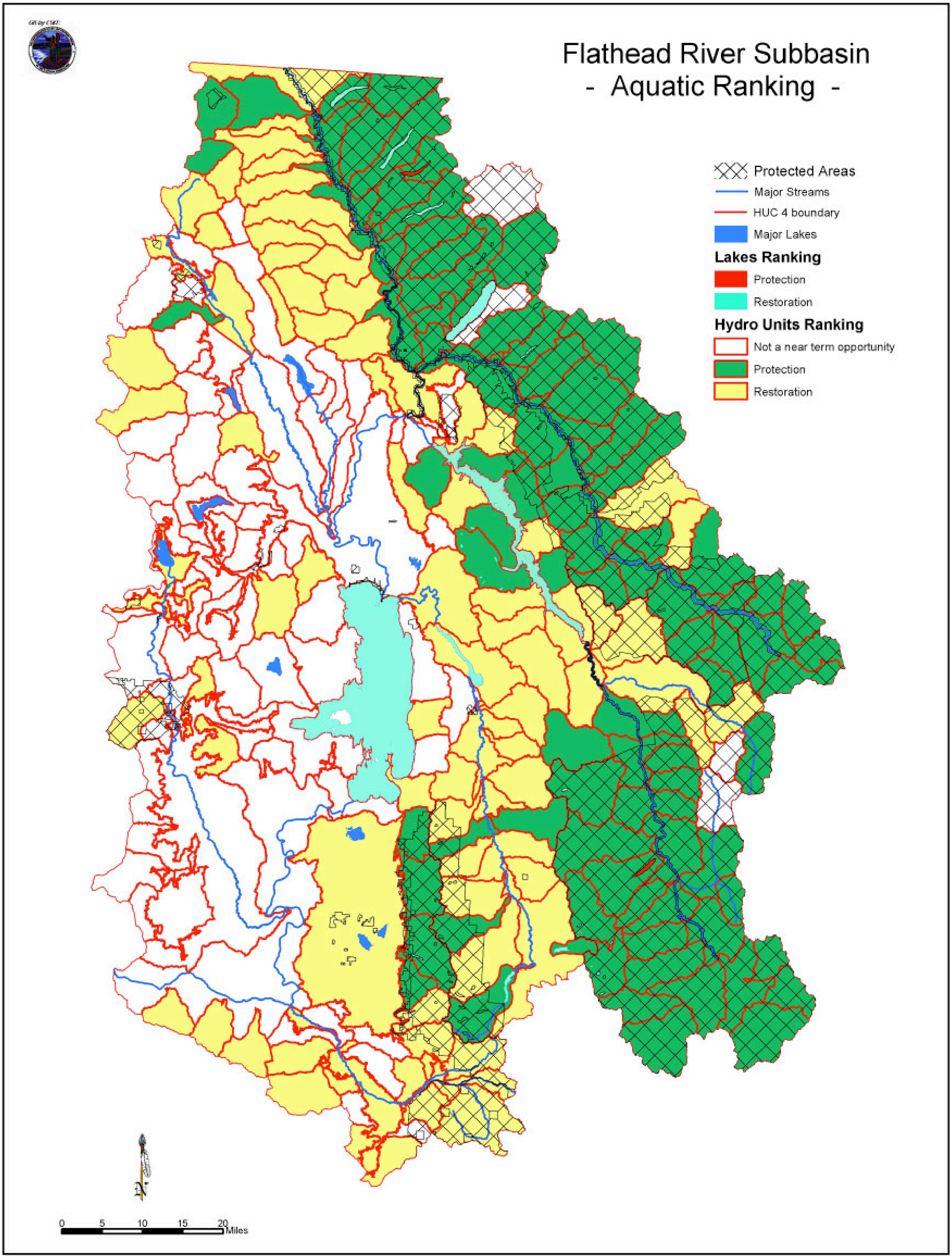

Figure 6.3. Aquatic near-term opportunities in the Flathead Subbasin.

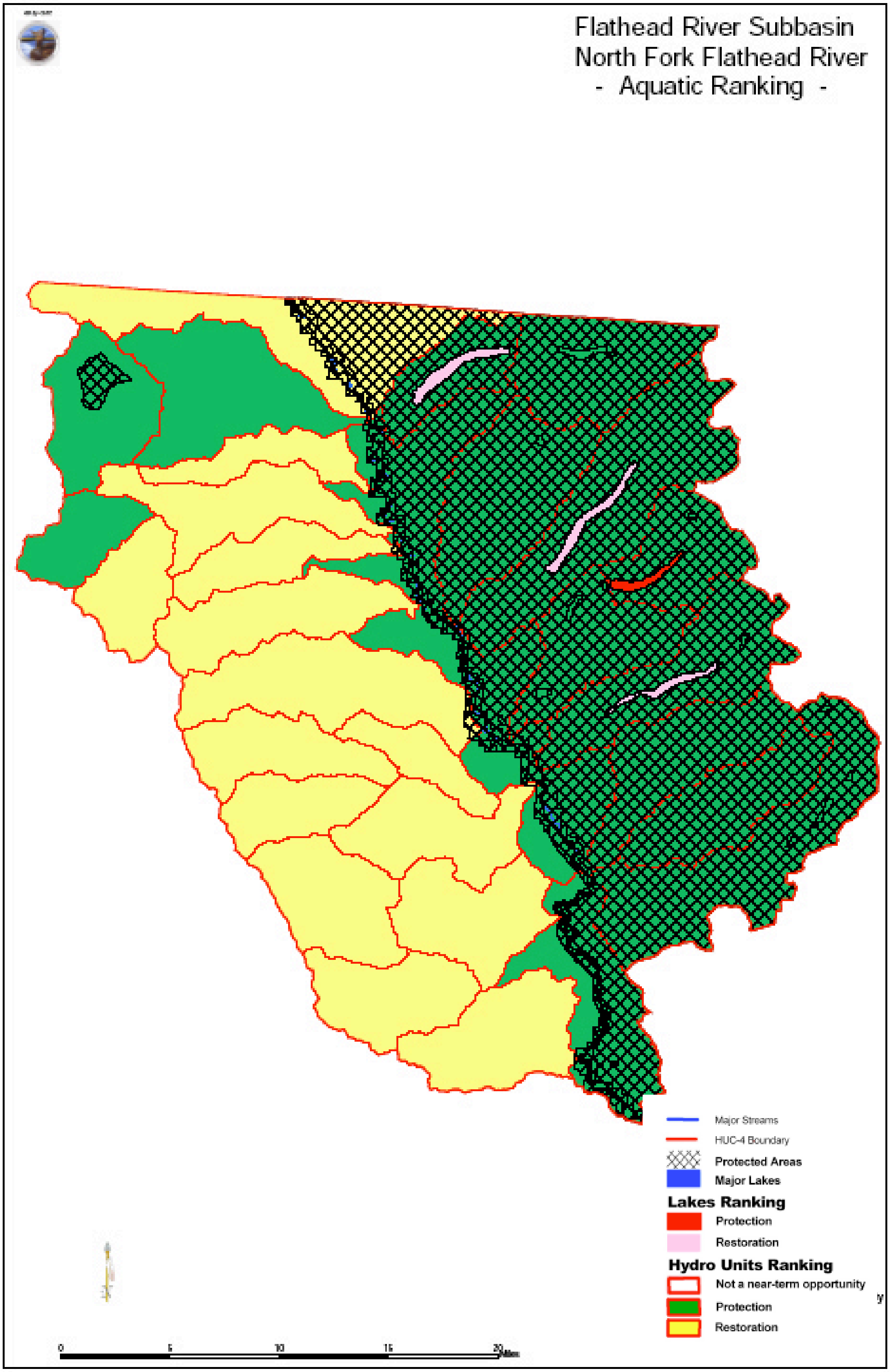

Figure 6.4. Aquatic near-term opportunities in the North Fork of the Flathead.

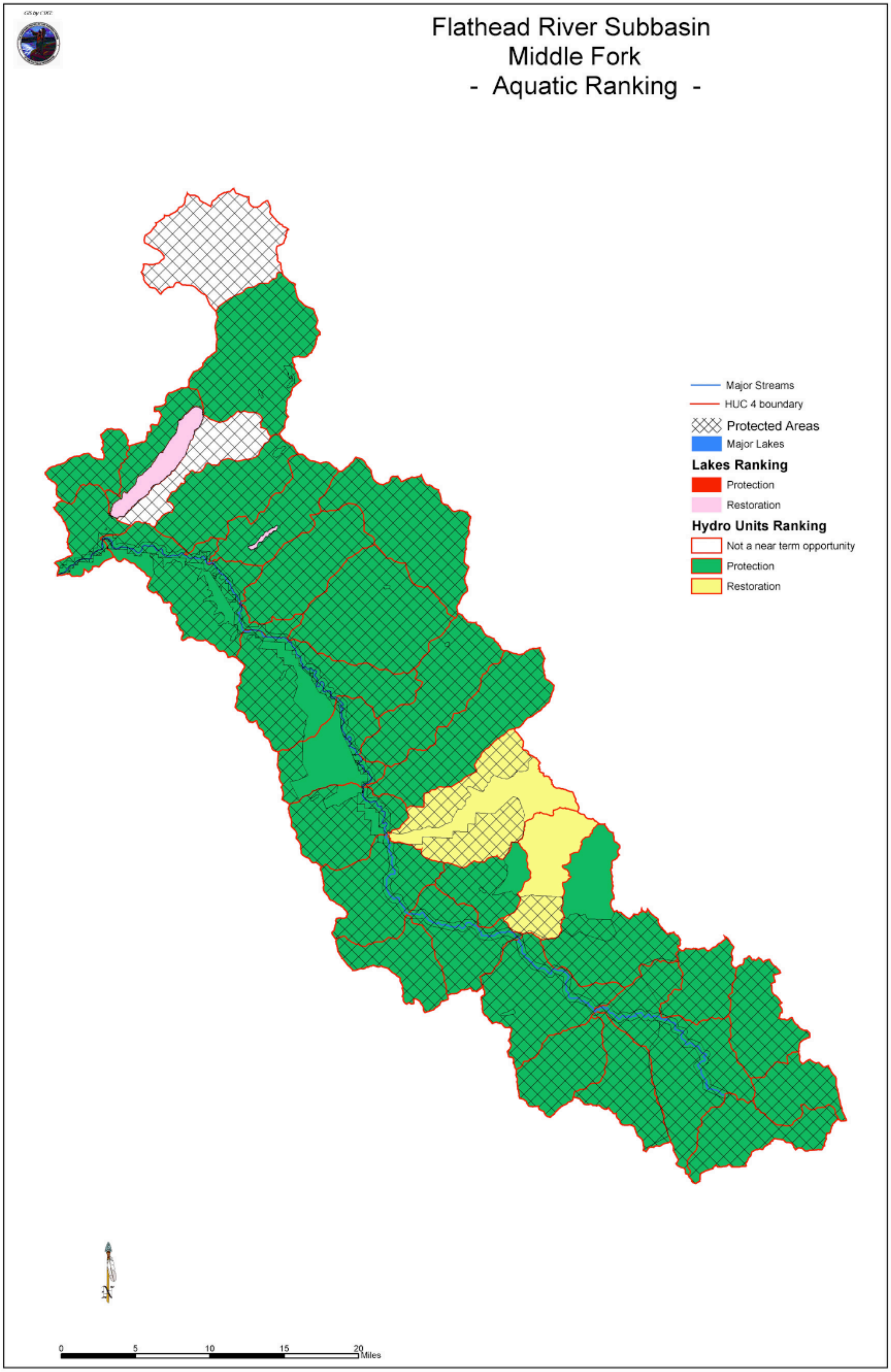

Figure 6.5. Aquatic near-term opportunities in the Middle Fork of the Flathead.

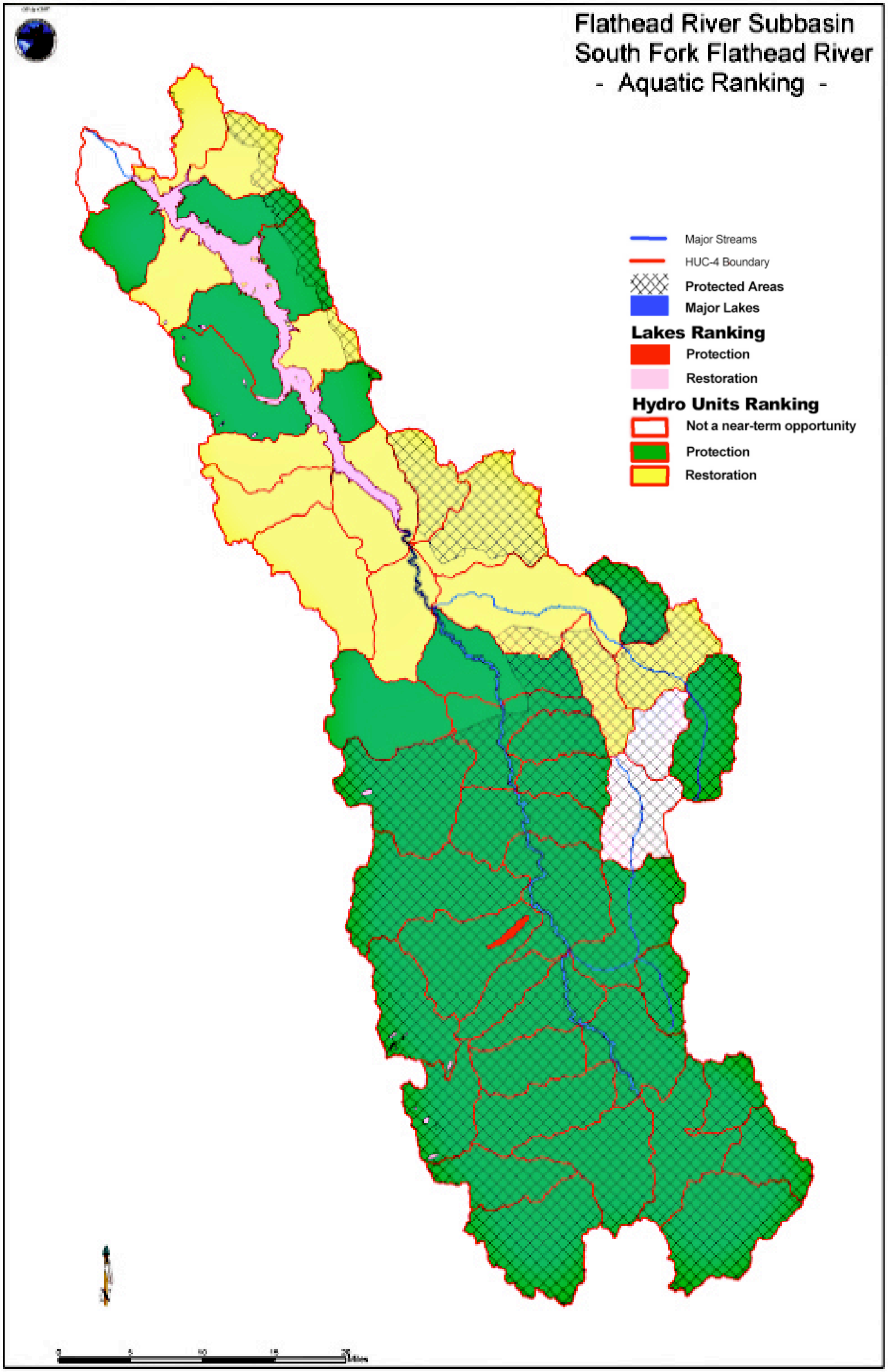

Figure 6.6. Aquatic near-term opportunities in the South Fork of the Flathead.

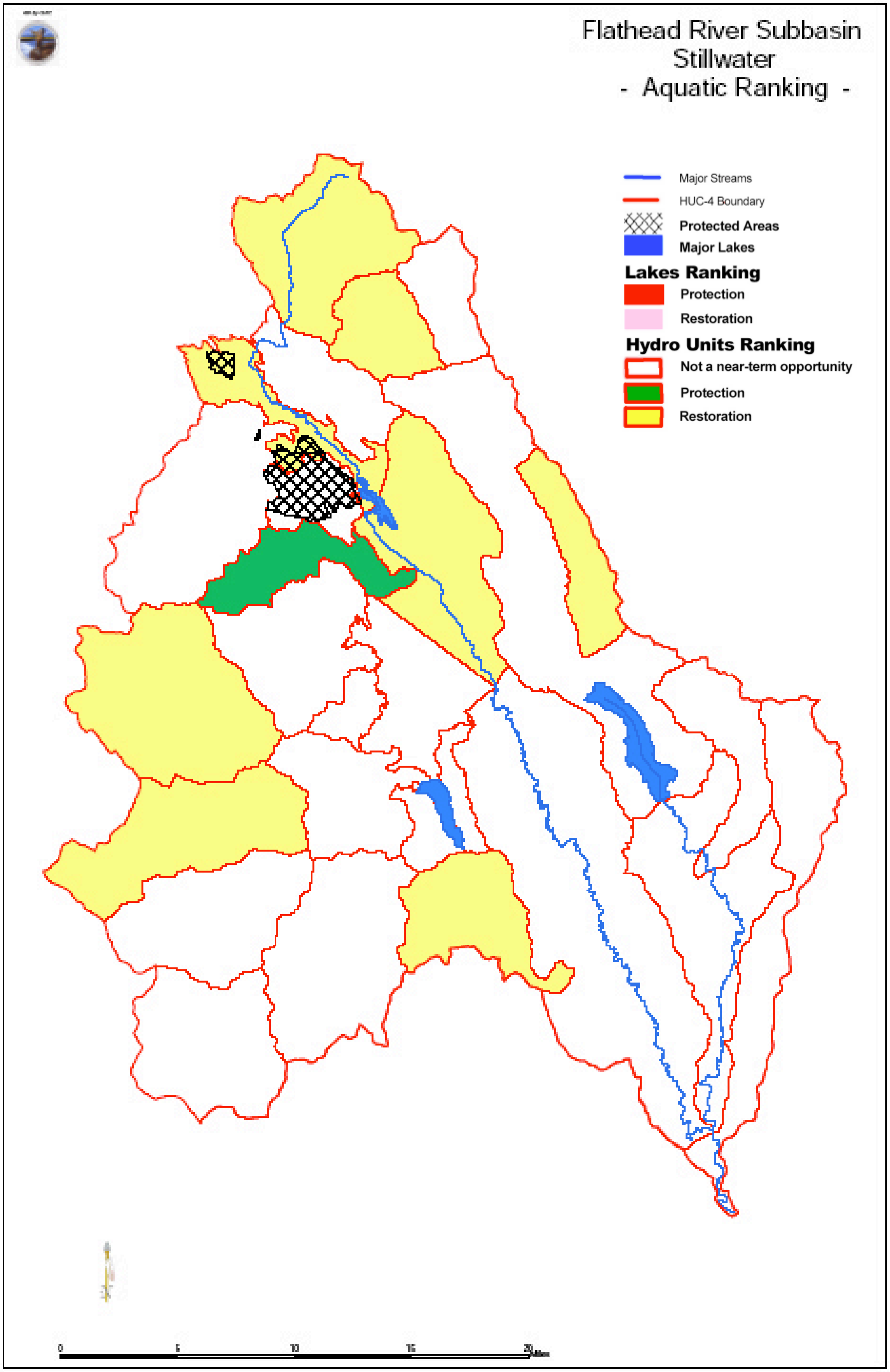

Figure 6.7. Aquatic near-term opportunities in the Stillwater Watershed.

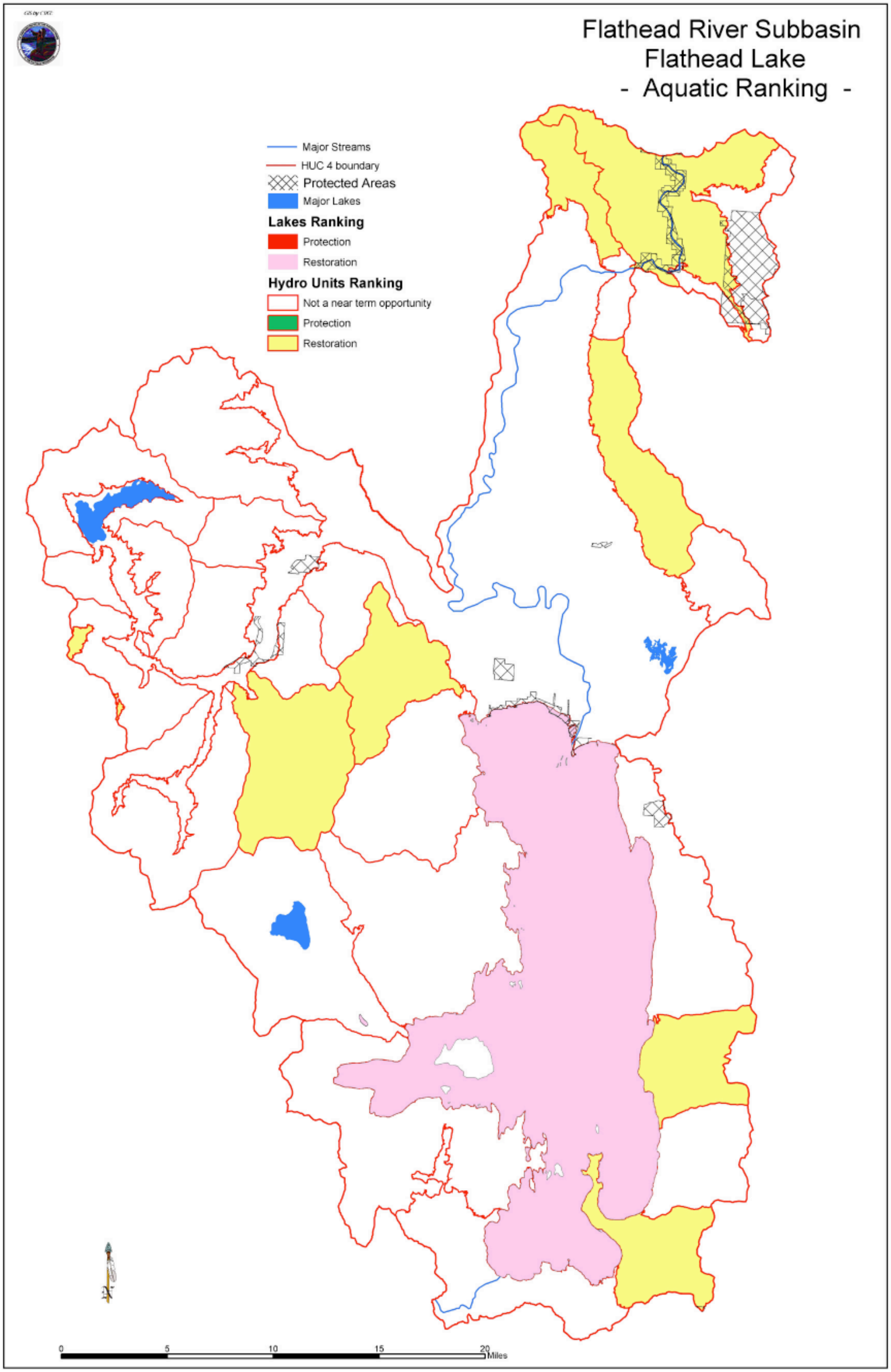

Figure 6.8. Aquatic near-term opportunities in the Flathead Lake Watershed.

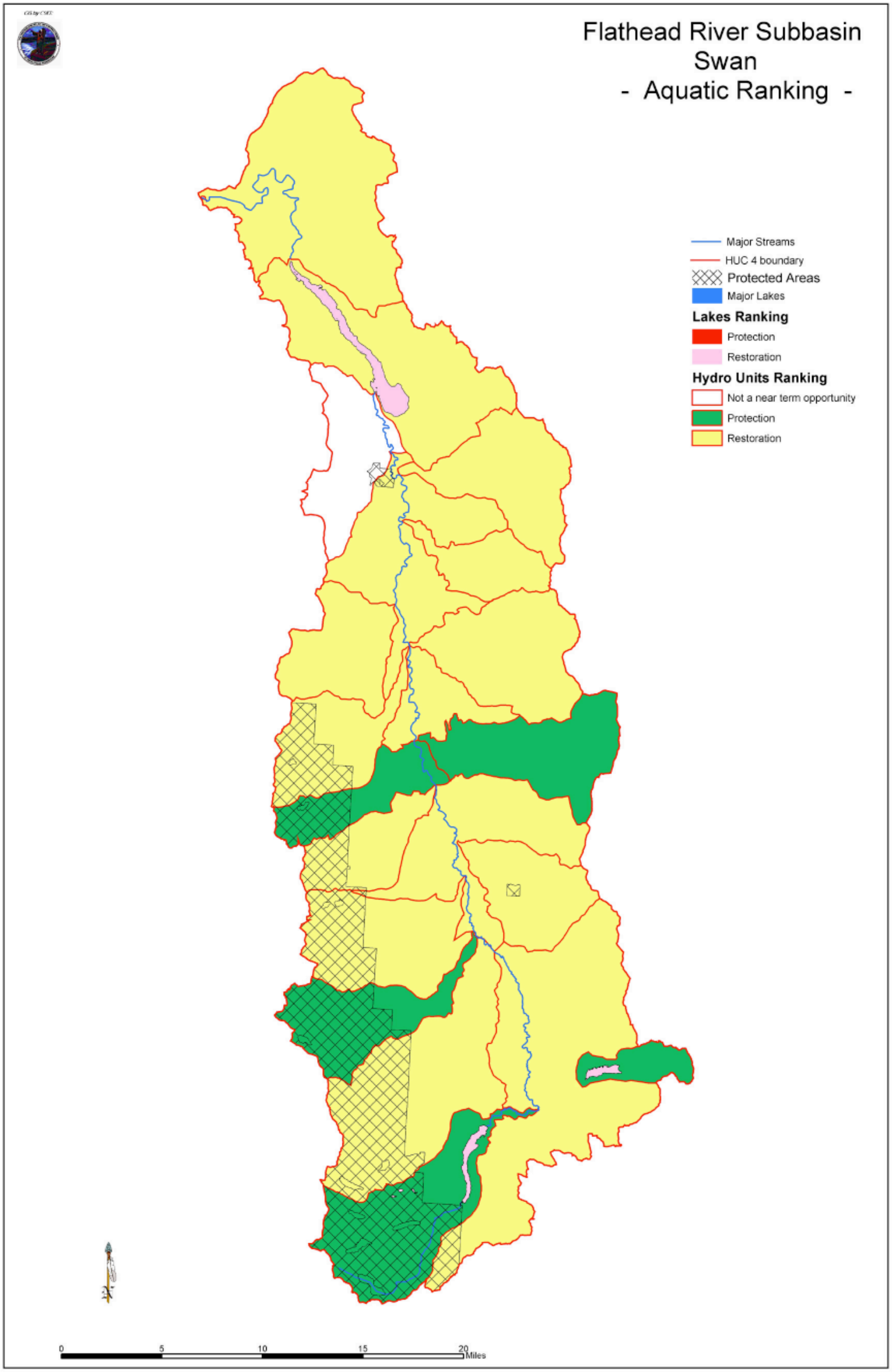

Figure 6.9. Aquatic near-term opportunities in the Swan Watershed.

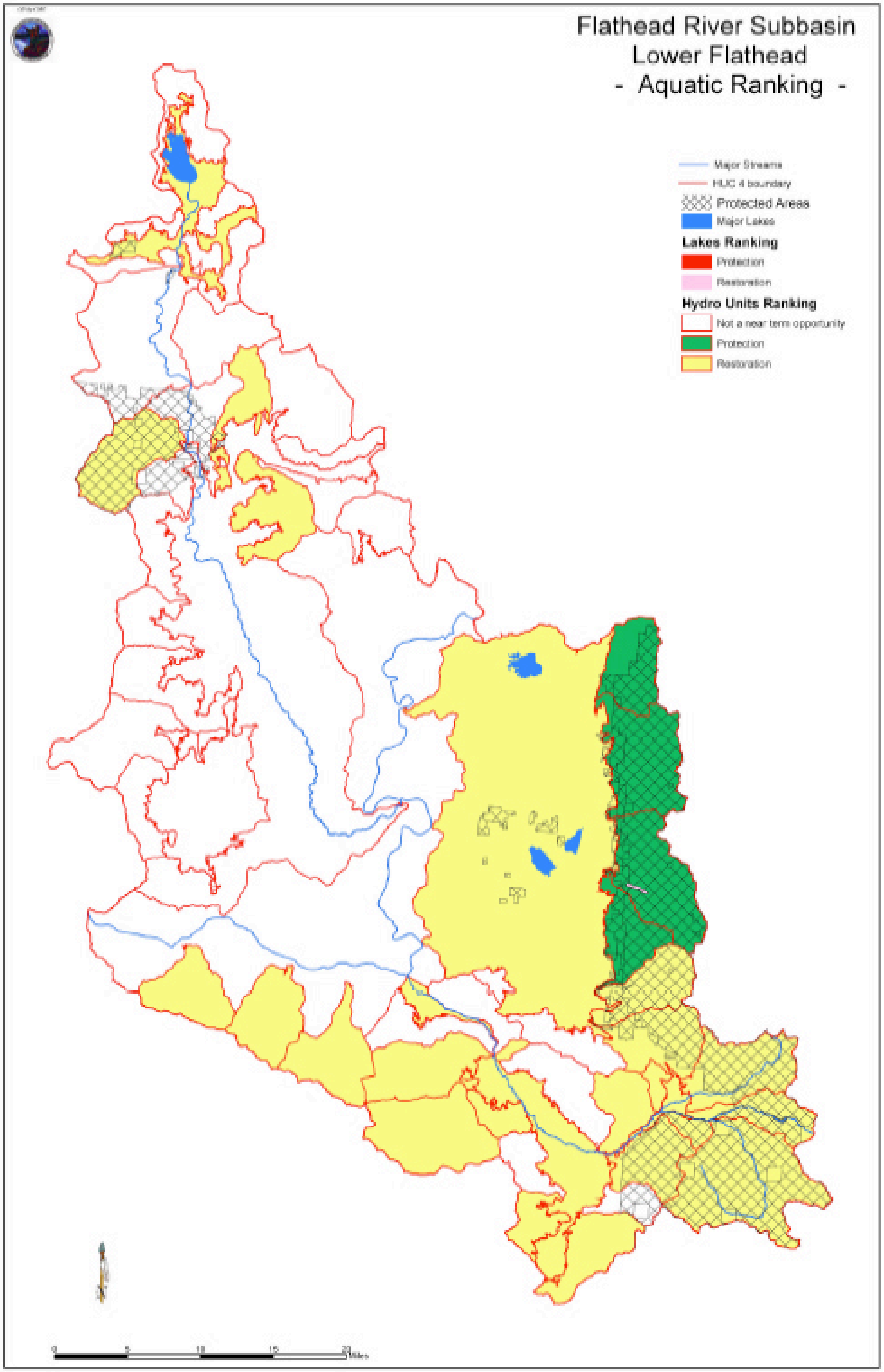

Figure 6.10. Aquatic near-term opportunities in the Lower Flathead Watershed.

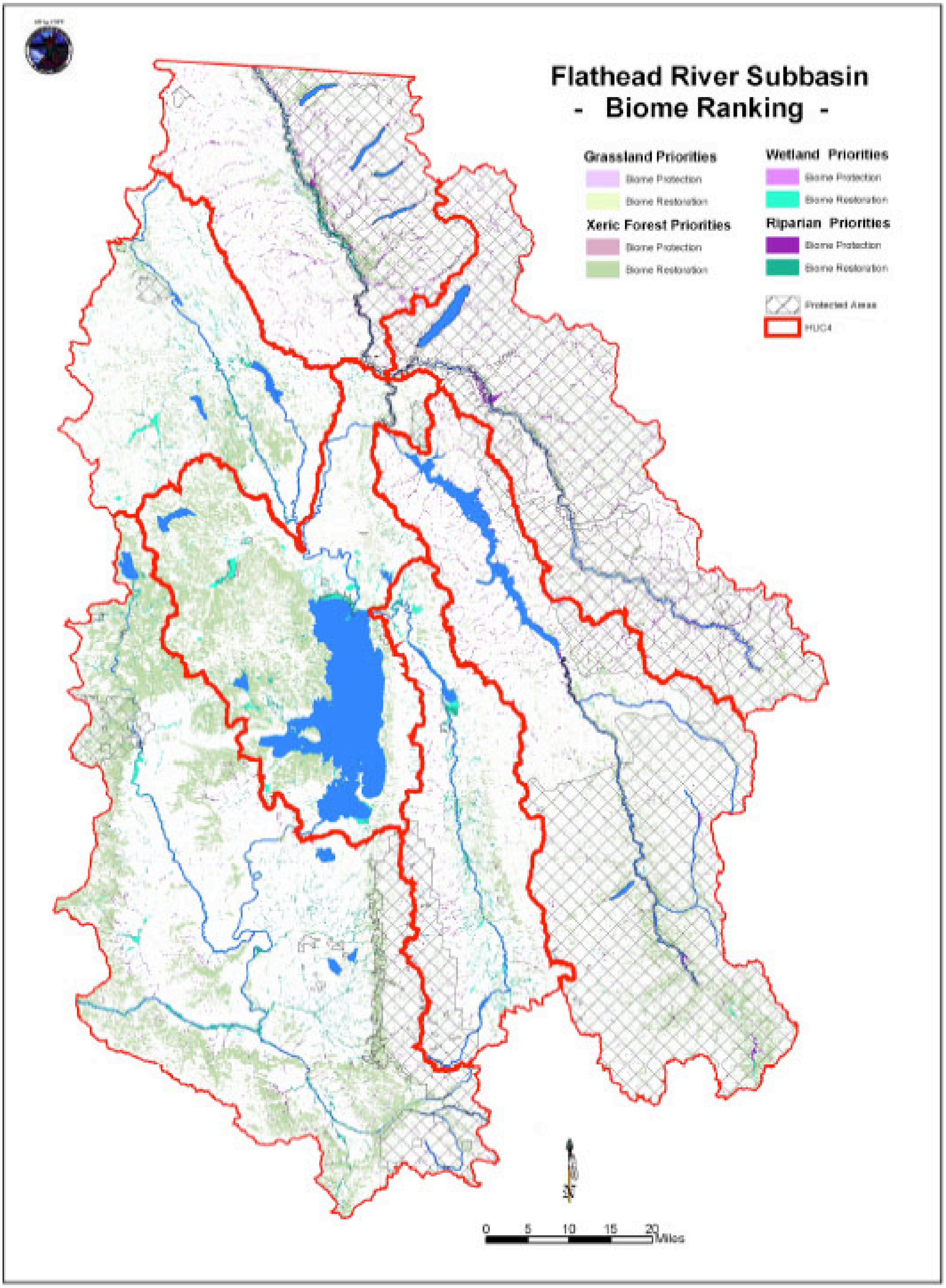

Figure 6.11. Terrestrial near-term opportunities in the Flathead Subbasin.

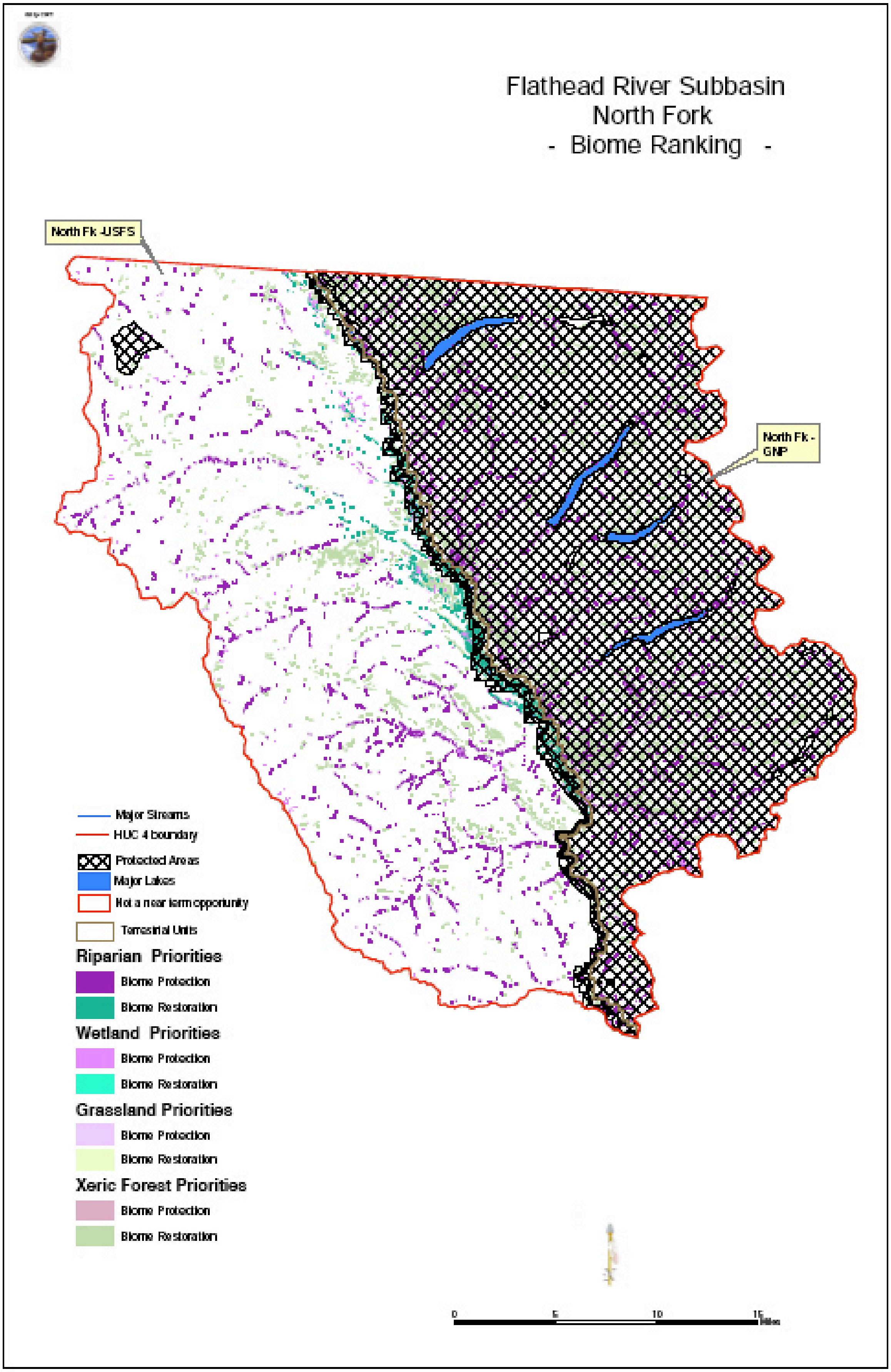

Figure 6.12. Terrestrial near-term opportunities in the North Fork of the Flathead Watershed.

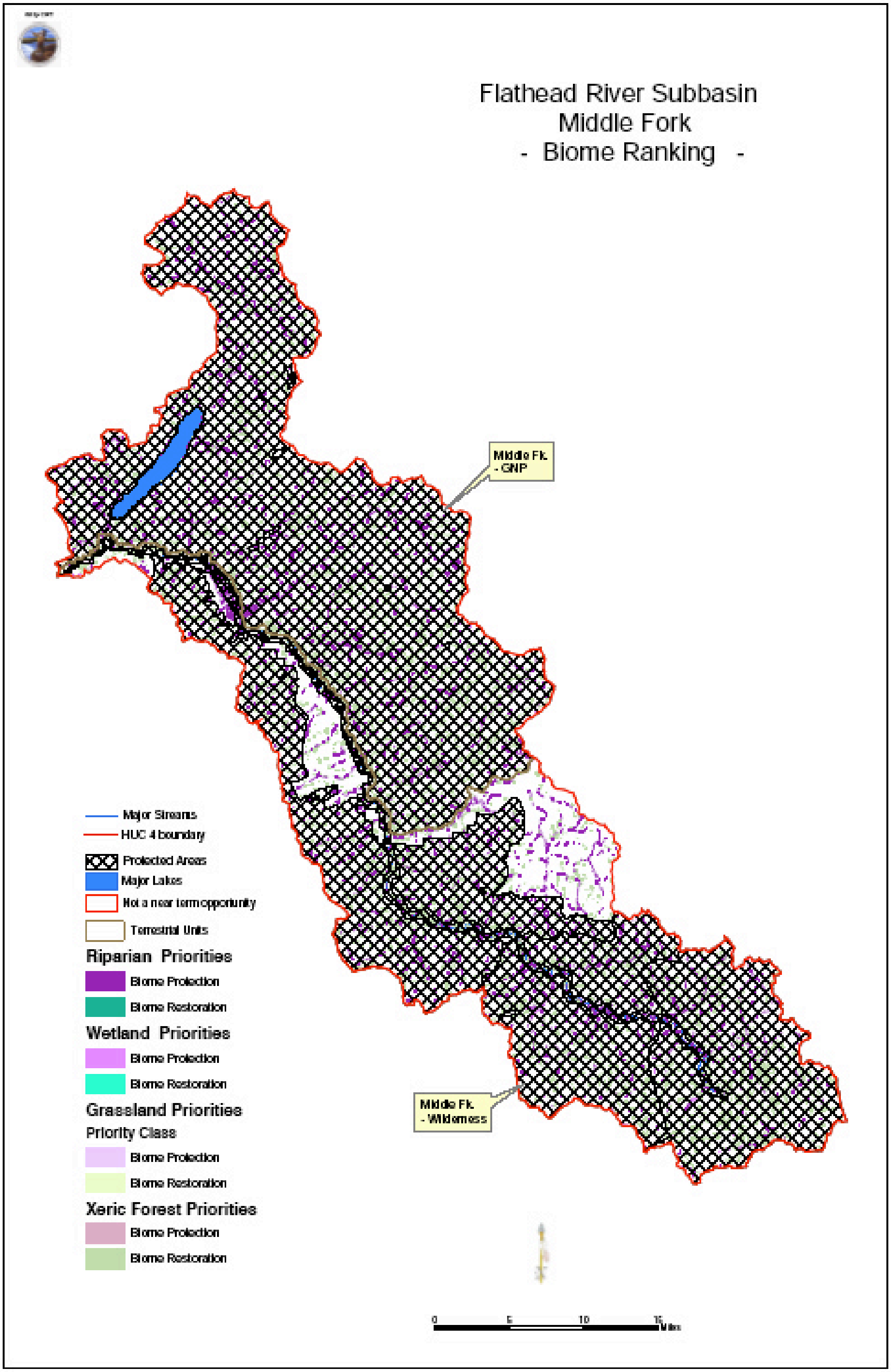

Figure 6.13. Terrestrial near-term opportunities in the Middle Fork of the Flathead Watershed.

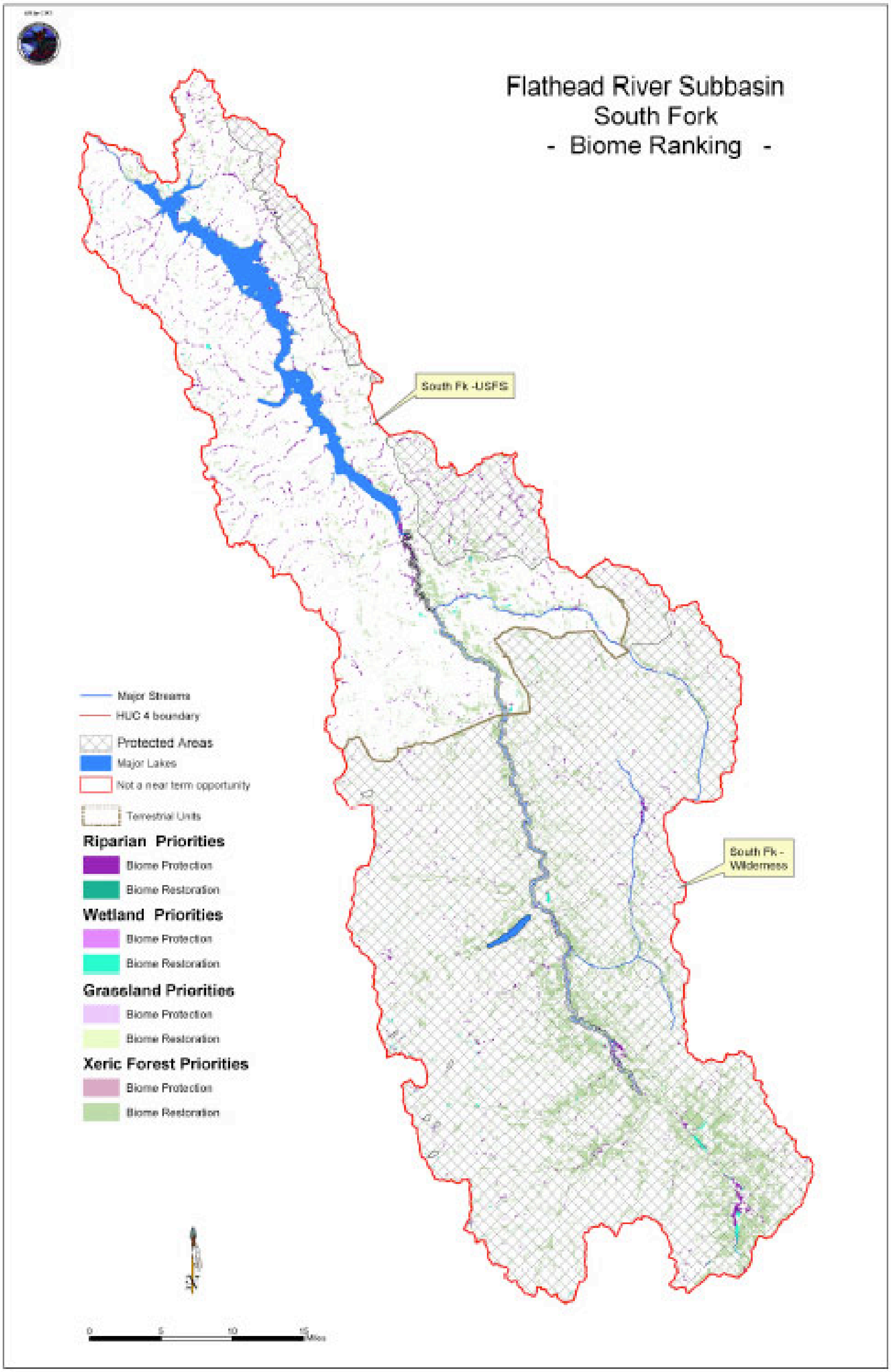

Figure 6.14. Terrestrial near-term opportunities in the South Fork of the Flathead Watershed.

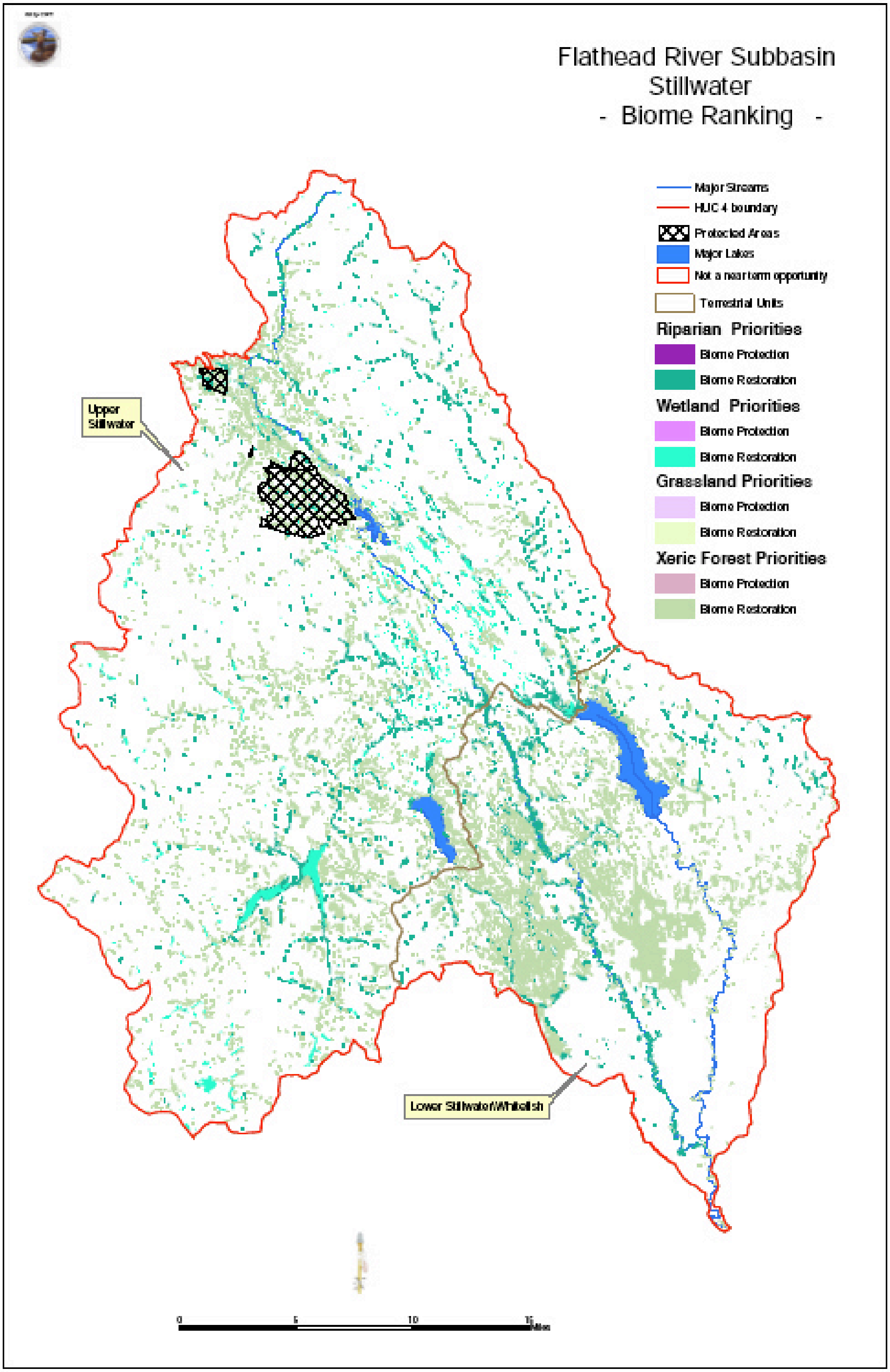

Figure 6.15. Terrestrial near-term opportunities in the Stillwater Watershed.

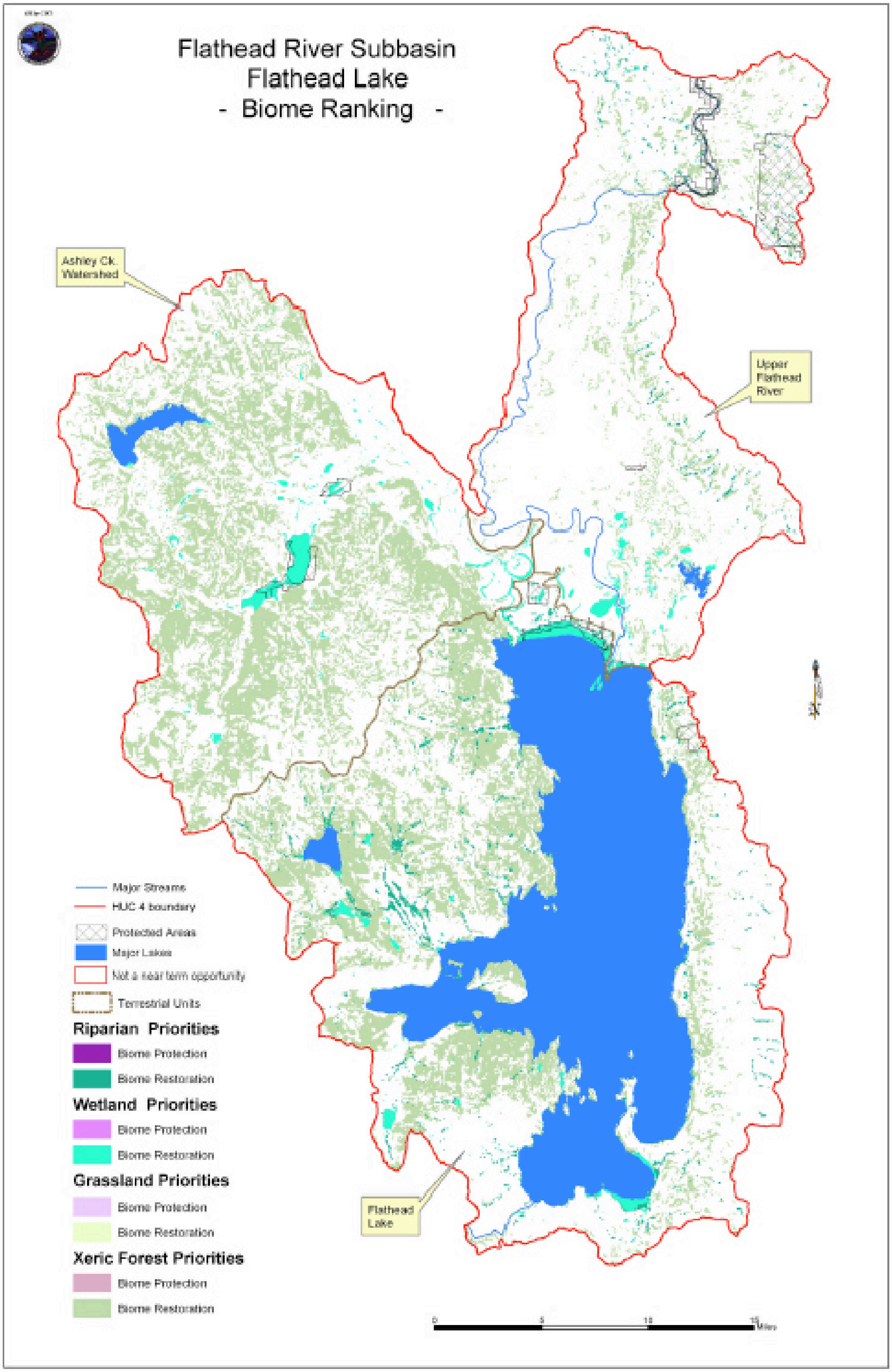

Figure 6.16. Terrestrial near-term opportunities in the Flathead Lake Watershed.

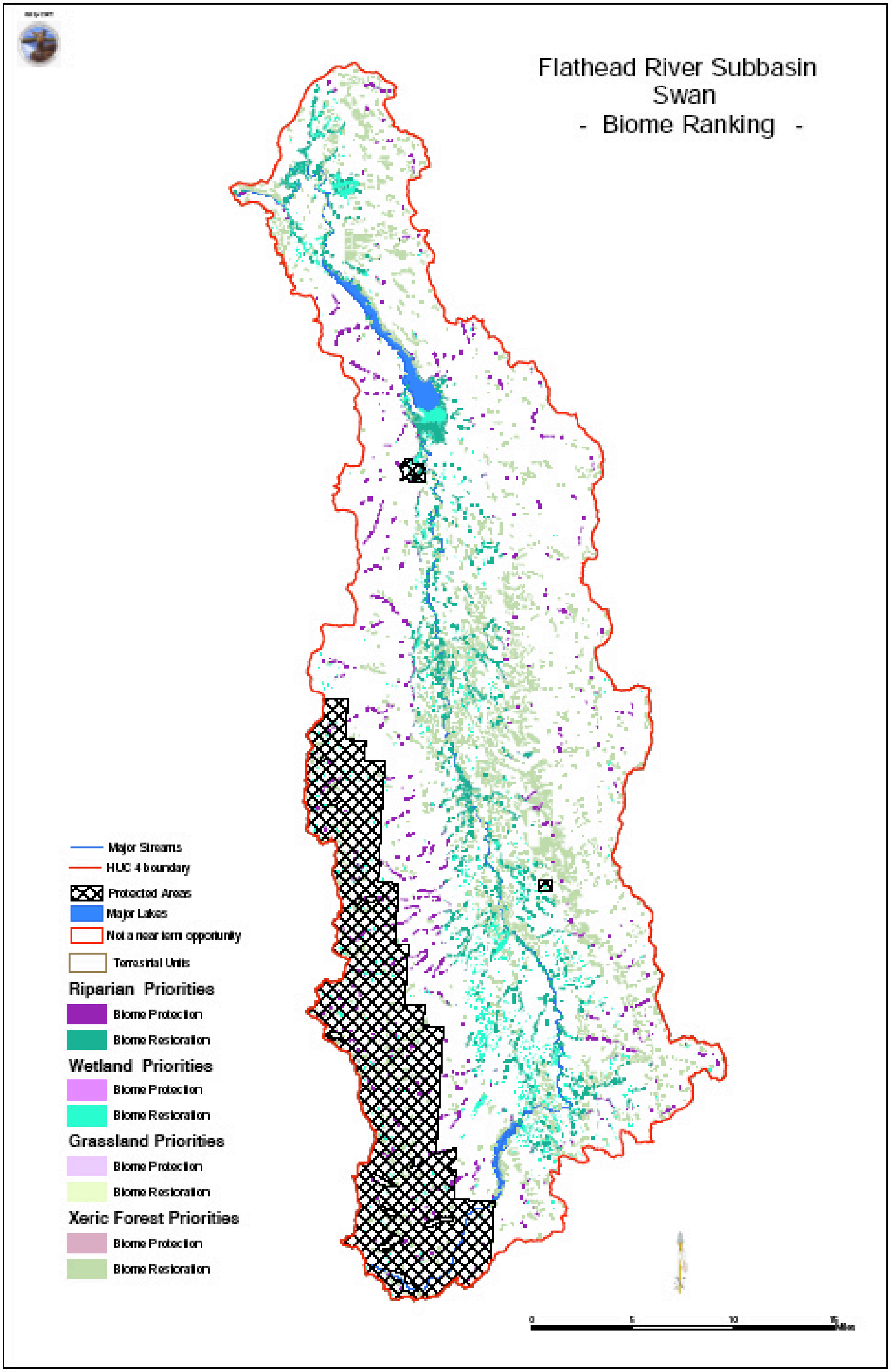

Figure 6.17. Terrestrial near-term opportunities in the Swan River Watershed.

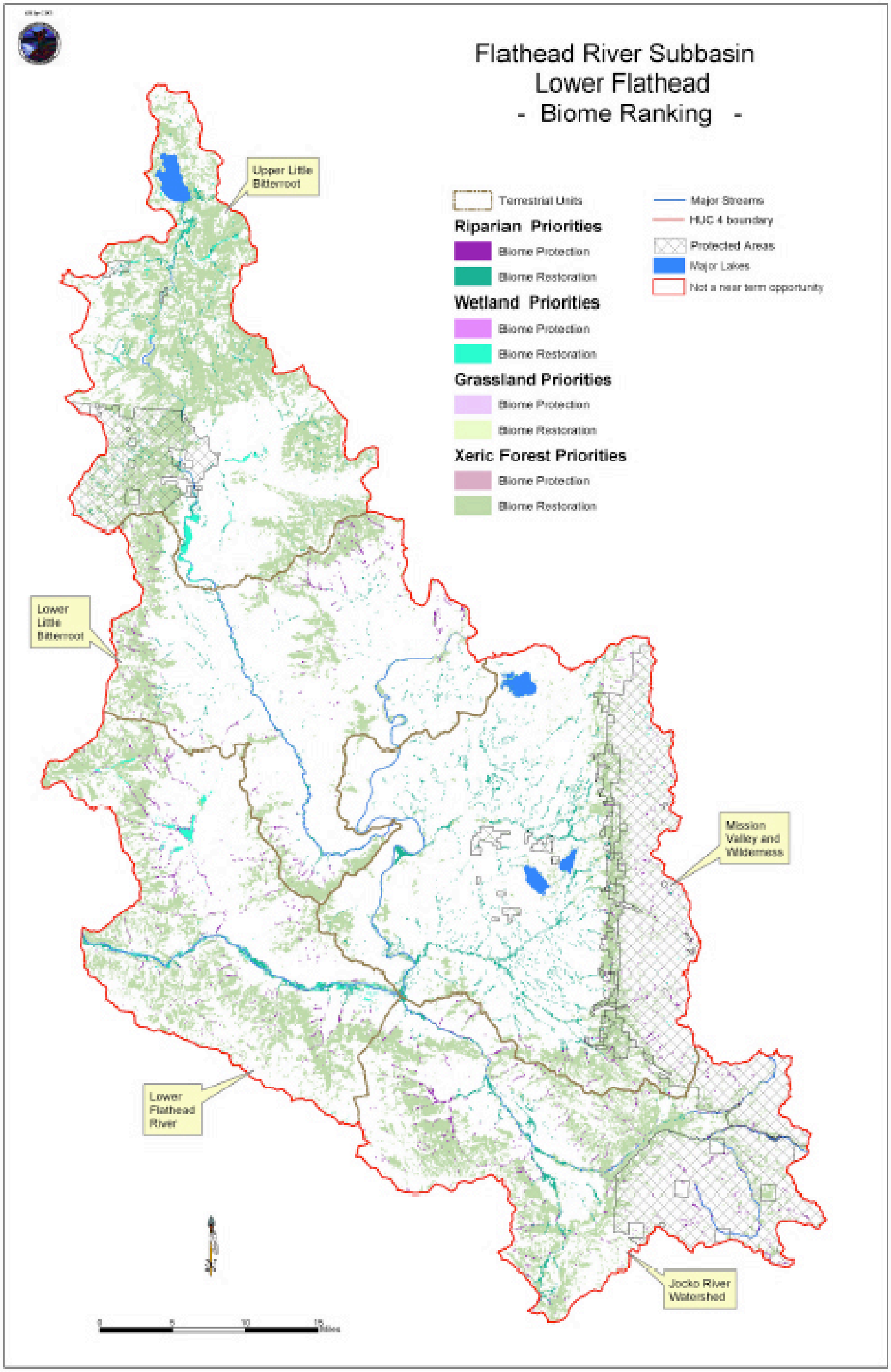

Figure 6.18. Terrestrial near-term opportunities in the Lower Flathead Watershed.

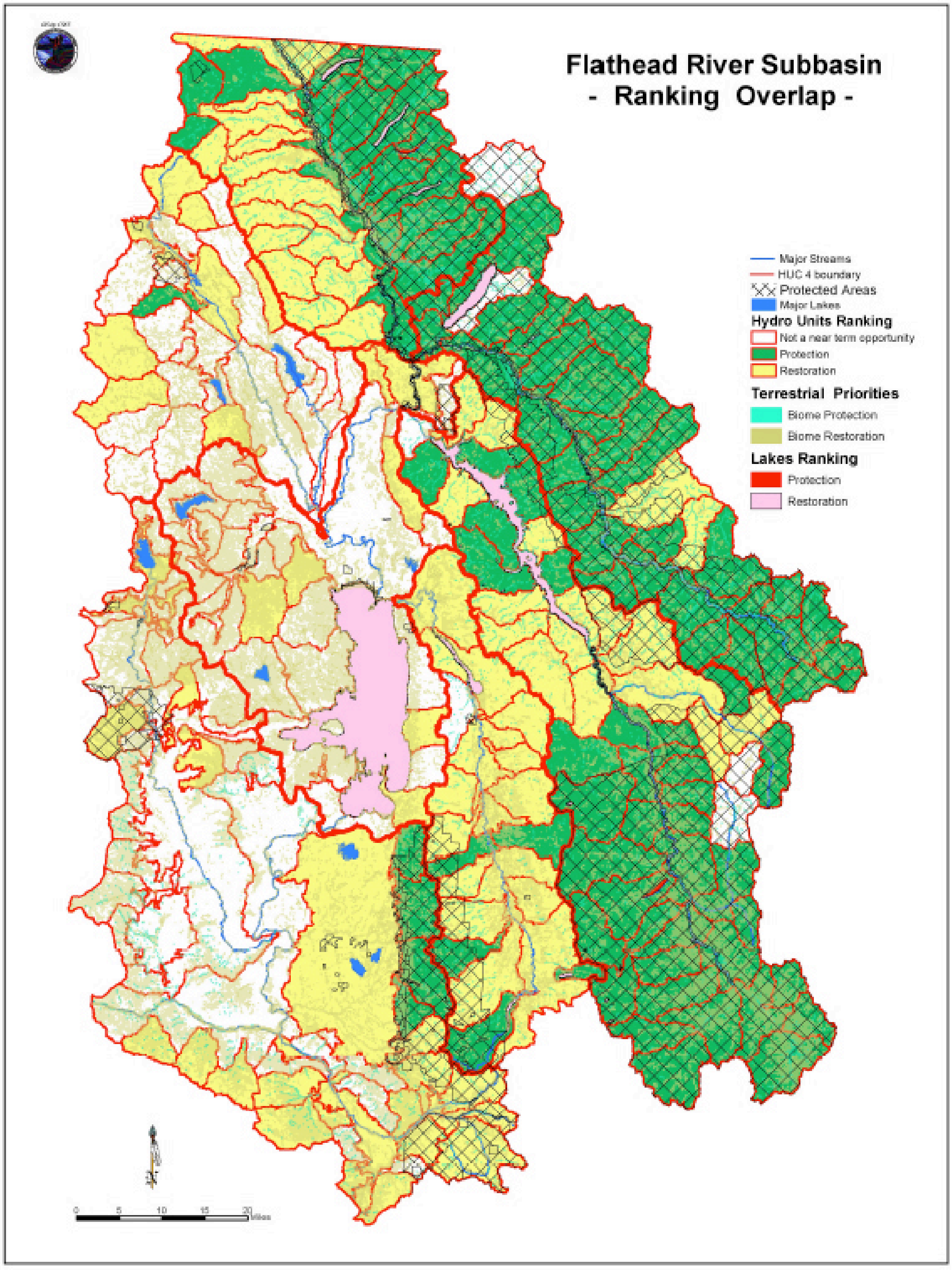

Figure 6.19. Overlay of aquatic and terrestrial near-term opportunities in the Flathead Subbasin.

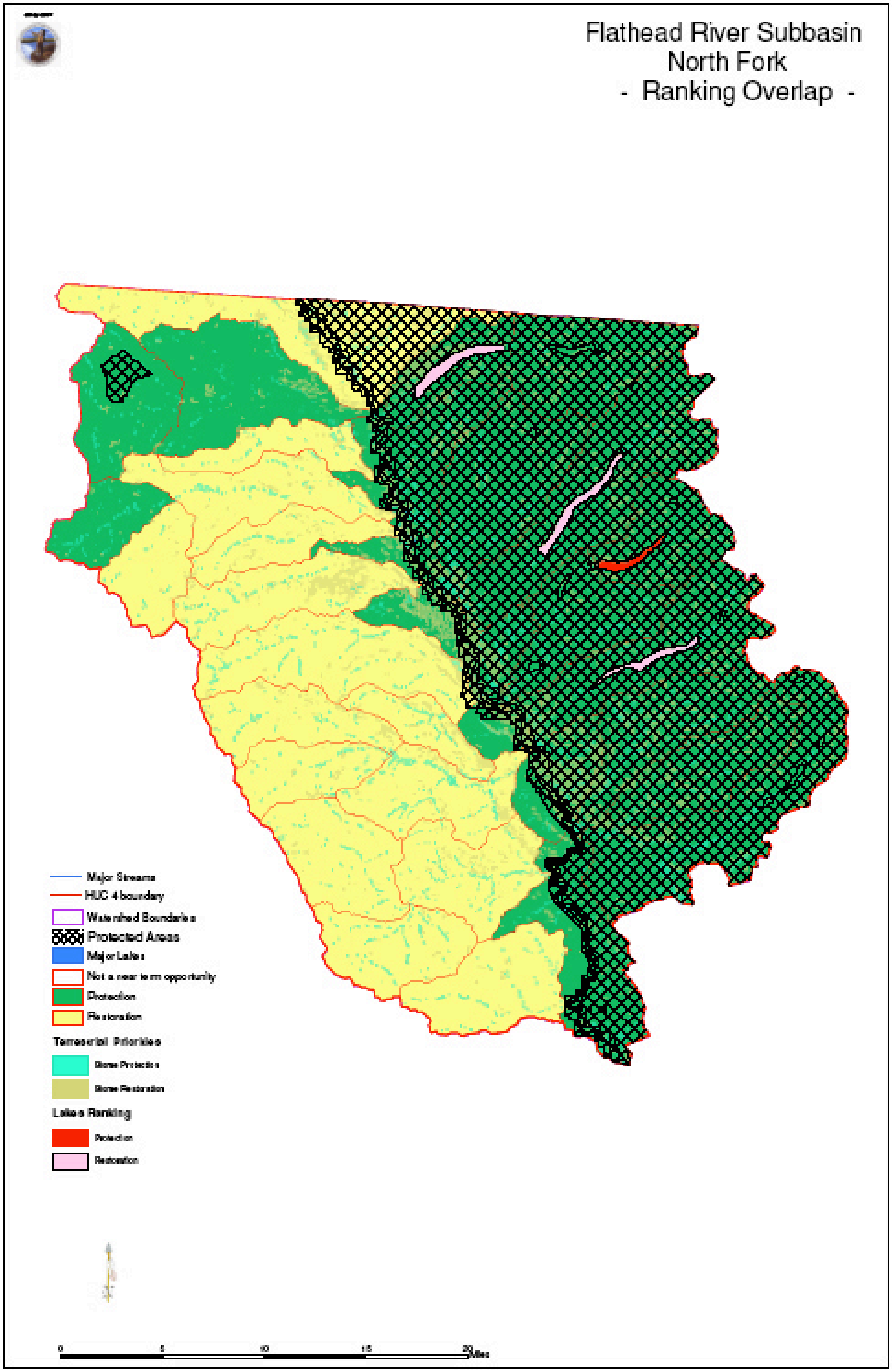

Figure 6.20. Overlay of aquatic and terrestrial near-term opportunities in the North Fork of the Flathead Watershed.

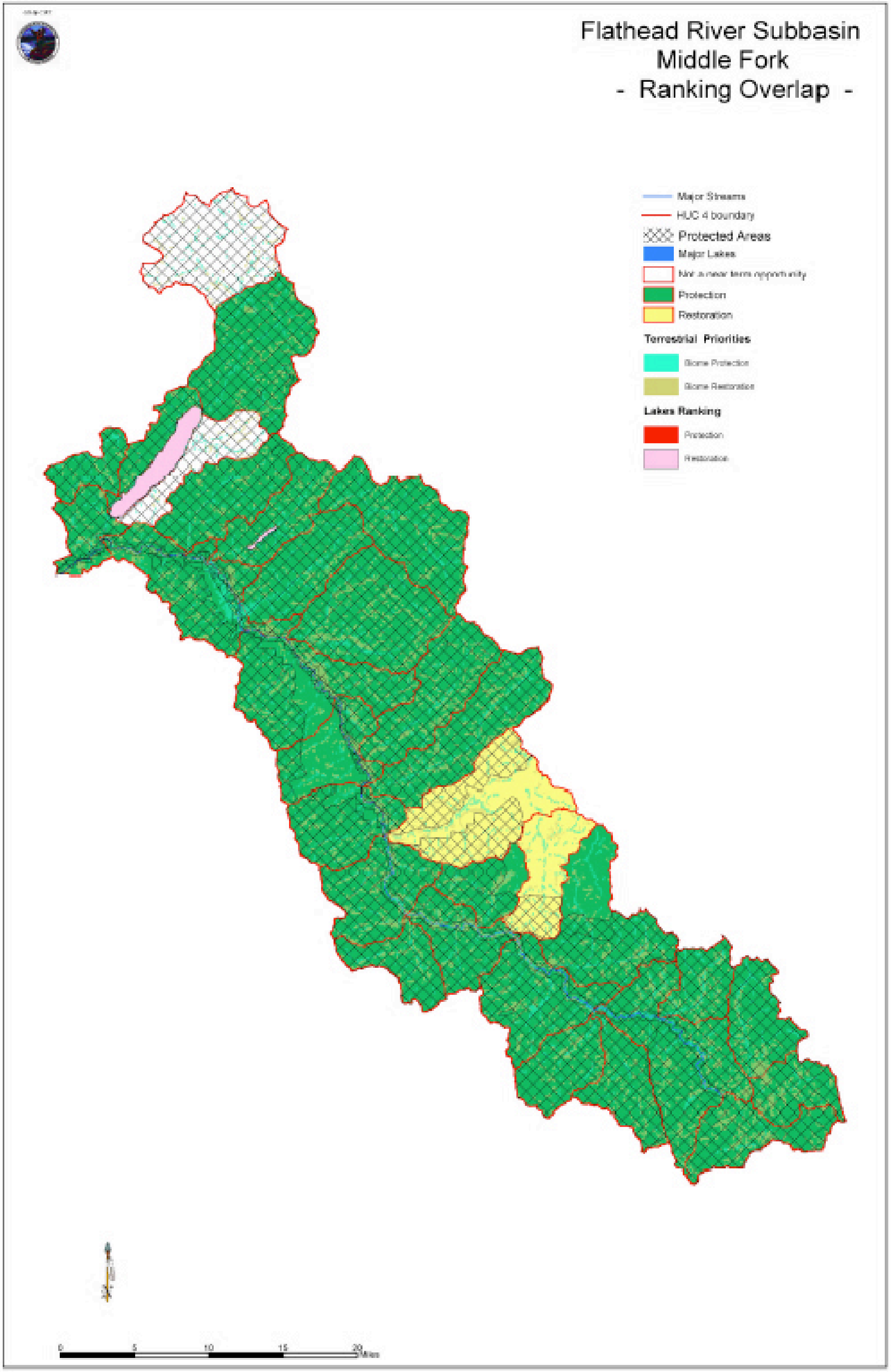

Figure 6.21. Overlay of aquatic and terrestrial near-term opportunities in the Middle Fork of the Flathead Watershed.

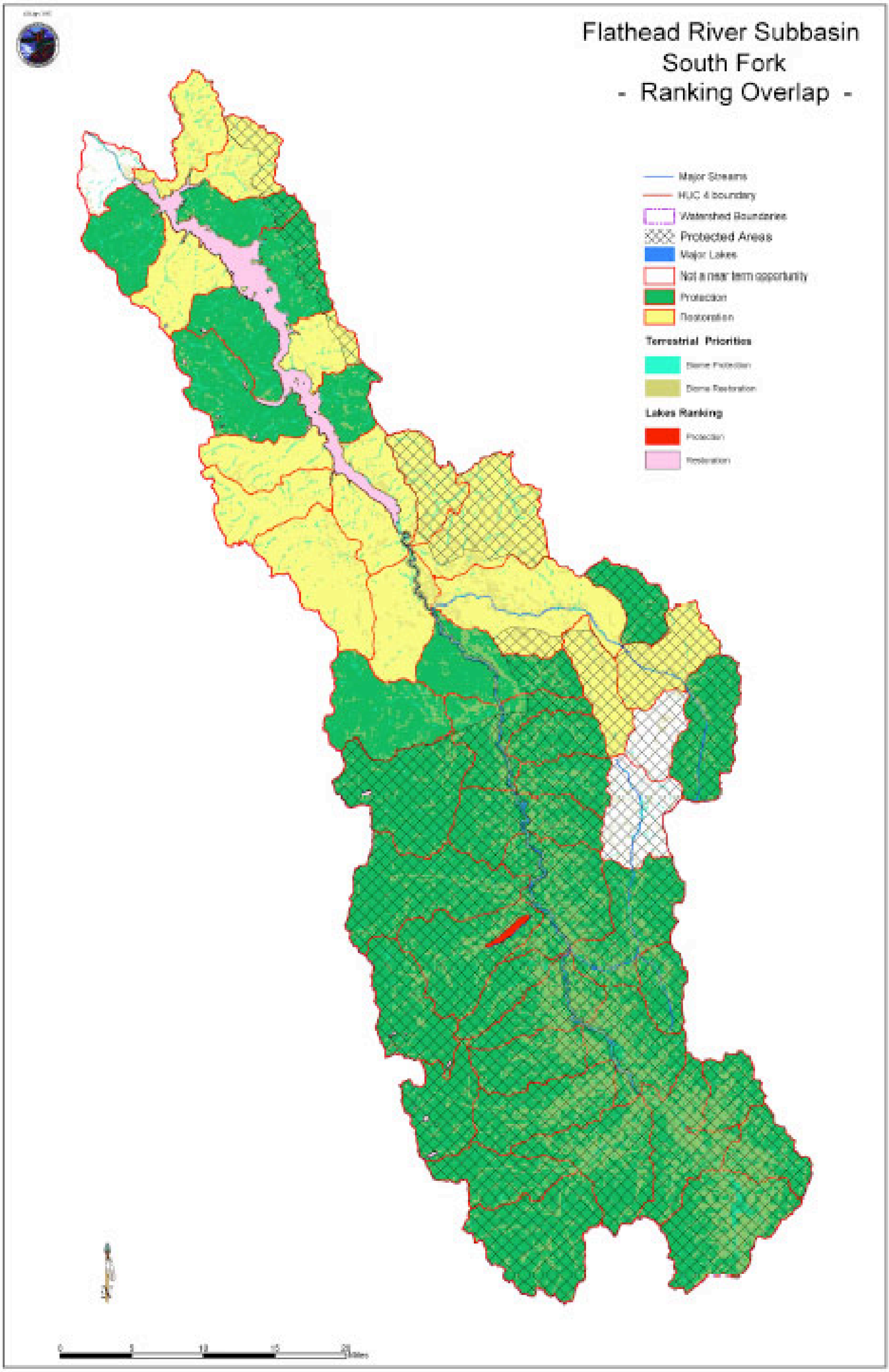

Figure 6.22. Overlay of aquatic and terrestrial near-term opportunities in the South Fork of the Flathead Watershed.

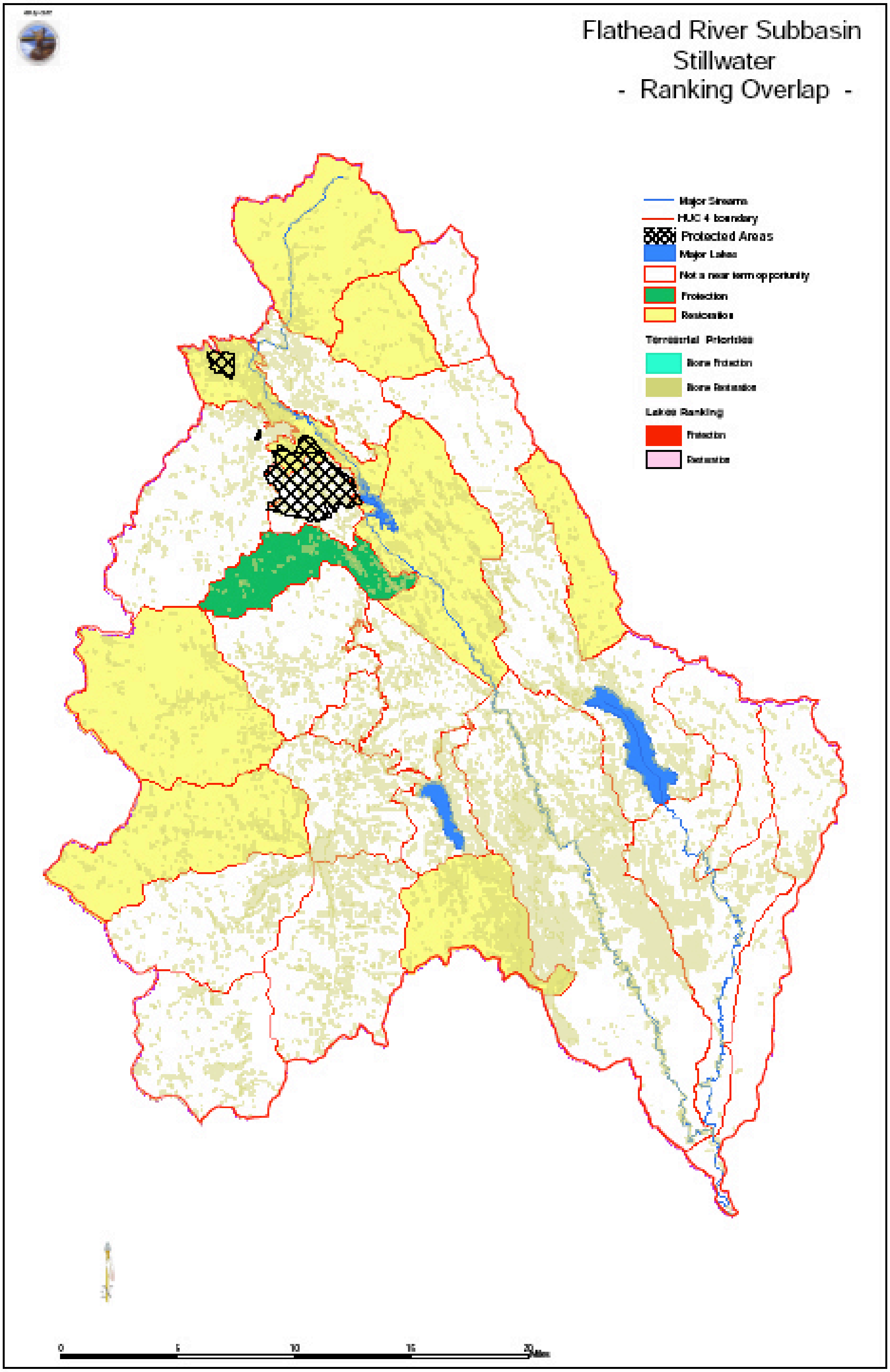

Figure 6.23. Overlay of aquatic and terrestrial near-term opportunities in the Stillwater River Watershed.

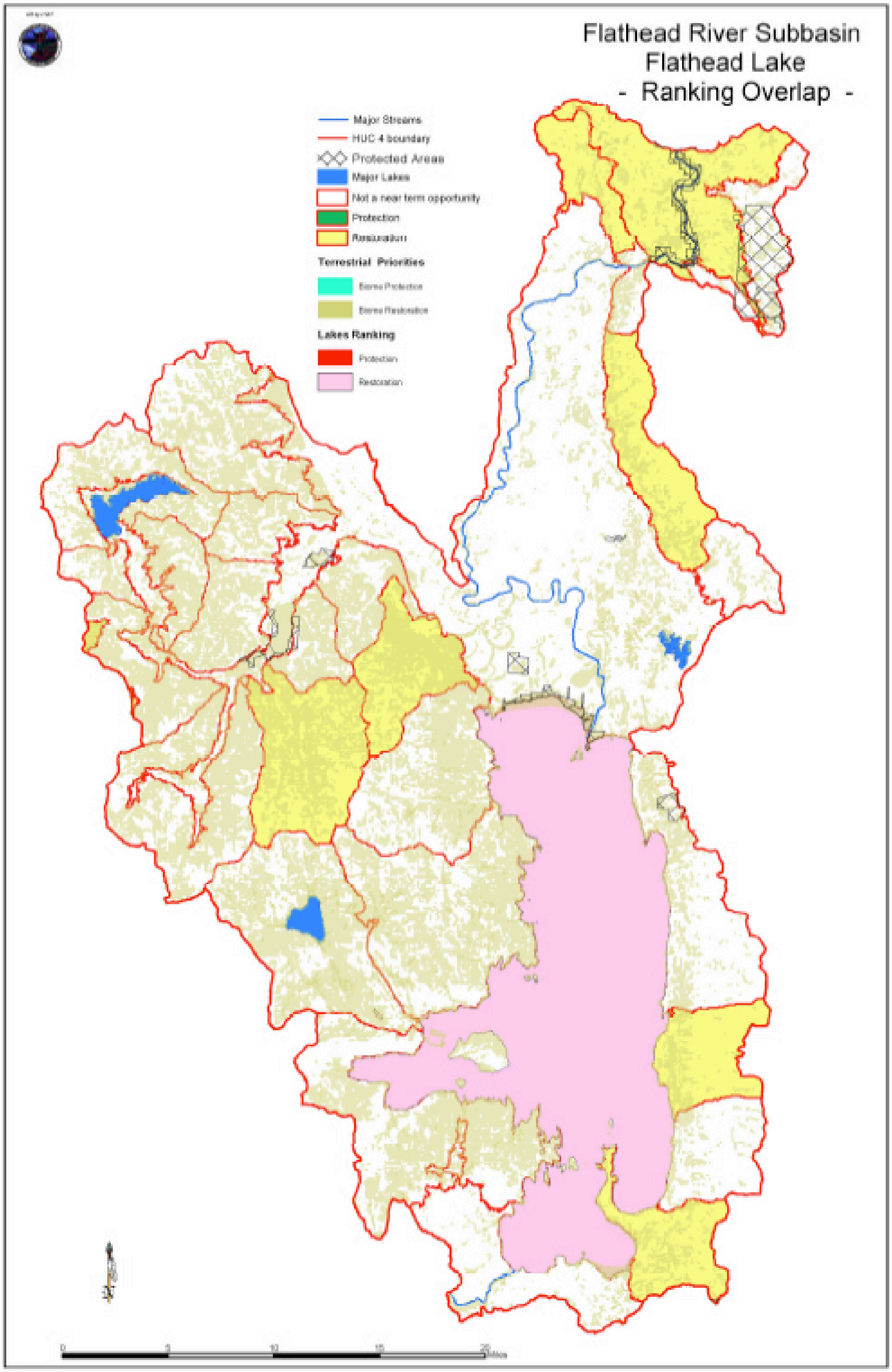

Figure 6.24. Overlay of aquatic and terrestrial near-term opportunities in the Flathead Lake Watershed.

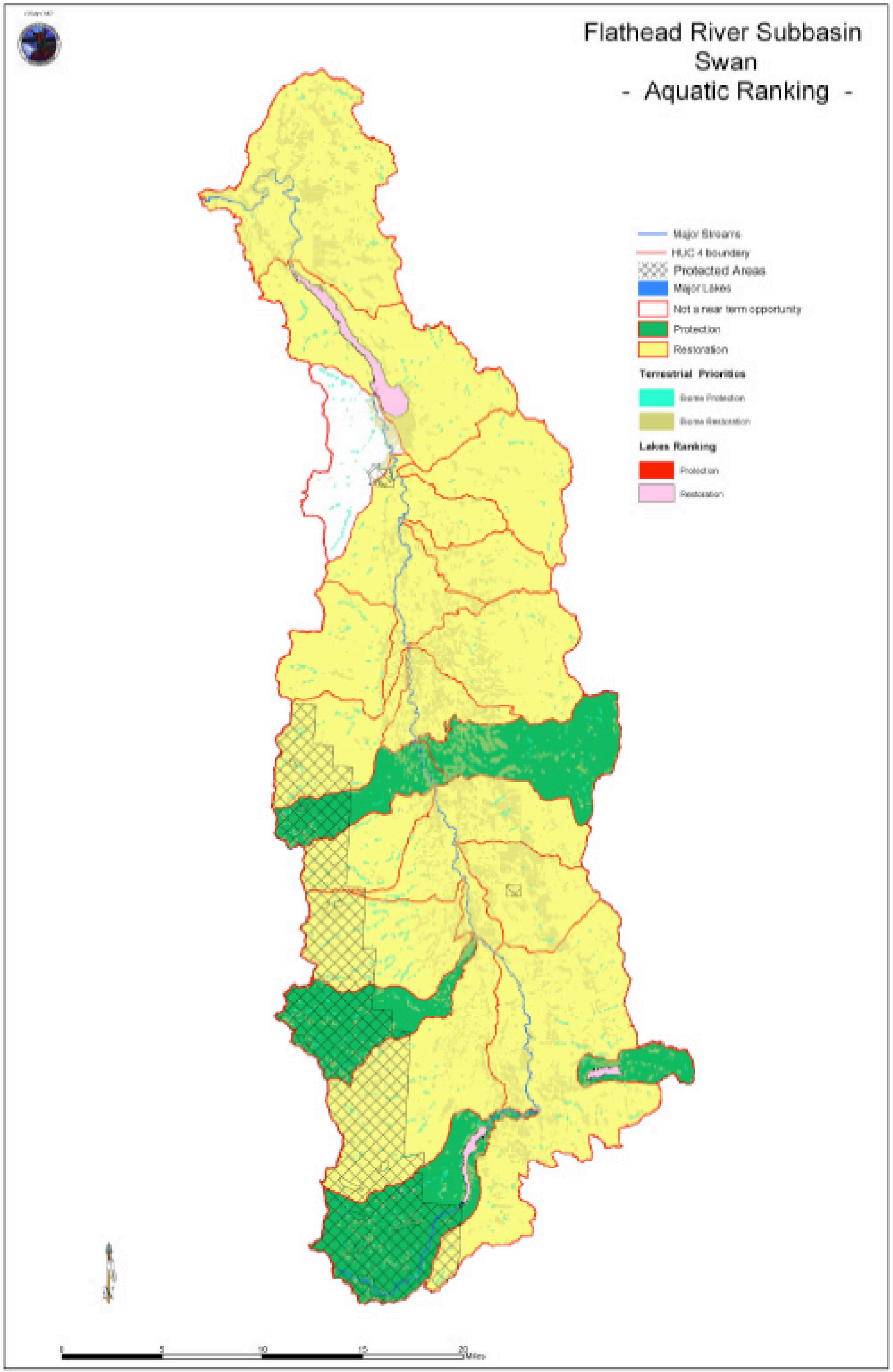

Figure 6.25. Overlay of aquatic and terrestrial near-term opportunities in the Swan River Watershed.

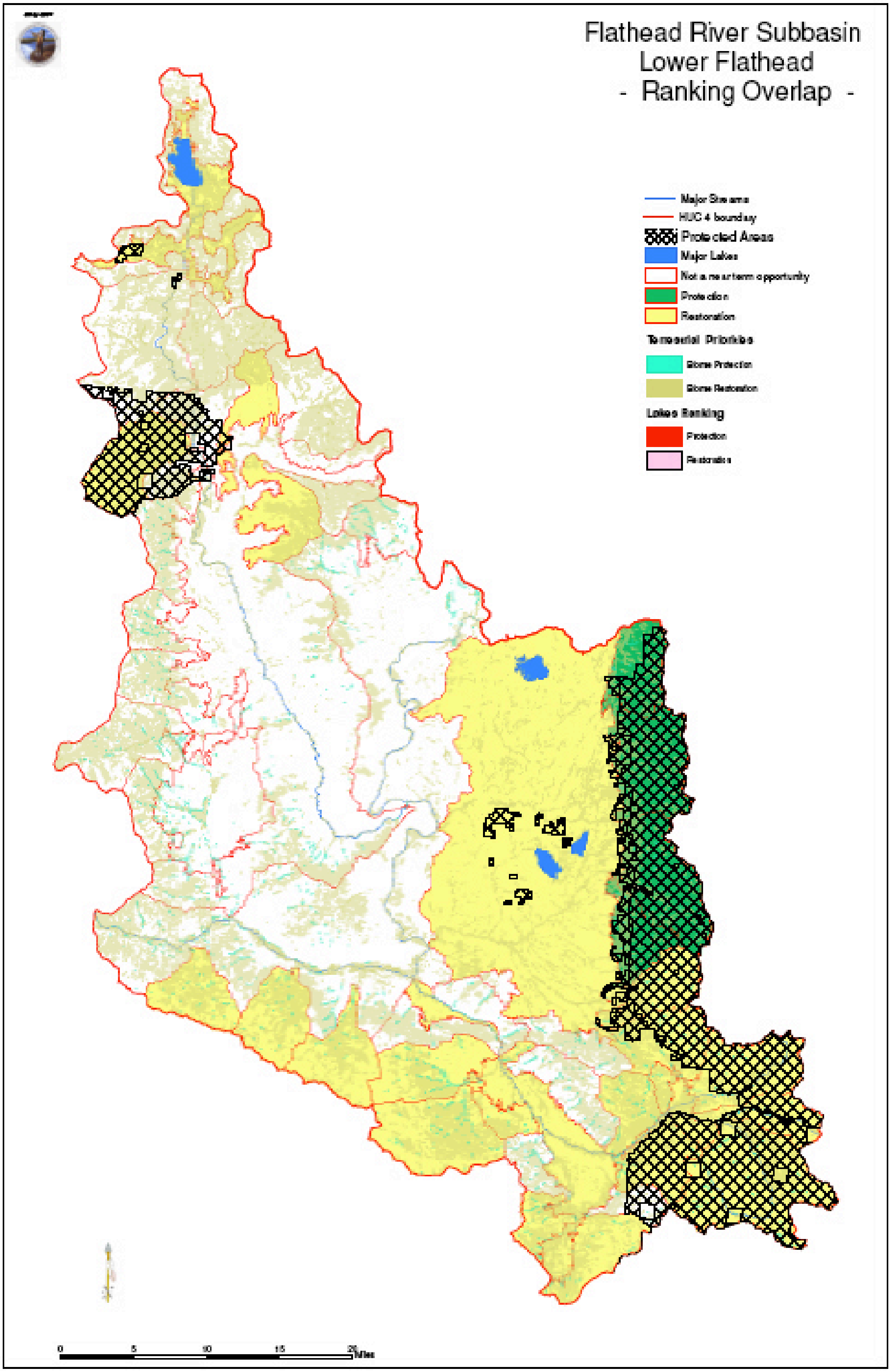

Figure 6.26. Overlay of aquatic and terrestrial near-term opportunities in the Lower Flathead Watershed.

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8. Appendices

Appendix 19	Limnology of Flathead Lake (an excerpt from: Stanford, J. A. and B. K. Ellis. 2002. Natural and cultural influences on ecosystem processes in the Flathead River Basin (Montana, British Columbia), pp. 269-284. IN: Baron, J. S. (Ed.), *Rocky Mountain Futures: An Ecological Perspective*. Island Press, Washington, D. C.)
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Appendix 41 GIS maps showing (1) bull trout genetic distribution and status in the Flathead Subbasin and (2) bull trout distribution, restoration/conservation areas, and core haibtat areas

Appendix 42 Streams in the Flathead Subbasin that Contain Brook Trout as of February 2003

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Appendix 44 Fisheries Vulnerability Analyses, Cohesive Strategy Team of Region 1 of the USFS

Appendix 45 American Wildlands GIS-based, coarse-scale analysis of the current condition of native aquatic integrity across an Upper Columbia basin. There are full reports on the modeling projects that can be downloaded from http://www.y2y.net/science/aquatic_research.asp

Appendix 46 Maps showing westslope cutthroat trout status by 6^{th} field HUC for the Flathead Subbasin as compiled by the USFS Region One Cohesive Strategy Team

Appendix 48 MFWP maps showing westslope cutthroat trout distribution and genetic purity in the North, Middle, and South Forks of the Flathead, Swan, and Flathead Lake watersheds

Appendix 50 Creston National Fish Hatchery Hatchery And Genetic Management Plan

Appendix 51 Westslope Cutthroat Trout Hatchery Brood Stock Histories

Appendix 52 Montana Trout Genetic Purity Data Set

Appendix 53 Status Review for Westslope Cutthroat Trout in the United States, September 1999

Appendix 54 Status Update (Shepard et al. 2003)

Appendix 55 Risk Scores for Flathead Subbasin Conservation Populations Assessed as Part of the Westslope Cutthroat Trout Status Review Update (2002)