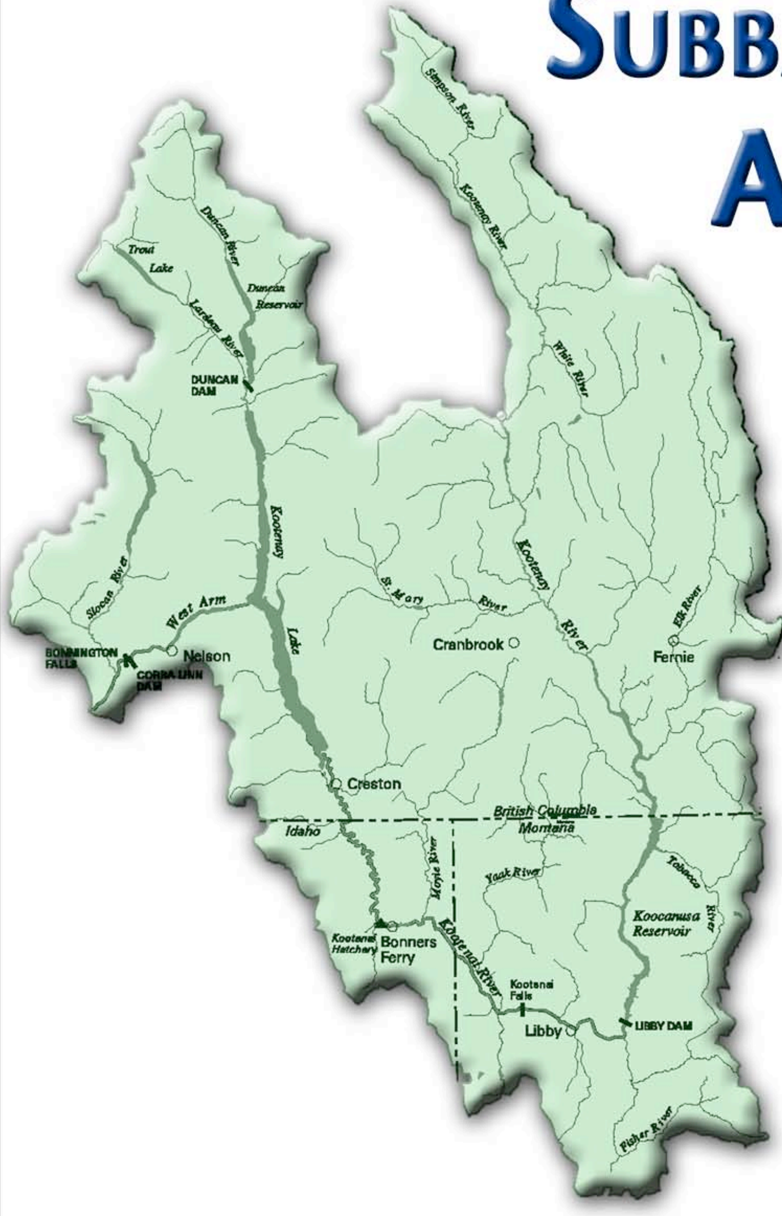
October 11, 2004

Kootenai River Subbasin Assessment



A report prepared by KTOI and MFWP for the Northwest Power and Conservaton Council

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

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Introduction

This assessment constitutes the technical evaluation of the biological and physical characteristics of the Kootenai River Subbasin, the first step in the development of a subbasin plan, which once completed will be reviewed and adopted as part of the Northwest Power and Conservation Council's Columbia River Basin Fish and Wildlife Program. The primary purpose of the plan is to help direct Bonneville Power Administration funding of projects that protect, mitigate, and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydropower system. This is an international basin, and while our analysis is focused on the U.S. portion of the subbasin, Canadian management agencies have contributed significant amounts of data, which we have included where appropriate.

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 will form the foundation of the management plan. Chapter 1 is 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-field Hydrologic Unit Code (HUC)[1] 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 the development of specific objectives, which are part 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 field HUCs), is a logical framework for developing objectives and strategies to protect, mitigate, and enhance the fish and wildlife of the Kootenai 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 114.

Click Here

The assessment and the other parts of the Kootenai Subbasin Plan have been designed as electronic documents with numerous web-based and internal links. Our intention has been to create a multilayered, electronic plan with user-friendly access to the enormous amount of information that went into the planning process. While we have made every attempt to ensure that the web links are

[1] *HUC stands for Hydrologic Unit Code. The US is divided and sub-divided into successively smaller HUCs. HUC 5, HUC 6, and HUC 7 refer to different sizes of hydrologic units or watersheds. A HUC 6 watershed ranges from 10,000 to 40,000 acres in size, and is the typical size of watershed at which a landscape analysis is conducted.*

accurate and while we intend to update the links on a periodic basis, websites can be somewhat fluid, and so some links may become inaccessible before they can be updated. Also, planners are not responsible for the content of websites that belong to other agencies and organizations.

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 Kootenai 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 (the principle aquatic assessment tool that we used for streams), Paul Anders for his work on LQHA (a lake version of QHA), Mike Panian for developing the terrestrial assessment tool (called 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 our other colleagues in the British Columbia ministries for their help and cooperation with this effort.

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1 Subbasin Overview

1.1 Subbasin Description

The Kootenai River Subbasin is situated between 48° and 51° north latitude and 115° and 118° west longitude and includes within its boundaries parts of southeastern British Columbia, northern Idaho, and northwestern Montana. It measures 238 miles by 153 miles and has an area 16,180 sq miles. Nearly two-thirds of the Kootenai River's 485-mile-long channel and almost 70 percent of its watershed area, is located within the province of British Columbia. The Montana part of the subbasin makes up about 23 percent of the watershed, while the Idaho portion is about 6.5 percent (Knudson 1994). The primary focus of this assessment is on that part of the subbasin that falls within the U.S.; those parts of the subbasin upstream and downstream in British Columbia are covered in less detail.

The subbasin is characterized by north-to-northwest trending mountain ranges separated by straight valleys running parallel to the ranges (figures 1.1 and 1.2). Most of the terrain is rugged, mountainous, and heavily forested. Elevations range from 1,370 ft above mean sea level, where the Kootenai enters the Columbia River near Castlegar, B.C., to 11,870 feet at the summit of Mt. Assiniboine on the Continental Divide in the northeastern part of the basin. The section of the Kootenai Subbasin lying in the U.S. ranges from an elevation of 2,310 feet where the river enters Montana to 1,750 ft where it leaves the U.S. and returns to Canada.

The headwaters of the Kootenai River, which is spelled Kootenay in Canada[1], originate in Kootenay National Park, B.C. The river flows south into the Rocky Mountain Trench, and then enters Koocanusa Reservoir (also known as Lake Koocanusa) created by Libby Dam and located near Libby, Montana. After leaving the reservoir, the Kootenai River flows west, passes through a gap between the Purcell and Cabinet Mountains and enters Idaho. From Bonners Ferry, it enters the Purcell Trench and flows northward through flat agricultural land (formerly a floodplain/wetland complex) toward the Idaho-Canada border. North of the border, it runs past the city of Creston, B.C. and into the south arm of Kootenay Lake. Kootenay Lake's west arm is the outlet, and from there, the Kootenai River flows south again to join the Columbia River at Castlegar, B.C. At its mouth, the Kootenai has an average annual discharge of 30,650 cfs (KRN 2003). The Continental Divide forms much of the eastern boundary of the subbasin, the Selkirk Mountains the western boundary, and the Cabinet Range the southern. The Purcell Mountains fill the center of the river's J-shaped course to where it joins Kootenay Lake.

LINKS

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

Click Here

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

Click Here

[1] *In this assessment we have used the U.S. spelling for both the U.S. and Canadian portions of the river and the subbasin to avoid confusion. For all other locations in Canada and the U.S., we use the proper place name, regardless of the spelling.*

LINKS

For general ecological information on the Kootenai, go to the Kootenai Resource Information System website at: http://www.krisweb.com/kriskootenai/krisdb/html/krisweb/index.htm

Click Here

The Environmental Statistic Group—Hydrologic Unit Project website has general information on the Kootenai 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 Kootenai, 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

In its first 70 miles (from the source to Canal Flats), five rivers—the Vermillion, Simpson, Cross, Palliser and White—empty into the Kootenai. Together those streams drain an area of approximately 2,080 square miles. At Canal Flats, the Kootenai enters the Rocky Mountain Trench, and from there to where it crosses the border into Montana, a distance of some 83 miles, it is joined by several more tributaries (Skookumchuck, Lussier, St. Mary, Elk, and Bull Rivers and Gold Creek). Collectively, they drain another 4,280 square miles. After entering Montana, the Tobacco River and numerous small tributaries flow into Koocanusa Reservoir. Between Libby Dam and the Montana-Idaho border, the major tributaries are the Fisher and Yaak Rivers. In Idaho, the major tributary is the Moyie River, which joins the Kootenai from the north between the Montana-Idaho border and Bonners Ferry, Idaho. The Goat River enters the river in Canada, near Creston, B.C.

Almost all of the major tributaries to the river—including the Elk, Bull, White, Lussier, and Vermillion Rivers—have a very high channel gradient, particularly in their headwaters. The highest headwater areas lie almost 10,000 vertical feet above the point at which the Kootenai River enters Kootenai Lake. Much of the mainstem, however, has a low gradient; from near Canal Flats to where the river enters Kootenay Lake, a distance of 300 miles, the river drops less than 1000 feet. Still, even there valley-bottom widths are generally under two miles and are characterized by tree-covered rolling hills with few grassland openings. Only in the Bonners Ferry-to-Creston area and the Tobacco Plains are there slightly wider floodplains.

In terms of runoff volume, the Kootenai River is the second largest Columbia River tributary. In terms of watershed area (10.4 million acres), the subbasin ranks third in the Columbia (Knudson 1994).

The Kootenai River can be divided into seven segments based on geomorphic characteristics. The Headwaters Segment (1) is that portion of the river upstream from Canal Flats. The headwaters drain one national park, two provincial parks, and extensive "crown" or public land administered by the B.C. Forest Service along the BC-Alberta border in the Northern Rocky Mountains (the actual origin is in Kootenay National Park west of Mount Assiniboine). The length of this river segment is about 70 miles. Major tributaries include the Vermillion, Simpson, Cross, Palliser and White Rivers. The Canal Flats to Wardner Segment (2) extends from Canal Flats to the head of Koocanusa Reservoir at Wardner, B.C. Major tributaries in this segment—the Skookumchuck, St. Marys, Wildhorse, and Bull Rivers—have delivered enormous volumes of gravel and silts across a broad river floodplain, which is 1 to 1.5 miles wide and 150 to 300 vertical feet below the general level of the Rocky Mountain Trench (Jamieson and Braatne 2001). The Koocanusa Segment (3), which bridges the International border, encompasses all of Koocanusa Reservoir. Koocanusa Reservoir is 90 miles long and 370-feet deep, has a surface area of approximately 73 mi^2 and a volume of 5.9 million acre-feet at full capacity. Created by Libby Dam, it backs water 42 miles into Canada. Major tributaries in this segment include the Elk and Tobacco Rivers and Gold Creek. Pre-dam, the river flowed through a series of alluvial braided floodplains sections, then entered a restricted canyon-like section from Rexford to the dam site. The Libby Segment (4) begins at Libby Dam in Montana and runs to the confluence with the Moyie River in Idaho. Characterized by steep terrain, the river flows through a canyon and a constricted floodplain. The river length in this reach is 57 miles; the Idaho portion about 12 miles. The Moyie to Bonners Segment (5), extends from the Moyie River to Bonners Ferry, a distance of just 4.7 miles. The river here is characterized by an extensively braided channel. The Bonners to Kootenay Lake Segment (6), stretches just over 51 miles. The river flows through flat agricultural land here, has a much slower velocity and less gradient than the other segments, and numerous meanders. The reach is located entirely within the Purcell Trench (Snyder and Minshall 1996). The last segment (7) is the Kootenay Lake Segment. Kootenay Lake, a regulated lake with water levels managed by the operations of the Coral Lynn Dam at Nelson, lies between the Selkirk and Purcell Mountain ranges. It is 66.5 miles long and approximately 2.5 miles wide with a mean depth of 308.4 feet and a maximum of 505 feet (Daley et al. 1981). In addition to the Kootenai River, which enters its south end, the Kootenay Lake is also fed by the Lardeau/Duncan system at its north end. The outlet of the main lake, at Balfour, British Columbia, forms the east end of the West Arm. At this outlet, a sill approximately 26 feet in depth produces a distinct boundary between the main lake and the West Arm that is physically and limnologically different from the main lake. The south and north arms are also limnologically distinct (B. Jamieson, pers. comm. 2004).

In terms of ecological classification systems, the Montana portion of the Kootenai Subbasin lies in the Flathead Valley sections of the Northern Rocky Mountains Steppe-Coniferous Forest-Alpine Meadow Province (M333) and includes the subsections listed in table 1.1. The Idaho portion of the Kootenai Subbasin lies in the Northern Rockies Section. In the British Columbia Ecoregion Classification system, the Canadian portion of the subbasin falls within four ecoregions, which are within the Southern Interior Mountains Ecoprovince (table 1.2).

LINKS

Appendix 1 includes a series of Kootenai Subbasin Geographical Area descriptions prepared by the USFS that provide a good overview of the subbasin. Each includes maps and information on: Ownership, Forest Access and Recreation; Bear Management Units and Lynx Analysis Units; Roadless Areas, Special Interest Areas, Research Natural Areas, Proposed Wilderness, and Wild and Scenic Rivers; Watershed condition and 303(d) streams; TE&S watersheds by aquatic species (bull trout, westslope cutthroat trout, Columbia River redband trout); Habitat type groups and old growth; timber harvest; wildfire, and human population density.

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

Click Here

Table 1.1. Ecological Units of the U.S. Portion of the Kootenai Subbasin (Nesser et al. 1997).

Section	Subsection	Code
Okanogan Highlands		**M333A**
	Selkirk Mountains	M333Ab
	Northern Idaho Valleys	M333Ac
Flathead Valley		**M333B**
	Purcell/North Cabinet	M333Ba
	Cabinet Mountains	M333Be
	Salish Mountains	M333Bb
	Flathead River Valley	M333Bc

Table 1.2. Ecological classification of the B.C. portion of the subbasin. Source: B.C. Ecoregion Classification System).

Province	Region	Section
Southern Interior Mountains		
	Northern Columbia Mountains	
		Northern Kootenay Mountains
		Central Columbia Mountains
		Southern Columbia Mountains
		Eastern Purcell Mountains
		McGillvray Range
	Northern Continental Divide	
		Crown of the Continent
		Border Range
	Southern Rocky Mountain Trench	
		East Kootenay Trench
	Western Continental Ranges	
		Southern Park Ranges

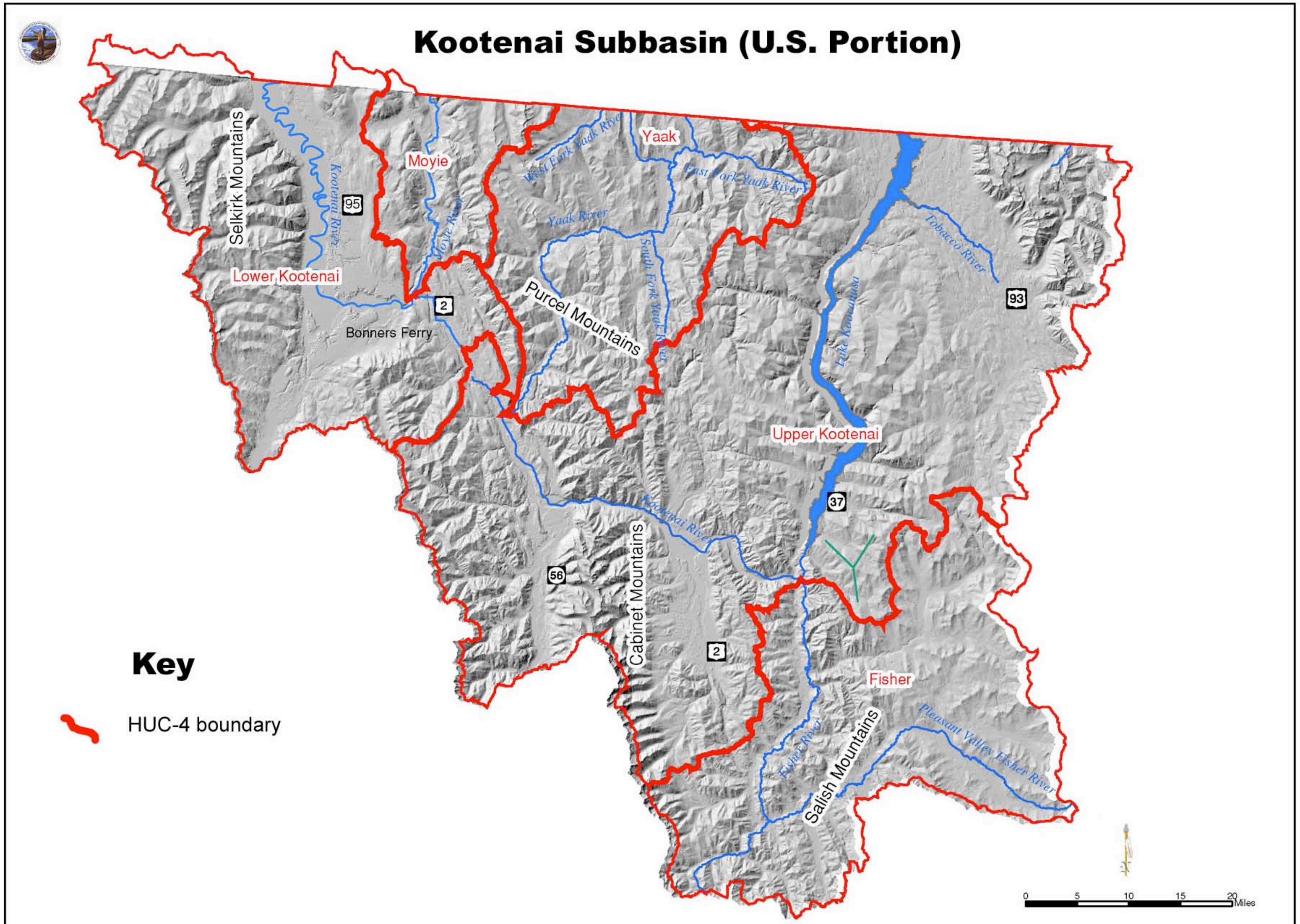

Figure 1.1. Kootenai Subbasin, U.S. Portion.

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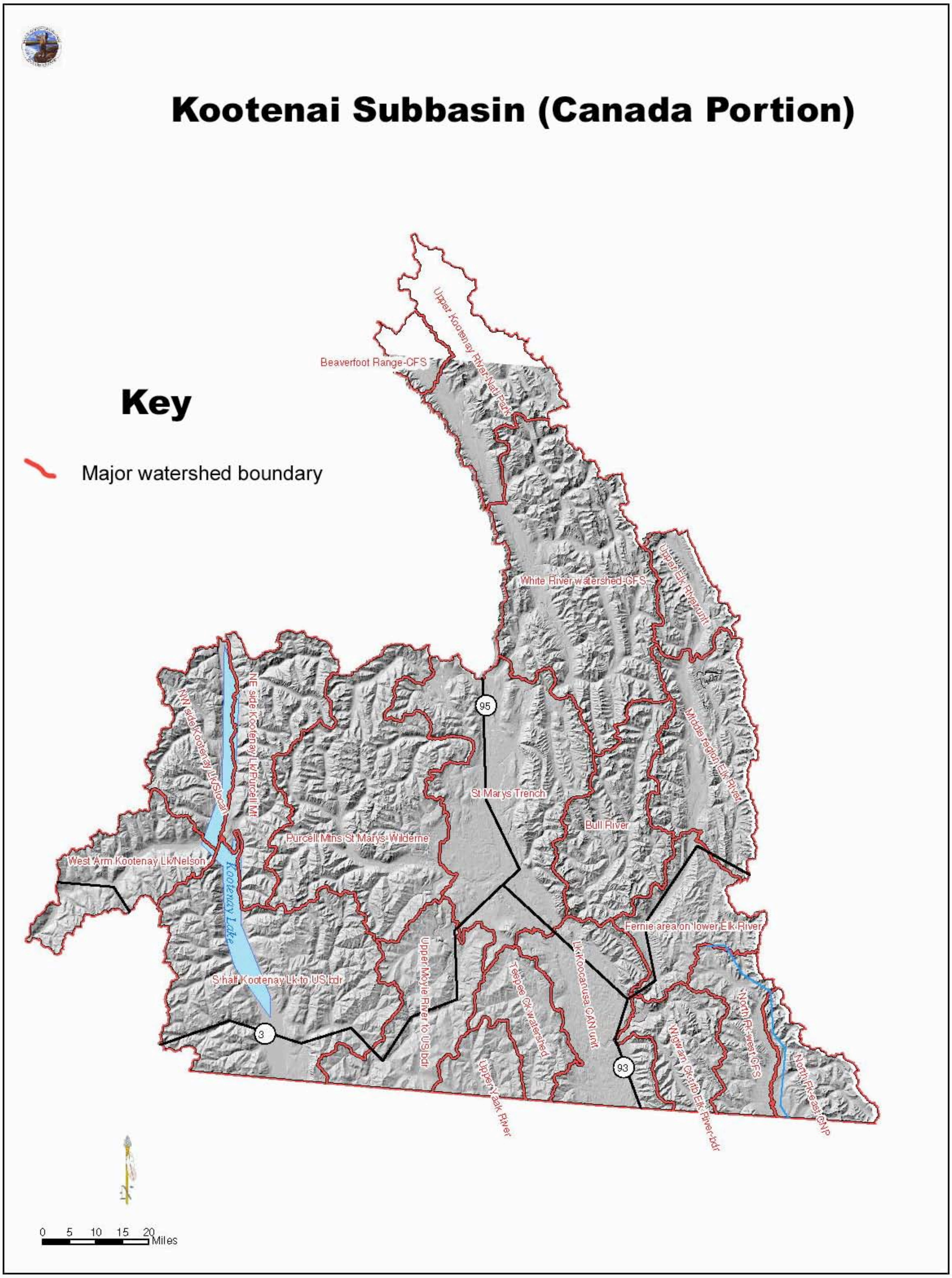

Figure 1.2. Kootenai Subbasin, Canada Portion.

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1.1.1 Land Status and Administrative Structure[2]

The Upper Kootenai River watershed (all of the Montana portion of the subbasin except the Fisher and Yaak watersheds) encompasses 2,290 square miles (1,465,600 acres). Land ownership is 78.5 percent U.S. Forest Service, 1.7 percent State of Montana, and 19.8 private and other public entities. The Fisher River watershed encompasses 817 square miles (522,880 acres). Ownership in the Fisher watershed is 36.5 percent U.S. Forest Service, 4.1 percent State of Montana, and 59.4 percent private and other public entities. The Yaak River watershed encompasses 611 square miles (391,040 acres), 96.4 percent of which is managed by the U.S. Forest Service. Another 3.6 percent is in private ownership or managed by other public entities. The Lower Kootenai (all of the Idaho portion of the subbasin except the Moyie watersheds) encompasses 889 square miles (568,800 acres), of which 76.7 percent is managed by the U.S. Forest Service. Another 23.3 percent is in private ownership or is managed by other public entities. The Moyie River encompasses 208 square miles (133,120 acres). Land ownership in the Moyie is 99.7 percent U.S. Forest Service and 0.3 percent private and other public entities. Table 1.3 summarizes ownership in the Idaho and Montana portions of the subbasin. Figure 1.3 shows ownership in the U.S. portion of the subbasin.

SNAPSHOT

Roughly 71 percent of the the U.S. portion of the basin is owned and managed by the Kootenai and Idaho Panhandle National Forests. Most of the remaining timberland is privately owned by Plum Creek, a large multi-state corporation. The B.C. portion of the subbasin is mostly "Crown Land."

Table 1.3. Landownership in the US portion of the Subbasin. Source: CSKT.

Owner	Acres	Percent
Montana Portion of the Subbasin		
U.S. Forest Service	1,753,033	73.36%
U.S. Bureau of Land Management	260	0.01%
Other Federal	9,579	0.40%
State of Montana	51,887	2.17%
Private land	206,432	8.64%
Corporate Timber land	368,390	15.42%
Other	157	0.01%
Idaho Portion of the Subbasin		
U.S. Forest Service	421,693	62.27%
U.S. Bureau of Land Management	6,274	0.93%
Other Federal	2,766	0.41%
State of Idaho	26,702	3.94%
Private land	187,452	27.68%
Corporate Timber land	32,295	4.77%
Other	1,325	0.20%

LINKS

Appendix 2 contains brief descriptions of major land management agencies in the subbasin and their jurisdictional responsibilities with respect to fish and wildlife restoration and protection.

Click Here

Appendix 86 summarizes federal activities and authorities on the Kootenai River.

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[2] *Adapted from USFWS (1999a)*

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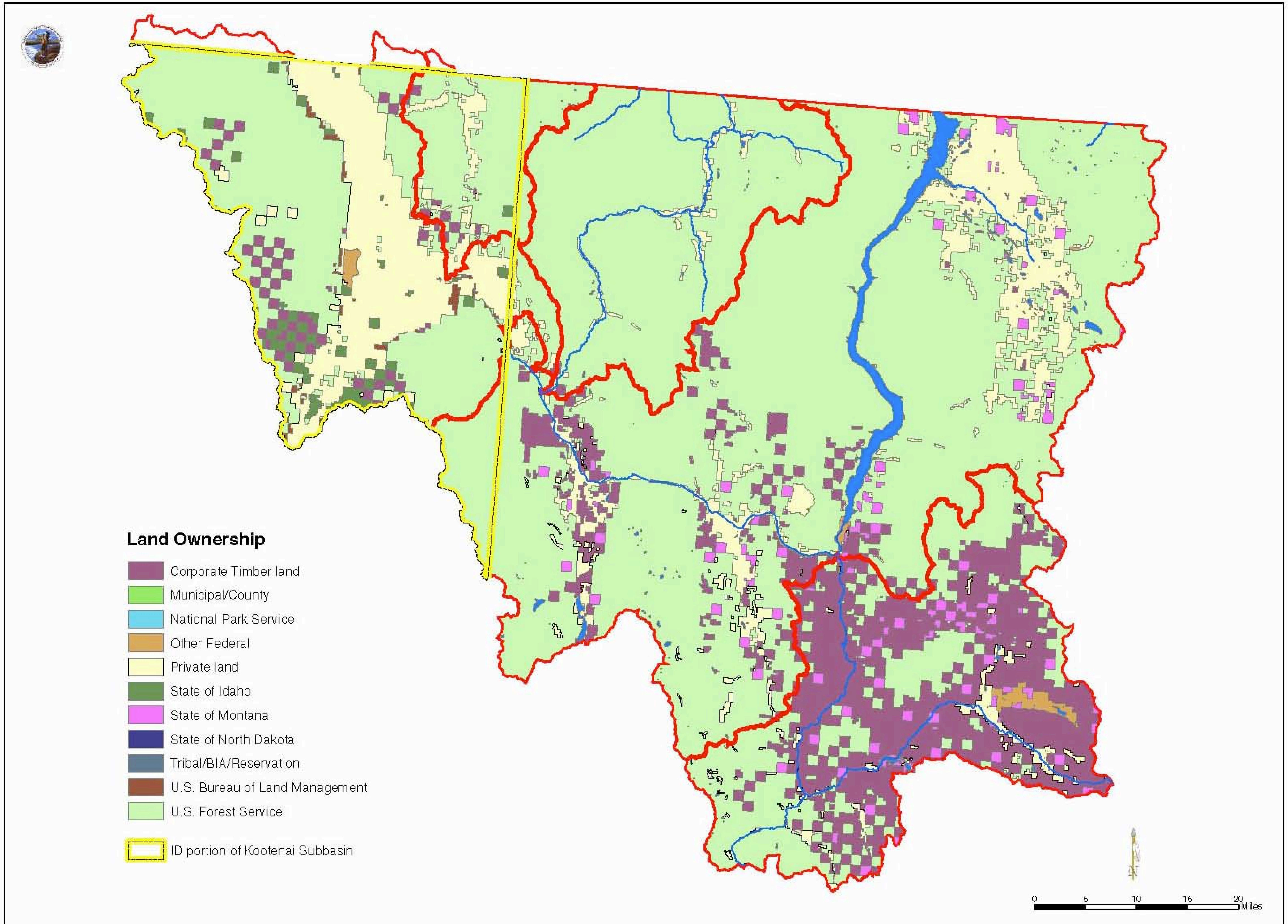

Figure 1.3. Landownership in the U.S. portion of the Kootenai Subbasin.

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1.1.2 Climate

The strongest determinants of weather across the subbasin are the Pacific Ocean and mountains. Warm, moist Pacific air masses from the Pacific bring most of the weather during winter, spring, and fall; mountains in turn control where most of the moisture carried by those airmasses will fall. The mountains also act as a barrier to the flow of continental air, especially during winter.

The subbasin falls within the Continental/Maritime Province (Rain and Snow) (USDA Forest Service 1980), which means temperature regimes and precipitation patterns are strongly influenced by moist, Pacific air masses. Because of the strong influence of inland marine airflow, precipitation in the subbasin is generally heavier than other, more easterly parts of the Rocky Mountains. However, precipitation tends to vary on a decadal basis, with wet periods and dry periods, each of which can last several years to decades (Finklin and Fischer 1987). In the Kootenai Subbasin, extended droughts raise the fire danger and stress trees, especially the more drought intolerant species.

Summers are generally cool to warm, winters cold and wet. Both seasons tend to be relatively mild compared to areas to the east at the same latitude because of the warm, moist Pacific air masses. The mean temperature for Libby, Montana, and Bonners Ferry, Idaho, in July is just 67 °F, and for most of the near-lake area around Kootenay Lake it is 64 °F. In January, Bonners Ferry, Libby, and the Kootenay Lake area average a mild 25 °F. Over half of the precipitation that falls over the subbasin comes as winter snow, with November and December usually being the wettest months (Bauer 2000). Winters are typically cloudy with overcast conditions prevailing as much as 75 percent of the time. (The Cranbrook, B.C., area is an exception to this rule. It receives considerably more sunlight hours than other parts of the subbasin.) Partly cloudy conditions generally prevail during spring, and during the summer months more than 50 percent of the days are clear (Panhandle Basin Bull Trout Advisory Team (1998).

Continental air masses are responsible for the occasional intrusions (from the northern and arctic regions) of cold and frigid air that interrupt the usual pattern of mild winter weather. These cold fronts can bring winter temperatures down to -30 °F. But temperatures this low are infrequent because mountains generally restrict the westward flow of the cold, continental Arctic air masses. A large, semipermanent high pressure center over the Pacific Ocean controls the summer climate in the subbasin. Prevailing westerlies weaken, and the frequency and intensity of Pacific storms decline. In middle and late summer the "Pacific high" often exerts dominance over western North America, allowing continental air to bring generally warm, clear weather to the subbasin. The predictable summer drought, usually occurring in July and August, is a defining characteristic of the

SNAPSHOT

The Kootenai River Subbasin's climate is affected by both modified maritime and continental influences. Maritime influences are dominant in the winter and result in rain or snow. Continental influences are generally dominant in the summer. Winters are neither as wet nor as warm as Pacific coastal areas, but are generally warmer and wetter than areas to the east. The dominant maritime influence gives way to continental influences as one moves eastward through the subbasin. Weather patterns are complex, with local variations stemming from differences in elevation. Adapted from PBTTAT (1998)

LINKS

Appendix 3 has climate summary descriptions for major portions of the Canadian part of the subbasin.

Click Here

For climate summary data go to: http://www.krisweb.com/kriskootenai/krisdb/webbuilder/selecttopic_climate.htm

Click Here

For additional climate information on the subbasin, http://www.wcc.nrcs.usda.gov/cgibin/state.pl?state=id

Click Here

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

Click Here

For individual B.C. climate station data, go to: http://scitech.pyr.ec.gc.ca/climhydro/mainContent/main_e.asp?province=bc

Click Here

local, temperate climate (USFS KNF 2002). Afternoon thunderstorms are not uncommon during the summer in the subbasin, but severe storms are infrequent.

One notable effect of these two overlapping climatic provinces is the generation of "rain-on-snow" events (which occur in the subbasin every 3 to 10 years). Two to three days of continuous rain falling on the snow pack can cause significant flooding and flood-associated damage and resource impacts. These storms often occur after continental influences have dominated the area (USFS KNF 2002).

The mountainous character of the country and its extreme elevation differentials over short distances can produce strong local differences in climate. In winter, frontal systems generated over the North Pacific move eastward until they reach the subbasin, along the way encountering successive mountain barriers that trend northwest-southeast, or roughly perpendicular to upper air flow. As the moist air flows from the west meets a range of mountains, it is forced up the mountain slopes. It cools as it rises, which forces some of its moisture to fall as rain or snow. As the air crosses the range it descends over the eastern slopes. As it drops, it is warmed by compression, which causes the clouds to thin out, creating a rain shadow. Hence, the mountain ranges largely determine the overall distribution of precipitation.

Appendix 3 has climate summary descriptions for major portions of the Canadian part of the subbasin.

Precipitation

Montana[3]

Less than 15 inches falls in the Tobacco Valley (just 13.8 inches in the Eureka Valley [Kuennen and Gerhardt 1995]). This is reflected by the grasslands and open stands of trees found adjacent to the town of Eureka. The prairie-like appearance of the valley north of Eureka is a palouse prairie remnant, and a similar remnant occurs in the Wycliffe area near Cranbrook, B.C.

More than 100 inches of precipitation falls in the Cabinet Mountains located southwest of Libby, the majority as snow. The area downstream of Libby is in the interior wet belt with annual precipitation exceeding of 40 inches. Upstream areas receive under 40 inches.

Idaho

The mean annual precipitation for the Idaho portion of the subbasin is only 30 inches but varies. Just under 21 inches falls annually at Porthill, Idaho. The Kootenay

[3] *Adapted from USFS KNF (2002)*

Lake portion of the Purcell Trench in B.C. receives about 30 inches a year. Creston receives just under 20 inches. An estimated 120 inches falls at the highest elevations.

Approximately 70 to 80 percent of the total precipitation falls as snow. The annual snowfall varies from about 40 inches at the lower elevations to 300 inches in some parts of the mountain areas. Most of the snow falls during the November to March period, although heavy snowstorms can occur as early as mid-September or as late as May 1.

Temperatures

Montana

The average annual temperatures for Libby and Eureka are 45.1 °F and 44.7 °F, respectively. The characteristic topography of high mountain ranges and low valleys has a large influence on local air temperatures, particularly during periods of clear skies. While days during the summer are usually warm (about half of the days of July and August have maximum temperatures of 90 degrees or warmer), it cools quickly after sunset. Summer nighttime lows are commonly in the forties. These large daily differences are reflected by a relatively short growing season. Temperature inversions are common, especially in the winter. Fog is common in the winter, adding to the moderated temperatures.

Idaho

The characteristic topography of high mountain ranges and low valleys has a large influence on local air temperatures, particularly during periods of clear skies. A mean annual temperature of about 41 °F is representative of the subbasin as a whole with a fairly wide range between reporting stations. The average annual temperatures for Porthill and Bonners Ferry are 45.7 °F and 46.9 °F, respectively. While days during the summer are usually warm (about half of the days of July and August have maximum temperatures of 90 degrees or warmer), it cools quickly after sunset. Summer nighttime lows are commonly in the forties. July is the warmest month with mean temperatures ranging from 67 °F at Libby to 57 °F at Sinclair Pass. The extreme maximum temperatures of record at the same stations are 109 °F and 97 °F. January is the coldest month of the year with mean recorded temperatures ranging from 22 °F at Libby to 12 °F at Sinclair Pass. The extreme low temperatures at the same stations are -46 °F and -44 °F respectively. Extremely cold temperatures are not common, however, and at Libby temperatures of 0 °F are reached on only 12 days in an average year. Temperature inversions are common, especially in the winter. Fog is common in the winter, helping to moderate temperatures.

SNAPSHOT

Mountain ranges trending north to northwest separated by long straight valleys characterize the subbasin. Except for the relatively broad, flat valleys in these trenches where the terrain is moderate; the area is typified by narrow valleys and rugged steep slopes with frequent rock outcroppings. Bedrock is chiefly folded and faulted crustal blocks of metamorphosed, sedimentary rock materials of the Precambrian Belt series—erosion-resistant siliceous argillites, quartzites, and impure limestones that have been subjected to low-grade metamorphism. Granitic intrusions (sills, stocks, and batholiths) occur throughout the subbasin.

1.1.3 Geology and Geomorphology[4]

General

Situated along the west limb of the Rocky Mountains, the Kootenai Subbasin is underlain principally by metamorphosed sedimentary rock of the Belt Supergroup. Belt rocks were laid down during the middle and late part of the Proterozoic Eon of the Precambrian Era (about .57 to 1.5 billion years ago) (Harrison, Cressman, and Wipple 1983). They have been stratified into the Lower Belt, the Ravalli Group, the Middle Carbonate Group, and the Missoula Group. The rocks are mostly quartzites, siltites, argillites, dolomites, and limestones, which are composed of sand, silt, clay, and carbonate materials that have been altered by pressure and heat. The rocks of the thicker, older formations are more visible in the northern part (north of the Kootenai River/Fisher River junction) of the Montana portion of the subbasin while the rocks of the younger formations are more visible in the western part. In places, Precambrian-aged diabase sills occur within the belt formations. Most are a few hundred feet thick, although the Moyie sill of northern Idaho and southeastern B.C. is 1,400 feet thick. Intrusions of Cretaceous-aged granitic-like rock occur, but they are generally small.

The Belt rocks themselves are fine-grained, hard, highly stable, and resistant to erosion; they account for the generally high stability of the subbasin's watersheds (Makepeace 2003) and they have profoundly influenced basin and channel morphology (Hauer and Stanford 1997). Where exposed, they form steep canyon walls and slopes and confined stream reaches, and there is generally a large amount of topographic relief between ridge crests and valley floors. Another characteristic of Belt Supergroup rocks is that they are deficient of nutrients. Hence the subbasin's bedrock geology contributes little in the way of dissolved ions, nutrients, and suspended particulates to streams (Makepeace 2003; Stanford 2000).

Small exposures of sedimentary rocks of the Cambrian Period (approximately 500 to 570 million years ago) and Devonian Period (approximately 360 to 410 million years ago) occur in Swamp Creek south of Libby and north of Eureka along the Canadian border, respectively. Cretaceous-age (approximately 70 to 140 million years ago) rocks (syenite and pyroxenite) are exposed in the Alexander and Pipestone Planning Subunits of the Kootenai National Forest. Cretaceous-age intrusions of granitic-like rock are located in the Callahan, Keeler, and Lake Subunits.

Upstream from Montana in B.C., the subbasin is defined by a range in the Columbia Mountains (the Purcells), the southern Rocky Mountain Trench,

[4] Adapted primarily from: USFS KNF (2002); Deiter (2000); and PWI (1999). Paragraphs on the B.C. part of the subbasin upstream from MT adapted from Ryder, J. (2003)

and the southern Rocky Mountains. The Purcells are lithologically and structurally complex. In general, summit elevations range from 6900 to 8800 feet (although Mt. Findlay is 10,371 ft). Where summits are high, the mountains are extremely rugged, and where deep valleys flank high peaks, local relief of 6500 feet is not uncommon. Ridges and peaks above 6500 to 8200 feet are not overridden by ice and are serrated. Lower summits and crests are subdued and rounded and may have a thin covering of till. Drift is present on valley floors (along with fluvial materials) and on gentler mountain slopes at relatively low elevations. Steeper slopes consist of rock outcrops and rubbly colluvium. Avalanching occurs on steep valley sides at all elevations. Glacial drift is widespread on valley floors and gentler lower slopes of the intervening valleys.

The Rocky Mountain Trench is a 1,000-mile-long, asymmetric, fault bounded half-graben in which bedrock strikes northwest and dips northeast and which is covered by glacial and fluvial deposits (Holocene fluvial sediments occupy extensive areas and consist of terrace gravels and floodplain silts, sands and gravels). The trench and other northwest-trending valleys were created during a regional southwest-directed extensional event that followed early Cenozoic eastward thrusting (Constenius 1996).

In the southern Rocky Mountains of B.C., the topography reflects the structural control of underlying folded and faulted sedimentary rocks. Erosional landforms of alpine and valley glaciation such as cirques, troughs and horns are commonly asymmetric where they are cut in moderate to steeply dipping strata. The broadest troughs are located along zones of 'soft' rock. Summit elevations range up to 11,800 feet and local relief is typically 3500 to 4900 feet. The distribution of drift in the Rockies is similar to that in the Purcell Mountains. However, rapid disintegration of the well jointed sedimentary rocks of the Rockies has given rise to much talus development, and to the formation of mantles of rubbly debris over bedrock slopes above timberline.

Downstream from Idaho in B.C., the western margin of the subbasin encompass the eastern edge of the Priest River Complex, which exposes Cretaceous granitic rocks of the Kaniksu batholith (Link 2002). This uplift intrudes Belt Supergroup rocks, causing high-grade deformation.

The Purcell Trench, which the Kootenai River enters at Bonners Ferry, is perhaps the most important structural feature of the lower part of the subbasin. Lying between the Selkirk and Purcell Mountains, it is a glacially-enlarged, asymmetric, fault-bounded half-graben similar in its physiography to the Rocky Mountain Trench, which is larger and which sits the other side of the Purcell Range. The Purcell Trench also holds Kootenay Lake. The bottom of the trench, the lower slopes of the valley and alluvial terraces are covered with deposits of

LINKS

Appendix 4, the focus of which is soils, also includes a good deal of basic geologic information for major portions of the Canadian part of the subbasin.

Click Here

Appendix 5, presents a concise geologic history of the Idaho portion of the subbasin and describes some aspects of the area's geology in more detail.

Click Here

glacial debris (till and fluvioglacial gravels) and older sediments. Other major structural features created by faults in this part of the subbasin include the Moyie River corridor and the valley between the Purcell and Cabinet mountains.

Kootenay Lake is situated in an arcuate belt of complexly folded sedimentary, volcanic, and metamorphic rocks of Precambrian to early Mesozoic age that have been intruded by granitic rocks of the Nelson Batholith (Daley et al. 1981).

Figure 1.4 and 1.5 show geology of the U.S. and Canadian portions of the subbasin, respectively.

LINKS

For more detailed descriptions of landforms go to Appendix 6.

Click Here

Glaciation

Within the last 2 to 3 million years, mountains in the subbasin have experienced several episodes of continental glaciation that has significantly altered their appearance. The last major advance by the Cordilleran ice sheet reached its maximum extent roughly 15,000 years ago and ended about 10,000 years ago. It left unconsolidated surface sediments in many watersheds that include glacial tills, glacial stream deposits, and fine-grained glacial-lake sediments. Eskers and kames (depositional ridges), kettle lakes, and drumlins (depositional mounds) are features that can be seen resulting from the continental glaciation. Soil material derived from continental glaciation contains large amounts of fine sands and silts, depending on whether the soil particles were ground from quartzite, siltite, or argillite bedrock. Other landform features associated with glaciation are lacustrine and outwash terraces. These are created by material moving into lakes and material deposited by moving meltwaters. The lacustrine soil materials are composed mostly of silt- and clay-sized particles. Rocks are generally nonexistent. Outwash or meltwater soil materials range from silts to boulders.

Alpine glaciation occurred mainly in the Cabinet Mountains, south and southwest of Libby, and the Galton Mountains, east of Eureka. Alpine glaciation creates a spectacular landscape, leaving such features as horns, arêtes, cirque lakes and headwalls, and steep valley trough walls. There are also valley and end moraines that are built as the alpine ice pushed its way out into the lower valleys.

Glacial Lake Kootenai, caused by an ice dam that blocked outflow of the Kootenai River from the west arm of Kootenai Lake, formed as the Continental glaciers receded. While the ice dam was in place, the Kootenai River spilled into the Pend Oreille Basin over the hydrologic divide near McArthur Lake. At its maximum, glacial Lake Kootenai connected the modern Kootenai and Pend Oreille Lakes. Northcote (1973) notes that the extensive connections between waters of the Kootenai system and the large glacial lakes in valleys of the Columbia system to the south during this period allowed the Kootenai to be colonized by fish species whose entrance would now be blocked by the falls on the Kootenai River, about 12 miles upstream from the junction of the Kootenai and Columbia Rivers.

During this period, heavy silt loads from streams and glacial melt water were deposited into the lake. The Kootenai River eroded and removed much of the lake deposits as the ice dam cleared. As a result, river breaklands in the Idaho portion of the subbasin were created from the Kootenai River floodplain to the top of the remaining lake sediments that form benches on both sides of the Purcell Trench. These benches have a nearly uniform upper elevation between 2,200 to 2,300 feet. In addition to lake deposits, the bench lands surrounding the Kootenai and Moyie Rivers also contain moraines and valley train deposits which tend to be well drained. As a result surface runoff is converted to ground water flow and the streams become influent causing them to go dry or become intermittent when draining over these deposits.

Faulting and repeated glaciation has caused the base elevation of the lower Kootenai River to be significantly lowered, and as a result, tributaries to the Kootenai have had to vigorously down cut to try to match grade with the Kootenai valley in Idaho. Of the major tributaries, only Deep and Boundary Creek have matched grade with the Kootenai River. The remaining tributaries have waterfalls which are barriers to fish migration. The rapid tributary down cutting has resulted in oversteepened mountain slopes, which tend to be less stable than slopes that have not yet been similarly affected. Natural and management induced landslides are most common on these landforms.

For larger lower Kootenai River tributaries, the elevation of oversteepened stream gradients and valley side slopes range from 3,000 to 4,200 feet in elevation in the Selkirks (3,500 feet is most common). Similar patterns of streams and slopes range about 2,400 to 2,600 feet in the Moyie River and Boulder Creek, which flow out of the Purcell and Cabinet Mountains.

Remnant lacustrine deposits along tributary streams and the mainstem continue to be a source of fine sediments. The river formed an extensive network of marshes, tributary side channels, and sloughs. Some of these wetlands continued to be supported by groundwater recharge, springtime flooding, and channel meandering, but much of this riverine topography has been eliminated by diking and agricultural development, especially in the reach downstream from Bonners Ferry, Idaho.

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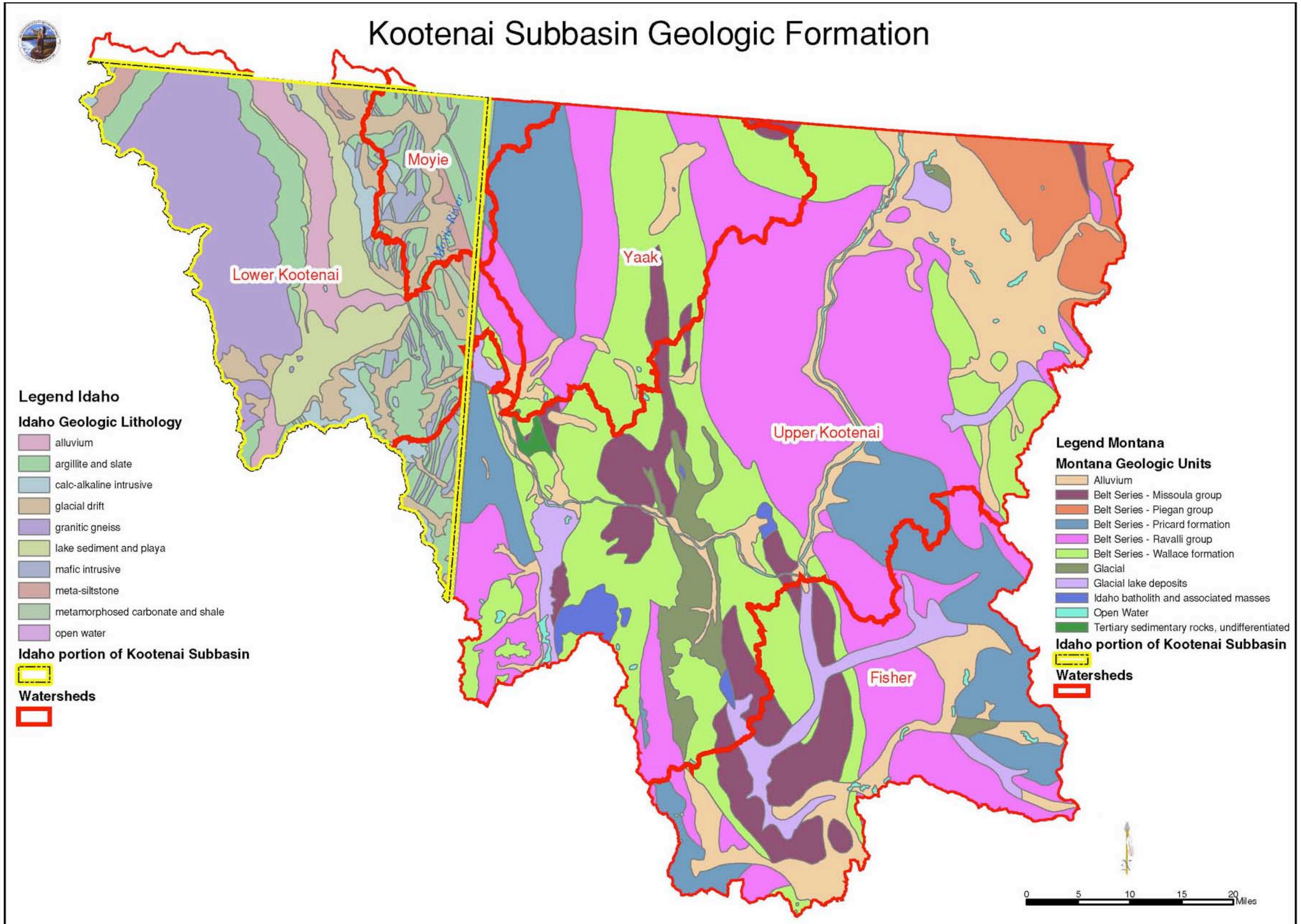

Figure 1.4. Geology of the U.S. portion of the Kootenai River Subbasin.

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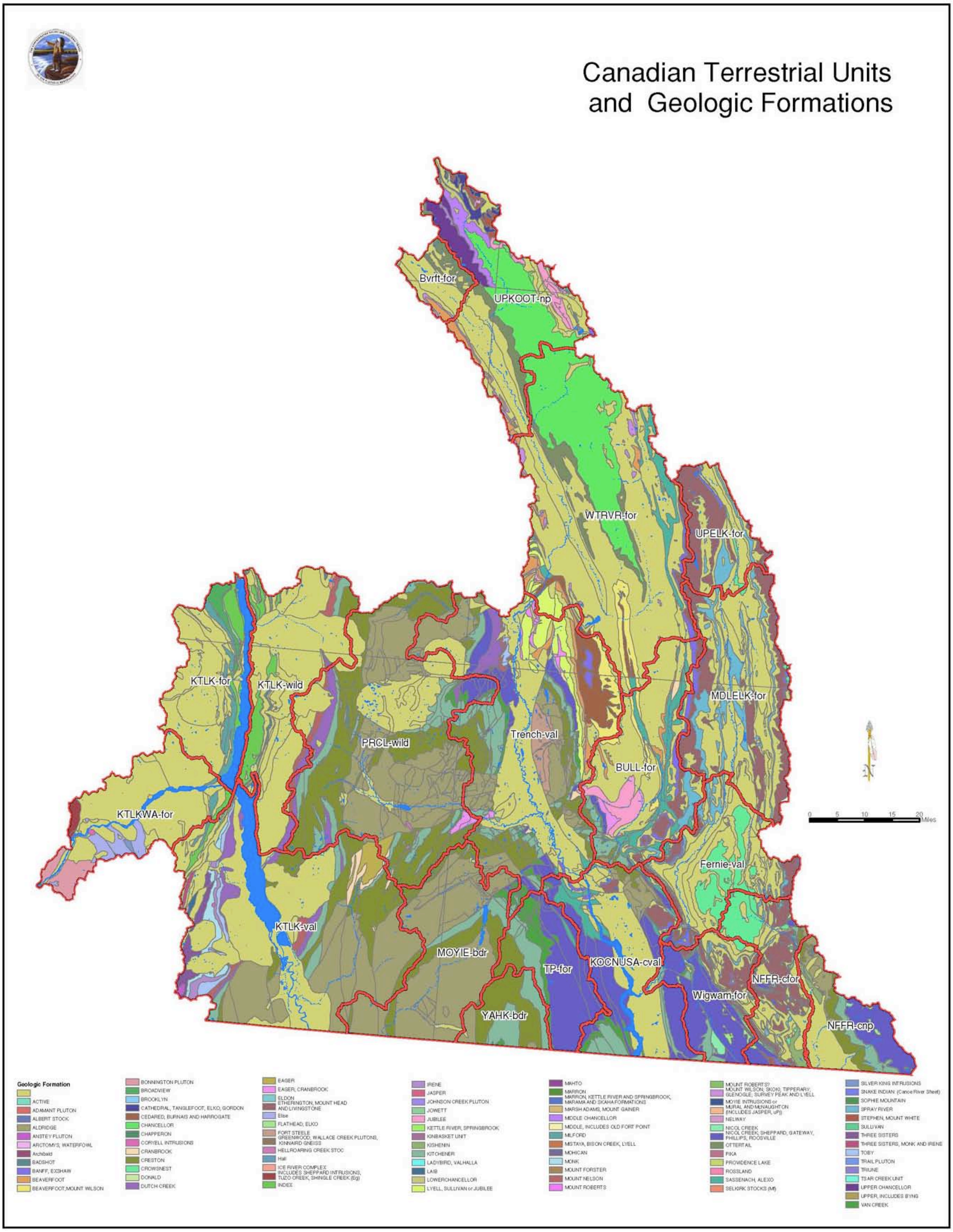

Figure 1.5. Geology of the Canadian portion of the Kootenai River Subbasin.

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1.1.4 Soils and Landtypes

Overview[5]

The basin is underlain by metasediments of the Belt Supergroup and granitic rocks of the Kaniksu Batholith. The Belt rocks are quartzite-based and weather into a broad range of size classes. Belt-rock derived soils are significantly more stable and resilient on hill slopes and in stream channels than the uniform coarse weathered granitic sands of the intrusive batholiths. The bedrock is typically covered with glacial till, which consists of unsorted and unstratified materials. The till derived from Belt rocks is usually medium textured with a moderate amount of rock fragments. That derived from granite is usually sandier and varies more in its rock-fragment content. The top portion of the glacial till is loose and permeable, while the lower part can be dense and impermeable. The dense layer can restrict water movement and root penetration. Deposits of outwash and alluvium are found in valley bottoms and were deposited by streams.

Glaciofluvial deposits are located on slopes and valley bottoms where ice lobes caused water to pond. Lacustrine sediments from glacial lakes are usually found at elevations below 2,600 feet, but they are also found at higher elevations. These deposits typically have a silt to sandy texture with few rock fragments. The lacustrine soil has more sand near the Pend Oreille-Kootenai divide.

A layer of volcanic ash—mostly from Mt. Mazama—that is 0.5 to 1.5 feet thick has covered most of the glacial material. The ash usually has a silt-loam texture with little gravel, cobble, or rock fragments. It normally has a high infiltration rate, high permeability, and a high water- and nutrient-holding capacity, making it excellent for tree growth. Ash, however, is easily compacted and displaced by heavy equipment.

Geologic groups weather to produce soils with similar properties, and the following brief descriptions[6] characterize this for the subbasin:

Alluvium is unconsolidated material sorted and deposited by water. The rock fragments are generally rounded. Alluvium forms flood plains, terraces, and alluvial basins along the major streams. Flooding, the fluctuation of the water table, and the need to protect stream banks and channels can limit management of soils that formed in alluvium.

SNAPSHOT

Soils are mostly derived from Belt-rock formations and are typically stable and resilient on hill slopes and in stream channels. Bedrock is generally covered with glacial till. The top portion of the glacial till is loose and permeable, while the lower part can be dense and impermeable. The dense layer can restrict water movement and root penetration. Deposits of outwash and alluvium are found in valley bottoms. Glaciofluvial deposits are located on slopes and valley bottoms. Lacustrine sediments from glacial lakes are usually found at elevations below 2,600 feet. A layer of volcanic ash covers most of the glacial material.

[5] *Adpated from Deiter (2000).*
[6] *Excerpted from: USDA USFS and NRCS 1995. Soil Survey of Kootenai National Forest Area, Montana and Idaho.*

LINKS

For more detailed information on landtype associations and soils, go to Appendix 10.

Click Here

Appendix 11, an excerpt from the draft Boundary County Soil Survey (NRCS 2003), has more detailed information about general soil groups and their locations within the Idaho portion of the subbasin.

Click Here

Appendix 12, excerpted from the Upper Kootenai Subbasin Review, provides background information on the soils of the upper Kootenai.

Click Here

Appendix 4 has soils information for each of the biogeoclimatic zones in the Canadian portion of the subbasin.

Click Here

Lacustrine deposits are unconsolidated silts and clays deposited on glacial lake bottoms. These deposits are typically varved with thin sedimentary layers resulting from seasonal variations in deposition. They form terraces that have gently sloping surfaces and steep risers. Soils that formed in lacustrine sediments are erodible when they are exposed by excavation and have low strength when they are wet.

Glacial outwash is material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. It forms terraces that have nearly level surfaces and steep risers. In some areas, the glacial outwash has been reworked by wind and the terraces include depressions and dunes that are characterized by low relief. Soils that formed in glacial outwash have sandy substrata containing rounded pebbles and cobbles.

Compact glacial till is unconsolidated silt, sand, gravel, and boulders deposited by a glacier. It is associated with continental ice sheets. It forms moraines or mantles glaciated mountain slopes and ridges. Soil substrata that formed in compact glacial till are hard and brittle when they are moist. They have a bulk density of 1.5 to 1.8 grams per cubic centimeter and restrict the penetration of roots and the movement of water.

Friable glacial till is associated with alpine glaciers. It forms moraines in U-shaped glacial valleys and in cirque basins and mantles glacial trough walls and glaciated mountain ridges. Soil substrata that formed in friable glacial till have bulk density of 1.2 to 1.5 grams per cubic centimeter. They do not restrict the penetration of roots and the movement of water.

Glacial drift is a combination of compact glacial till and lacustrine deposits in a pattern that is too complex to map separately. It forms kame and kettle topography. Soil substrata that formed in compact glacial till restrict the penetration of roots and the movement of water. Those that formed in lacustrine sediments do not restrict the penetration of roots and the movement of water.

Metasedimentary rocks are mainly argillites, siltites, quartzites, and dolomites of middle Proterozoic age. When weathered, these rocks produce loamy material containing many angular rock fragments. Soils that formed in material weathered from these rocks are on mountain slopes and ridges and glaciated mountain ridges. The content of angular rock fragments is 50 to 85 percent in soil substrata that formed in material weathered from metasedimentary rocks.

Granitic rocks are hard and coarse grained and are granitic stocks and metadiorite sills. When weathered, these rocks produce sandy material containing many rock fragments. Soils that formed in material weathered from these rocks are on mountain slopes. The content of subangular rock fragments is 50 to 85 percent in soil substrata that formed in material weathered from granitic rocks.

Micaceous rocks weather to produce material containing 40 percent or more mica. They are mostly pyroxenite. Soils that formed in material weathered from these rocks are on mountain slopes. The content of rock fragments is 0 to 35 percent in soil substrata that formed in material weathered from micaceous rocks.

Idaho

Table 1.4 lists general soil groups for the Idaho portion of the Kootenai (figure 1.6). Appendix 4 describes these general soil groups in more detail. Appendix 2 includes soil and parent material descriptions for large portions of the Canadian part of the subbasin.

Table 1.5 shows the percent of each HUC-6 watershed in the Idaho portion of the Kootenai that have highly erodible soils (as defined by NRCS) and that are therefore sensitive landtypes. Figure 1.6 shows the major soil groups in the Idaho portion of the Kootenai River Subbasin.

Montana

More specific descriptions[7] of Kootenai-Montana subbasin soils follow (unit numbers are keyed to figure 1.7).

Soils on Terraces

The landscape is characterized by nearly level to rolling terraces that have steep risers.

1. Soils formed in glacial outwash and alluvium; dry. This unit is north of Eureka and east of Koocanusa Reservoir. The average annual precipitation is about 14 inches. The vegetation consists of mountain grassland with some open-grown forest. The unit makes up about 1 percent of the Kootenai National Forest. It is about 75 percent Typic Xerochrepts, 15 percent Calcixerollic Xerochrepts, and 10 percent soils of minor extent. The Typic Xerochrepts have a surface layer and

[7] *Excerpted from: USDA USFS and NRCS 1995. Soil Survey of Kootenai National Forest Area, Montana and Idaho.*

Table 1.4. General soil groups for the Idaho portion of the subbasin. Source: NRCS (2003).

Landform	Soil
Flood plains and drainageways Level to undulating, poorly drained to moderately well drained soils	Schnoorson-Devoignes-Farnhamton: very deep, level to undulating, poorly drained to moderately well drained soils on flood plains Seelovers-Typic Fluvaquents-Aquic Udifluvents: very deep, level to undulating, poorly drained and somewhat poorly drained soils on flood plains and drainageways
Terraces or benches Nearly level to hilly, well drained, moderately well drained, and excessively drained soils on old glacial lake laid or glacial outwash terraces or benches	Rubson-Porthill-Frycanyon: very deep, nearly level to rolling, well drained and moderately well drained soils on old glacial lake terraces or benches Selle-Elmira: very deep, nearly level to hilly, well drained and excessively drained soils on terraces and dunes Stien-Pend Oreille: very deep, nearly level to rolling, well drained soils on glacial outwash terraces or benches
Terrace escarpments and canyonsides Steep, well drained soils	Wishbone-Caboose-Crash: very deep, steep and very steep soils on terrace escarpments and canyonsides
Foothills and mountains Strongly sloping to very steep, well drained soils	Pend Oreille-Idamont-Treble: very deep, strongly sloping to very steep soils on foothills and mountains Rock Outcrop-Mcarthur-Jaypeak: very deep, steep to extremely steep soils and rock outcrop on mountains and breaklands Rubycreek-Redraven-Baldeagle: very deep, moderately steep to very steep, cold soils on mountains and ridgetops at high elevations

Table 1.5. Percent of HUC-6 watersheds in the Idaho portion of the Subbasin with highly erodible soils.

Descriptive Name	Percent Sensitive Land Types	Descriptive Name	Percent Sensitive Land Types
Kootenai River blw Yaak River	**9%**	**Kootenai R blw Bonn Ferry (cont.)**	
Kootenai R abv Curley Cr	**4%**	Ball Cr	18%
Kootenai R abv Curley Cr	1%	Trout Cr	18%
Pine Cr		Parker Cr	22%
Curley Cr	11%	Long Canyon Cr	19%
Boulder Cr	**20%**	**Mission Cr**	**5%**
Boulder Cr abv MF Boulder Cr	28%	**Smith Cr**	**17%**
Boulder Cr blw MF Boulder Cr (incl MF Boulder Cr)	13%	Smith Cr abv Cow Cr	19%
EF Boulder Cr	12%	Cow Cr	13%
Kootenai River abv Bonners Ferry	**5%**	Smith Cr blw Cow Cr	18%
Deep Cr	**6%**	**Boundary Cr**	**8%**
Deep Cr abv McArthur Lake outlet	0%	Boundary Cr abv Grass Cr	9%
Deep Cr abv Brown Cr	8%	Grass Cr	10%
Fall Cr	6%	Boundary Cr blw Grass Cr	7%
Ruby Cr	6%	**Moyie River**	
Deep Cr blw Brown Cr	0%	**Moyie River in Idaho**	**14%**
Brown Cr (incl Twentymile Cr)	7%	Hawkins Cr	11%
Caribou Cr	10%	Moyie River abv Placer Cr	22%
Snow Cr	11%	Round Prairie Cr	9%
Kootenai River blw Bonners Ferry	**10%**	Meadow Cr	13%
Kootenai Valley	4%	Lower Moyie River	12%
Myrtle Cr	19%	Deer Cr	11%

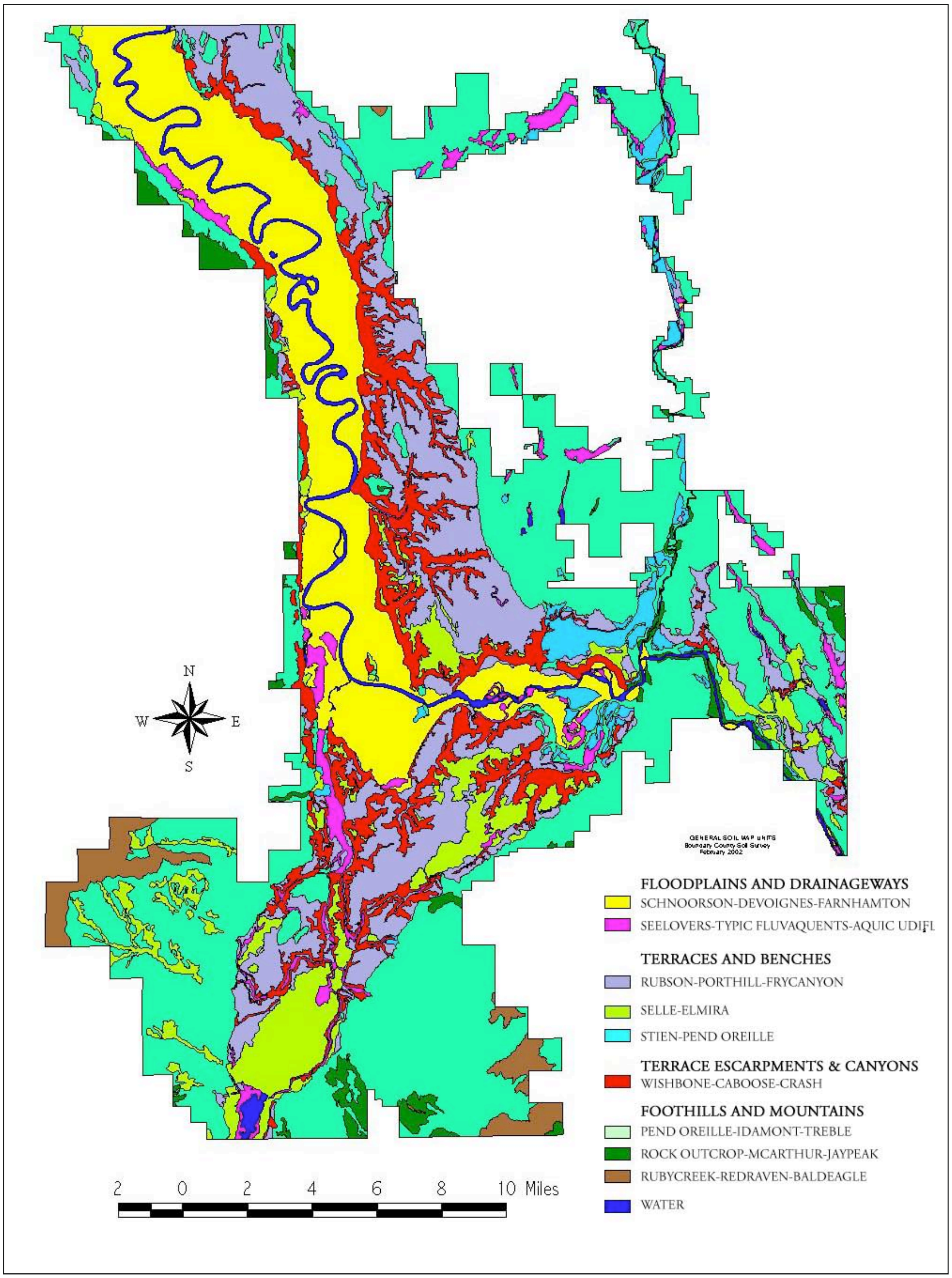

Figure 1.6. Major soil groups in the Idaho portion of the Kootenai.

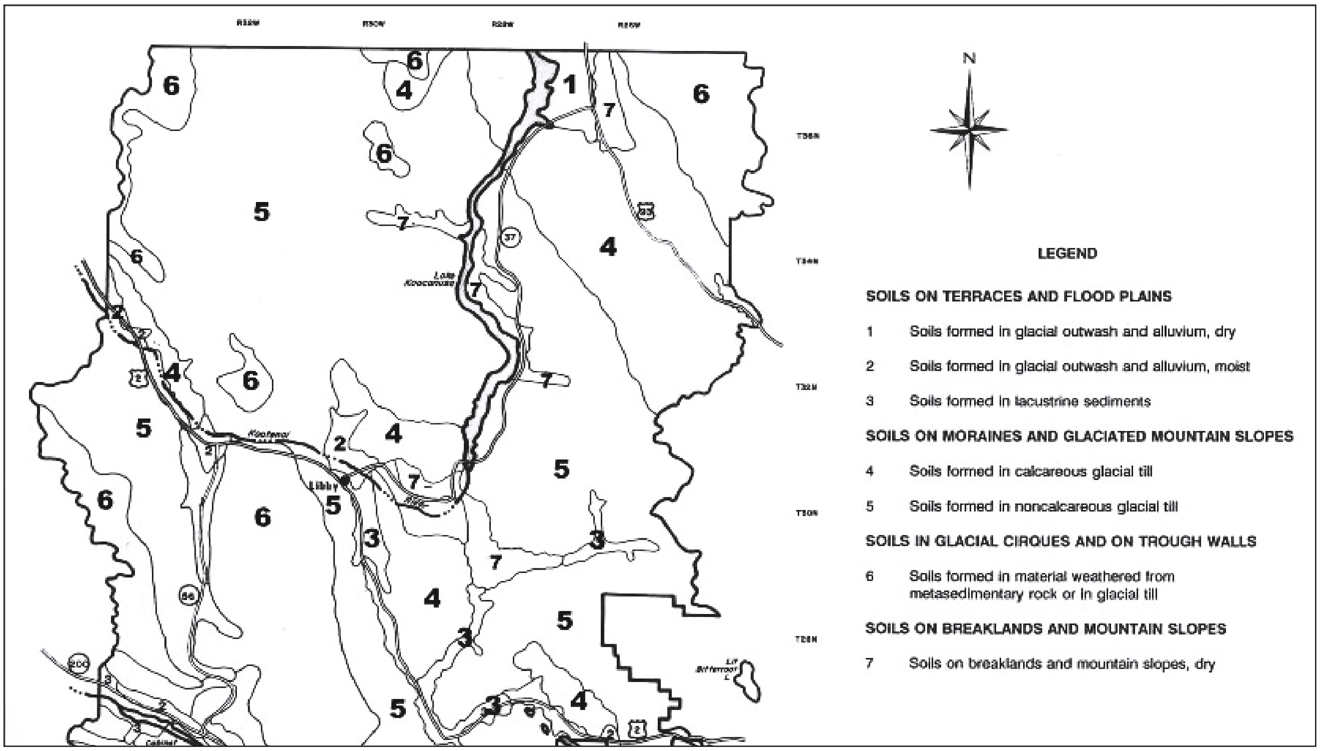

Figure 1.7. Major soil groups in the Montana portion of the Kootenai.

subsoil of very gravelly sandy loam and a substratum of extremely gravelly loamy sand or extremely gravelly sand. The Calcixerollic Xerochrepts are very fine sandy loam to loamy fine sand. They have lime in the subsoil and substratum. The soils of minor extent are fine-silty, mixed Typic Xerochrepts. They formed in lacustrine deposits. Livestock grazing is the major land use in this map unit. Forage productivity is high. Disturbed areas of soil are difficult to revegetate because of drought in summer.

2. Soils formed in glacial outwash and alluvium; moist. This unit is in the major valleys in the western part of the Kootenai National Forest and usually contains a major stream. The average annual precipitation is 20 to 40 inches. The vegetation consists of moist, mixed forest. The unit makes up about 2 percent of the Kootenai National Forest. It is about 60 percent Andic Dystrochrepts, 25 percent Eutrochrepts, and 15 percent soils of minor extent. The surface layer of the major soils is loess that has been influenced by volcanic ash. It is 7 to 14 inches thick. The Andic Dystrochrepts are underlain by gravelly outwash. The Eutrochrepts are underlain by very fine sandy loam and loamy fine sand outwash that has been reworked by wind. They have lime in the subsoil and substratum. The Andic Dystrochrepts do not have lime in the subsoil or substratum. Of minor extent in this map unit are soils in wet meadows. Timber productivity is high in this map unit. The protection of stream banks and channels is a major concern of watershed management.

3. Soils formed in lacustrine sediments. This unit is in the major valleys. The average annual precipitation is 20 to 40 inches. The vegetation consists of moist, mixed forest. The unit makes up about 4 percent of the Kootenai National Forest. It is about 45 percent Andic Dystric Eutrochrepts, 45 percent Eutric Glossoboralfs, and 10 percent soils of minor extent. The surface layer of the major soils is loess that has been influenced by volcanic ash. It is 7 to 14 inches thick. The subsoil and substratum are silt loam and silty clay loam. The Eutric Glossoboralfs have an accumulation of clay in the subsoil. The Andic Dystric Eutrochrepts do not have an accumulation of clay in the subsoil. The soils of minor extent are Andic Dystrochrepts. They are along drainages and on terrace risers. They have a substratum of very gravelly sand. Timber productivity is moderate or high in this map unit. The subsoil and substratum erode when they are exposed during road construction or logging. The silty sediments produced by the erosion of these soils is potentially damaging to fish habitat.

Soils on Moraines and Glaciated Mountain Slopes

The landscape is characterized by gently sloping to very steep moraines and mountain slopes that are mantled with glacial till. The underlying till is dense and brittle. It restricts the movement of water and the penetration of roots.

4. Soils formed in calcareous glacial till. This unit is on moraines and glaciated mountain slopes in the drier eastern half of the Kootenai National Forest. The soils are underlain by glacial till that has been influenced by limestone. The vegetation consists of moist, mixed forest or dry, mixed forest. The unit makes up about 14 percent of the Kootenai National Forest. It is about 50 percent Typic Eutroboralfs, 25 percent Typic Eutrochrepts, and 25 percent soils of minor extent. The major soils have lime in the lower part of the subsoil and in the substratum. The Typic Eutroboralfs have an accumulation of clay in the subsoil. The Typic Eutrochrepts do not have an accumulation of clay in the subsoil. The soils of minor extent are Dystric Eutrochrepts and Eutric Glossoboralfs. They do not have lime in the lower part of the subsoil or in the upper part of the substratum. Timber productivity is moderate or high in this map unit. The slope limits the operation of tractors in places.

5. Soils formed in noncalcareous glacial till. This unit is on moraines and mountain slopes in the northern three-fourths of the Kootenai National Forest. The soils are underlain by glacial till primarily weathered from quartzite, argillite, siltite, and similar noncalcareous metasedimentary rocks. The vegetation mainly consists of moist, mixed forest. The unit makes up about 50 percent of the Kootenai National Forest. It is about 45 percent Andic Dystrochrepts, 45 percent Andic Cryochrepts, and 10 percent soils of minor extent. The surface layer of the major soils is loess that has been influenced by volcanic ash. It is 7 to 14 inches thick. The Andic Dystrochrepts are below elevations of 5,000 feet, and the Andic Cryochrepts are above elevations of 5,000 feet. The soils of minor extent are Lithic Cryochrepts and Dystric Eutrochrepts. The Lithic Cryochrepts are on ridges at the higher elevations. They have bedrock within a depth of 20 inches. The Dystric Eutrochrepts are on steep southerly aspects. Their surface layer, which is loess, is mixed with the underlying material. Timber productivity is moderate or high in this map unit. The slope limits the operation of tractors in places.

Soils in Glacial Cirques and on Trough Walls

The landscape is characterized by steep or very steep glacial cirque headwalls and the upper slopes of U-shaped glacial valleys. Gently sloping to steep moraines are in cirque basins and on glacial valley bottoms. The underlying till is friable. It is easily penetrated by roots and infiltrated by water.

6. Soils formed in material weathered from metasedimentary rock or in glacial till. This unit is at the higher elevations throughout the Kootenai National Forest. It is in scattered areas but is mostly in areas of the Whitefish Range, Cabinet Mountains, and Northwest Peak and along the Bitterroot Divide. The vegetation mainly consists of subalpine forest with some moist, mixed forest in the valley bottoms. The unit makes up about 16 percent of the Kootenai National Forest. Andic Cryochrepts, Lithic Cryochrepts, and rock outcrop each make up about one-third of the unit. The surface layer of the major soils is loess that has been influenced by volcanic ash. It is 7 to 14 inches thick. The Andic Cryochrepts are on moraines and the lower valley slopes. They are deep. The Lithic Cryochrepts and the rock outcrop are on the upper valley side slopes and cirque headwalls. The Lithic Cryochrepts have bedrock within a depth of 20 inches. Timber productivity is high on moraines in the valley bottoms and low or very low in the other areas. The harsh subalpine climate limits forest regeneration and productivity on cirque headwalls and upper slopes. Machine operation is limited by the slope and the rock outcrop on the cirque headwalls and upper troughwalls. This map unit is scenic and has relatively high value for recreational activities. It is an important source of late summer streamflow.

Soils on Breaklands and Mountain Slopes

The landscape is characterized by very steep slopes adjacent to major rivers. The slopes dominantly are 45 to 100 percent. The soils are underlain by material weathered from the underlying bedrock.

7. Soils on breaklands and mountain slopes; dry. This unit is on breaklands that have southerly aspects. The vegetation consists of dry, mixed forest or open-grown forest. The unit makes up about 4 percent of the Kootenai National Forest. It is about 35 percent Typic Ustochreps, 30 percent Lithic Ustochrepts, 20 percent rock outcrop, and 15 percent soils of minor extent. The Typic Ustochrepts have bedrock at a depth of 20 to 60 inches or more. They are on the lower slopes and along drainages. The Lithic Ustochrepts have bedrock within a depth of 20 inches. They are on the upper slopes and near areas of the rock outcrop. The rock outcrop is throughout the unit. The soils of minor extent are Typic Calcixerolls. They are underlain by limestone bedrock. This map unit has potential as winter range for wildlife. Snow cover seldom limits access to forage. Drainage channels are steep and rapidly deliver sediments to the larger streams at the base of slopes. The hard bedrock and the slope limit excavation during road construction.

Table 1.6 shows the percent of each HUC-6 watershed in the Montana portion of the Kootenai (Upper Kootenai) that have highly erodible soils (as defined by NRCS) and are therefore sensitive land types.

Table 1.6. Percent of HUC-6 watersheds in the Upper Kootenai (Montana portion of the Kootenai River subbasin) with highly erodible soils.

Subunit(s) within Watershed	Watershed Number and Name	Percent Sensitive Land Types	Subunit(s) within Watershed	Watershed Number and Name	Percent Sensitive Land Types	Subunit(s) within Watershed	Watershed Number and Name	Percent Sensitive Land Types
Wigwam	170101010101 Wigwam R	3%	Ksanka	170101010406 Tobacco R	9%	Crazy Treasure	170101010704 Big Cherry Cr	11%
Dodge	170101010201 Bloom Cr		Boulder	170101010501 Boulder Cr		Crazy McSwede Treasure	170101010705 Lower Libby Cr	26%
Dodge	170101010202 Sink Cr	7%	McSutten	170101010502 Sutton Cr	2%	Treasure	170101010801 Flower Cr	10%
Dodge	170101010203 Young Cr	13%	UBig	170101010503 Up So Fk Big	26%	Treasure	170101010802 Parmenter Cr	16%
Dodge	170101010204 Dodge Cr	0%	Big Ubig	170101010504 Low So Fk Big	4%	Pipestone	170101010803 E Fork Pipe Cr	4%
Ksanka	170101010205 Phillips Cr	3%	Big	170101010505 Big Cr	6%	Pipestone	170101010804 Up Pipe Cr	10%
Boulder	170101010206 Sullivan Cr		McSutten	170101010506 McGuire Cr		Pipestone	170101010805 Low Pipe Cr	16%
Pinkham	170101010207 Upper Pinkham	4%	Parsnip	170101010508 Parsnip Cr		Pipestone	170101010806 Bobtail Cr	32%
Pinkham	170101010208 Lower Pinkham	3%	McSutten	170101010509 Tenmile Cr	5%	Quartz	170101010807 Quartz Cr	29%
Swamp	170101010301 Swamp Cr	4%	Cripple	170101010601 Fivemile Cr	8%	Spar	170101010901 Ross Cr	6%
Fortine	170101010302 Upper Fortine Cr	5%	Bristow	170101010602 Bristow Cr	0%	Spar	170101010902 Stanley Cr	31%
Swamp	170101010303 Edna Cr	6%	Bristow	170101010603 Barron Cr	14%	Lake Spar	170101010903 Upper Lake Cr	10%
Swamp Trego	170101010304 Mid Fortine Cr	13%	Cripple	170101010604 Warland Cr	3%	Spar	170101010904 Keeler Cr	20%
Murphy	170101010305 Deep Cr	6%	Cripple	170101010605 Cripple Horse Cr	8%	Lake Spar	170101010905 Lower Lake Cr	26%
Meadow	170101010306 Meadow Cr	3%	Bristow	170101010606 Jackson Cr	4%	OBrien	170101011001 OBrien Cr	15%
Meadow Murphy Swamp Trego	170101010307 Lower Fortine Cr	15%	Cripple	170101010607 Canyon Cr	0%	Callahan	170101011002 So Callahan Cr	19%
Grave	170101010401 Upper Grave Cr	8%	Cripple	170101010609 Dunn Cr	2%	Callahan	170101011003 No Callahan Cr	36%
Grave	170101010402 Lower Grave Cr	14%	Alexander	170101010610 Rainy Cr	28%	Callahan	170101011004 Callahan Cr	28%
Ksanka	170101010403 Therriault Cr	4%	Crazy	170101010701 Upper Libby Cr	6%	Callahan	170101011005 Ruby Cr	18%
Ksanka	170101010404 Sinclair Cr	2%	McSwede	170101010702 Swamp Cr	11%	Callahan	170101011006 Star Cr	9%
Ksanka	170101010405 Indian Cr	10%	Treasure	170101010703 Granite Cr	4%			

1.1.5 Hydrology[8]

Overview

In the U.S., the Kootenai Subbasin encompasses five, eight-digit USGS Hydrologic Unit Codes (HUCs) (table 1.7, figure 1.1). The Montana portion encompasses the Upper Kootenai, Fisher and Yaak, the Idaho portion the Lower Kootenai and the Moyie River.

Table 1.7. The five, eight-digit USGS Hydrologic Unit Codes (HUCs) in the Kootenai River Subbasin (Montana and Idaho Portions).

Hydrologic Code	Watershed Name
17010101	Upper Kootenai
17010102	Fisher
17010103	Yaak
17010104	Lower Kootenai
17010105	Moyie River

SNAPSHOT

The Kootenai River has a mean annual discharge of nine million acre-feet and a flow rate at its mouth of just under 30,650 cubic feet per second. Mountains in the subbasin receive about 70 to 80 percent of their precipitation as snow. The melting of this snowpack during the spring and summer months produces a characteristic"snowmelt hydrograph" in which peak runoff occurs between April and June.

Because the Kootenai River Subbasin is a transboundary watershed, the Kootenai River Network (KRN) KRIS project has delineated transboundary drainages that merge the USGS 4th-field hydrologic unit code (HUC) with similar watersheds in Canada created by the Rocky Mountain Data Consortium (figure 1.8). This delineation identifies eight watersheds (table 1.8).

Table 1.8. KRN Transboundary watersheds.

#	Watershed Name
1	Upper Kootenay
2	Middle Kootenay
3	St. Mary River
4	Elk River
5	Yaak
6	Moyie River
7	Fisher
8	Kootenay Lake

From its headwaters in B.C. to where the Kootenai River enters Kootenay Lake in B.C., the river drops 10,125 feet in elevation. Before it reaches Canal Flats, which lies some 70 miles south of its origin, the Kootenai River is fed by the Vermillion, Simpson, Cross, Palliser and White Rivers. At Canal Flats where

[8] *This section addresses the entire subbasin—the Idaho, Montana, and British Columbia portions.*

LINKS

For current river levels in the Kootenai Subbasin, go to: http://www.nwrfc.noaa.gov/

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

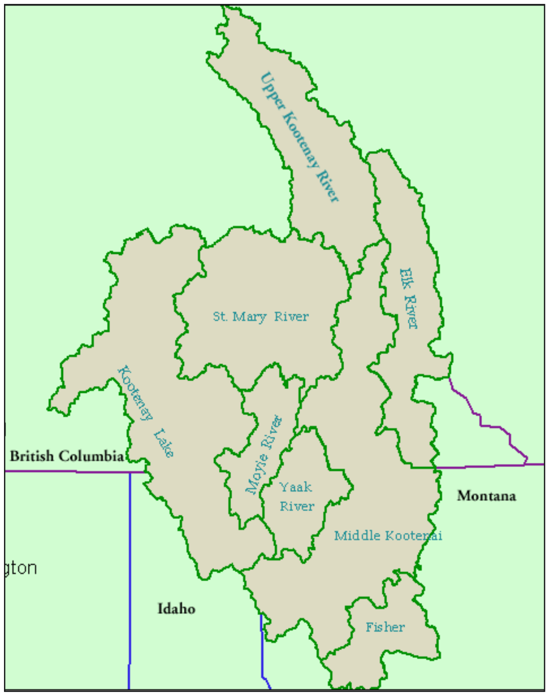

Figure 1.8. Kootenai Subbasin Watersheds delineated by the Kootenai River Network.

the Kootenai enters the Rocky Mountain Trench, the river drains an area of just over 2,000 square miles, and the mean annual discharge is 3,143 cfs—almost 20 percent of the flow that enters Kootenay Lake. The St. Mary and Bull Rivers are the two major tributaries entering the Kootenai River between Canal Flats and Koocanusa Reservoir (Lake Koocanusa). Together, they contribute 3,078 cfs to the Kootenai's flow. At Wardner, B.C., where the River enters Koocanusa Reservoir, the annual discharge is 7,344 cfs, or about 46 percent of the water flowing into Kootenay Lake.

Koocanusa Reservoir and its tributaries receive runoff from approximately 50 percent of the Kootenai River drainage basin. The reservoir has an annual average inflow rate of 10,615 cfs. It has a surface area of approximately 73 square miles and a volume of 5.9 million acre-feet at full capacity.

With an average flow of 2,718 cfs, the Elk River, which enters Koocanusa Reservoir north of Grasmere, is one of the Kootenai River's major tributaries. The Kootenai, Elk, and Bull, supply 87 percent of the inflow into Koocanusa Reservoir (Chisholm et al. 1989). The total drainage area north of the Canada-U.S. border is approximately 6,360 square miles or approximately one-third of the total drainage. The Tobacco River and numerous small tributaries flow into the reservoir south of the International Border. The Tobacco has an average annual discharge of 268 cfs.

Major tributaries to the Kootenai River downstream from Libby Dam include the Fisher, Yaak, and Moyie Rivers; their average combined discharge is 2,306 cfs, about 14.5 percent of the flow that ultimately enters Kootenay Lake. By the time the Kootenai River reaches Bonners Ferry, Idaho, the size of the drainage area has increased by two-and-one-half times what it is at Wardner, B.C., and the flow has increased to 14,981 cfs, about 94 percent of what the Kootenai River delivers to Kootenay Lake.

In addition to the Moyie (which drains 205 square miles), other main Idaho tributaries include Deep Creek (194 sq miles) and Boundary Creek (95 sq miles). About half of all Idaho tributary miles occur at a gradient greater than 6 percent.

The Kootenai River leaves Kootenay Lake through the lake's western arm. Just downstream from where it leaves the lake, its average annual discharge is 27,965 cfs. The river then flows to its confluence with the Columbia River at Castlegar, B.C. During presettlement times, a natural barrier at Bonnington Falls isolated fish from other populations in the Columbia River basin. Now a series of four dams maintain this separation. The natural barrier has isolated sturgeon and other species for approximately 10,000 years (Northcote 1973). Table 1.9 lists key gaging stations in the subbasin and the recorded mean discharge and drainage area for each. Figure 1.10 shows hydrography of the U.S. portion of the Kootenai Subbasin.

Table 1.9. Gaging stations in the Kootenai Subbasin.

Station Name	Mean Discharge (cfs)	Drainage Area (mi^2)	Percent of Basin (area)
Mainstem			
Kootenai River at Kootenay Crossing, B.C.	178	162	1%
Kootenai River at Canal Flats, B.C.	3143	2081	12%
Kootenai River at Wardner, B.C.	7344	5250	30%
Kootenai River below Libby, MT	10898	8985	51%
Kootenai River at Leonia, ID	13949	-	-
Kootenai River at Bonners Ferry, ID	14981	13000	74%
Kootenai River at Porthill, ID	15857	13700	78%
Kootenai Lake Outflow, B.C.	27965	17606	
Major Tributaries			
St. Mary River at Wycliffe, BC	1917	911	5%
Bull River near Wardner, BC	1161	591	3%
Elk River at Phillips Bridge, BC	2718	1718	10%
Tobacco River near Eureka, MT	268.5	440	2%
Fisher River near Libby, MT	483.7	838	5%
Yaak River near Troy	864	766	4%
Moyie River at Eastport, ID	690.9	570	3%

Tributaries

Mountains in the Kootenai Subbasin receive 70 to 80 percent of their precipitation as snow (USFS KNF 2000), and the streams are classic examples of the spring snowmelt system described by Poff and Ward (1989) (figure 1.9). Throughout

LINKS

For a 6th-field HUC interactive hydrologic map of the Kootenai Subbasin go to Appendix 7.

Click Here

General hydrologic information about the Kootenai 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 Kootenai: http://www.streamnet.org/subbasin/2001-subbasin-data.html

Click Here

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

Click Here

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

Click Here

most of the year, rain and snowmelt infiltrates the ground to become groundwater, which percolates through the soil and bedrock and then resurfaces downslope in wet areas and perennial streams. When precipitation and/or snowmelt exceeds the infiltration capacity of the ground, runoff occurs. Spring runoff begins in April. In unregulated tributaries flows generally peak in May or June. Typically, the hydrograph increases two-to-three orders of magnitude over winter base flow between April and June. Flood flows vary depending upon winter snowpack, the spring warming pattern, and rainfall. The slow release of groundwater provides the stream base flow starting anywhere from mid July to mid September. Low flows occur from November to March (USFS KNF 2000).

In the Kootenai Subbasin, rain falling on snow (ROS) is known to be a major cause of severe runoff and erosion with potentially intense and damaging floods and may also be a major cause of avalanches (Ferguson 2000). While most ROS impacts have been documented in the coastal regions of western North America, the Kootenai Subbasin has a topographic configuration that allows incursion of warm, moist air from the Pacific Ocean. These Pacific airmasses occasionally cause rain to fall on existing snow cover during winter and spring. The resulting floods are less frequent than on the coast but can be equally destructive (Ferguson 2000). Even during warm, dry years, parts of the subbasin may experience a ROS event. During wet, cool years and normal years, a good deal of the subbasin can experience anywhere from 5 to 10 ROS events (Ferguson 2000 and USFS KNF 2000).

The basin is nearly completely underlain with Precambrian sedimentary rock, which is generally deficient of nutrients, although there are limited areas of much younger and richer sedimentary and igneous rock. As a consequence, subbasin waters are generally low in nutrients (Makepeace 2003; Stanford and Hauer 1992).

Typically, Kootenai River tributaries have bed material consisting of various mixtures of sand, gravel, rubble, boulders, and varying amounts of clay and silt of glacio-lacustrine origin. Because of their instability during periods of high stream discharge, the fine materials are continually abraded and redeposited, forming braided channels with alternating riffles and pools.

Kootenai River

From Canal Flats to the head of Koocanusa Reservoir at Wardner, B.C., tributaries have deposited large amounts of gravel and silts across the Kootenai River floodplain, which ranges from 1 to 1.5 miles wide and is 150 to 300 vertical feet below the general level of the Rocky Mountain Trench. Fluvial outflows from the major tributaries have created hydraulic dams that slow the current and have

LINKS

For watershed maps of the subbasin and other information about Montana Rivers, go to: http://www.nwifc.wa.gov/SAGE/metadata/aquatic/Montana/Montana%20Rivers%20Information%20System%20(MRIS).htm

Click Here

For flood frequency and basin characteristic data from the USGS, go to: http://mt.water.usgs.gov/freq#TOC11

Click Here

For summaries of hydrologic data from any one of 14 Canadian and USGS gauging stations in the subbasin, go to Appendix 8.

Click Here

Appendix 9 contains spreadsheets with scores for a large number of watershed attributes for Kootenai River tributaries in the Upper Kootenai in Montana and the lower Kootenai in Idaho.

Click Here

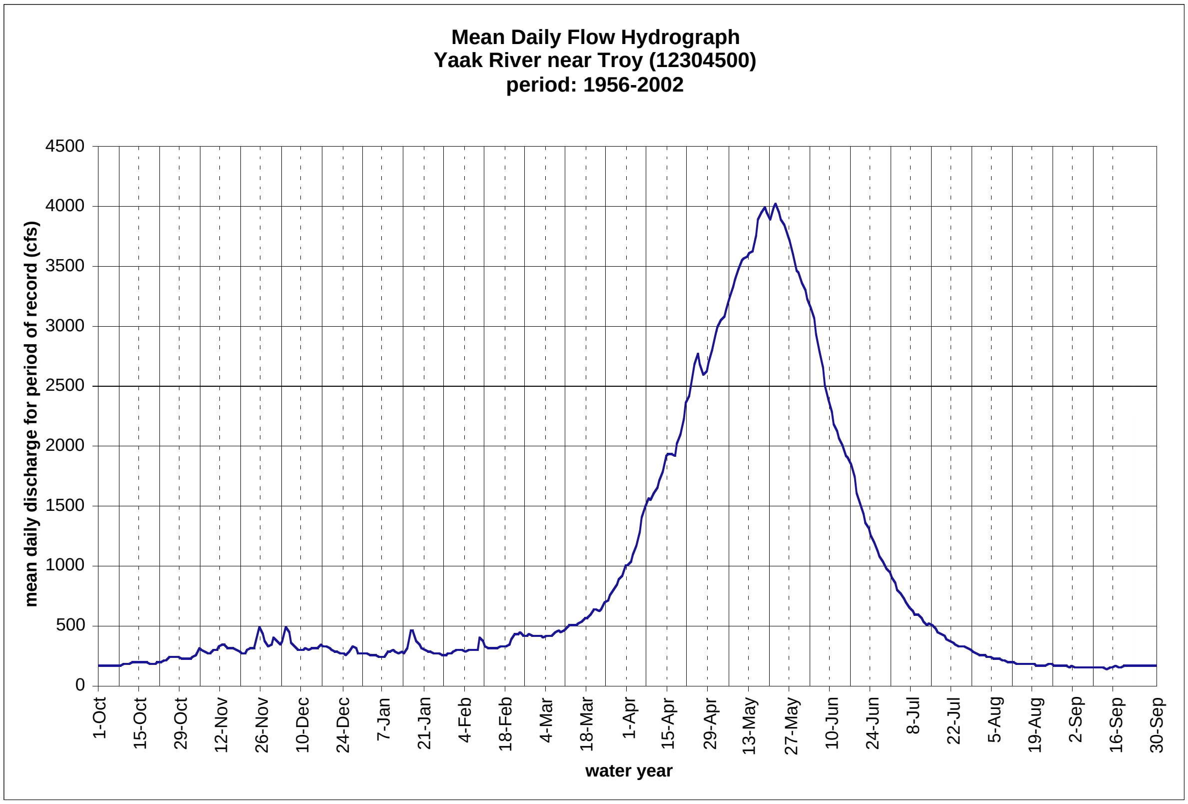

Figure 1.9. A representative hydrograph of the Kootenai Subbasin:Yaak River mean daily discharge values. Much of the subbasin has a snowmelt system prone to winter rain on snow events.

deposited silt upstream from the inflow and cobble downstream (Jamieson and Braante 2001). Between Libby Dam and the Moyie River, the river flows through a canyon in places, but otherwise has a limited flood plain due to the closeness of the mountains. The substrate consists of large cobble and gravel (Snyder and Minshall 1994). From the Moyie River to the town of Bonners Ferry, the river channel leaves the canyon and becomes extensively braided. Water depths are typically less than 9 meters, and substrates consist mostly of gravels. The river has an average gradient of 2.4 feet/mile, and velocities higher than 2.4 feet/second (Snyder and Minshall 1994). From just downstream from the town of Bonners Ferry to the confluence of the Kootenay Lake, the river slows to an average gradient of 0.08 feet/mile. It deepens—as deep as 36 feet in runs and 90 feet in pools—and meanders through the Kootenai Valley back into British Columbia and into the southern arm of Kootenay Lake. In this reach, water levels are affected by the level of water in the lake. The floodplain is largely clay, silt, and sand . The reach has been extensively diked and channelized, which has had profound effects on ecosystem processes (Bauer 1999).

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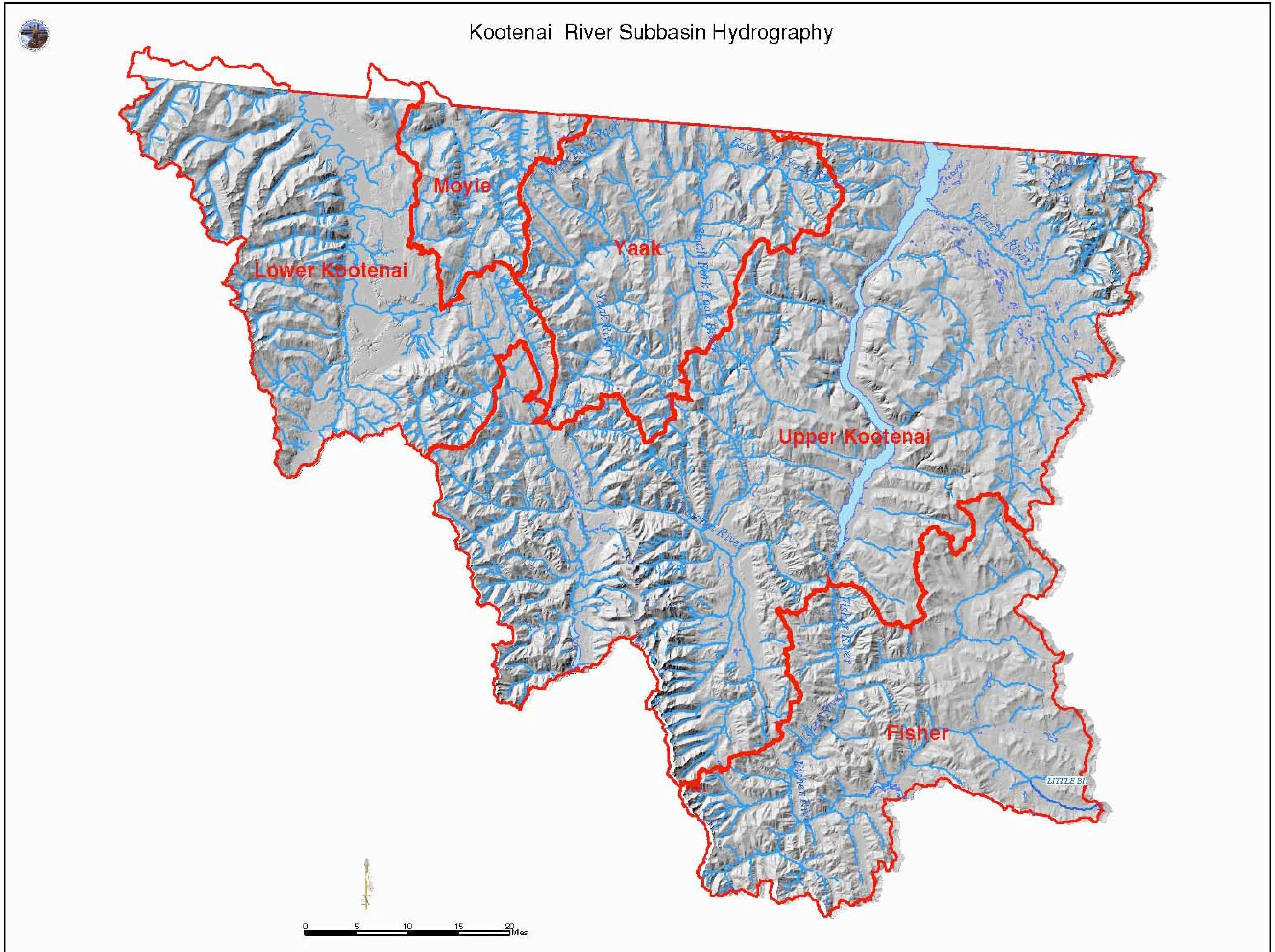

Figure 1.10. Hydrography of the U.S. portion of the Kootenai Subbasin.

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Ground Water[9]

The occurrence and distribution of ground water in the drainage is closely related to geology. Rock outcrops of the Belt series are tightly compacted with little or no porosity or permeability. In these areas ground water production is small. Glacial deposits consisting of a well-compacted, poorly sorted mixture of clay, silt, sand, and gravels interbedded with glacial-lake sediments of finely-laminated silty and clay characterize the valley bottoms. In certain areas, wells produce an abundance of water. The complex heterogenous nature of these deposits makes their water-bearing characteristics highly variable, and ground water supplies range from very low to excellent.

Numerous springs and seeps occur throughout the subbasin. Ground water provides much of the base flow of the river and its tributaries for a large part of the year. Characteristically, this water is of excellent quality but more mineralized than water derived from surface supplies.

Impoundments and Irrigation Projects

Under the terms of the Columbia River Treaty, the U.S. Army Corps of Engineers built Libby Dam in 1973, creating Koocanusa Reservoir (known also as Koocanusa Lake or Libby Reservoir), which spans the Canada-USA border. Koocanusa Reservoir is a 90-mile-long storage reservoir with a surface area of 188 km^2 (46,500 acres) at full pool. It is located upstream from the Fisher River confluence and east of Libby, Montana. The dam has a usable storage of approximately 4,930,000 acre feet and gross storage of 5,890,000 acre feet. The primary benefit of the project is power production. With the five units currently installed, the electrical generation capacity is 525,000 kW. The maximum discharge with all 5 units in operations is about 26,000 cfs. An additional 1,000 cfs can be passed over the spillway without causing dissolved gas supersaturation problems (USACE 2002). The surface elevation of Koocanusa Reservoir ranges from 2,287 feet to 2,459 feet at full pool. Presently, operations are dictated by a combination of power production, flood control, recreation, and special operations for the recovery of ESA-listed species, including Kootenai River white sturgeon and bull trout and salmon in the lower Columbia River.

Along with the Libby Dam/Koocanusa Reservoir complex, smaller dams are located on the Elk, Bull, and Goat Rivers on the Canadian side and on the Moyie River and Smith and Lake Creeks in the U.S. The 5 MW Aberfeldie G.S. on the Bull River is a run-of-river facility, with water flowing over the spillway much of the year. The 12 MW Elko G.S. is located on the Elk River, approximately

LINKS

For water information about the Kootenai River 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

For more information on dams in B.C., go to: http:www.bchydro.bc.ca/info/generation/generation891.html)

Click Here

[9] *Adapted from Panhandle Basin Bull Trout Advisory Team (1998)*

16 miles from its mouth on Koocanusa Reservoir (B.C. Hydro 2003). The Moyie Dam was constructed in 1949, the Lake Creek Dam around 1917, to supply power to the Snowstorm mines in Callahan Creek (PWI and Resources 1999). Prior to these dams being built there were natural falls near the dam sites that blocked fish passage.

When Kootenay Lake was impounded, the water level increased 7.8 feet, and now the annual drawdown is 9.8 feet. Kootenay Lake stretches 66.4 miles from the tip of its North Arm, near Lardeau, to the tip of its South Arm, near Creston and has a 28 mile-long West Arm jutting from Balfour to Nelson. The total lake covers 150.5 square miles. On average, its depth is 308 feet, and its width 2.3 miles. A total of 56 percent of the inflow to the lake is regulated by dams. The outflow from the West Arm, near Nelson, is regulated by the Corra Linn Dam (Living Landscapes 2003).

Completed in 1931, Corra Linn Dam, located several miles downstream from the outlet of Kootenay Lake in B.C., was the first major dam on the Kootenai River. It is capable of backing up water over the outlet of Kootenay Lake and therefore can control the level of the lake. Changes in Kootenay Lake levels affect river stages upstream as far as Bonners Ferry. To reduce flooding and groundwater seepage, the Grohman Narrows, outlet to Kootenay Lake, was blasted and dredged in the late 1930s. Because of that and the operations of the dam, Kootenay Lake stages are lowered during high flow periods by up to several feet, depending on discharge. Conversely, the dam increases lake levels by up to 6 feet during portions of the year. The required changes in Kootenay Lake levels throughout the year are prescribed by the International Joint Commission in the Order of 1938 (IJC 1938) (Tetra Tech 2003). In addition to Corra Linn, West Kootenay Power operates three hydroelectric generating stations on the lower Kootenai River in B.C.: Upper Bonnington; Lower Bonnington; and South Slocan. Each operates as a run-of-river generating station. The Duncan River feeds Kootenay Lake from the north and comprises 10 percent of the lake's inflow. In 1967, Duncan Dam was constructed on the Duncan River in B.C. to fulfill the obligations of the Columbia River Treaty. The 30 square kilometer Duncan Lake reservoir created behind the dam holds runoff from 925 square kilometers of the Purcell Mountains watersheds.

1.1.6 Water Quality

Overview

Water quality protection standards, objectives and/or criteria are not uniform across international, state, provincial, and tribal jurisdictions within the Kootenai River Basin. Differences exist not only in numerical values—for example allowable in-stream concentrations of potential pollutants—but also in how these standards or criteria are applied during regulation of water pollution.

The Kootenai River Subbasin is naturally oligotrophic and nutrient poor because the Belt Series rocks are the dominant geologic influence (PWI 1999). However, in the 1950s and 1960s fertilizer production, sewage, lead-zinc mining, and vermiculite discharges caused serious declines in water quality to the point that native fish populations were impacted (USFWS 1999).

Mining operations have been a part of the Kootenai River basin since the late 1800s (Georgi 1993). Many of the operations are extracting primarily lead, zinc, copper and silver. But they also mine gold, iron, nickel, cobalt, sulfur, thorium, and uranium. The number of abandoned mines in the entire Kootenai River watershed is estimated at 10,000 (Kootenai River Network 2000). Large "tailings dumps" are potentially substantial sources of metal pollution (Weatherly et al. 1980) because of their mechanical instability and surface slippage. Of 123 mines in Boundary County, Idaho, 54 (44%) are listed as "status unknown" with regard to geologic stability (US Geological Survey 1999). The discharge and tailings piles at many of the abandoned mines are not monitored; some of them may be contributing significant amounts of heavy metal pollution to the Kootenai River system. The Cominco fertilizer plant was also operated from 1953 to 1987, at the Sullivan mine site, along the St. Mary River in British Columbia (a tributary to the Kootenai River). This fertilizer plant is considered to have been a significant point source for phosphorous and metals loading within the Kootenai River (Kootenai River Network 2000).

Logging, lumber and pulp mill operations within the Kootenai River basin are potential point sources for toxic chemicals, including chlorophenols and dioxins. Agricultural operations within the lower watershed and around Eureka, Montana, are another source of non-point source contamination (Kruse 2000). Some of the effects of agricultural operations include disturbance of riparian zones and increased erosion, pesticide and metal loading from crop applications, and runoff of improperly disposed or bioaccumulated chemicals. Urban development, recreation, and transportation contribute contaminants to the Kootenai River system through fuel and lubricant discharge, drainage ditch and sewer system runoff, municipal discharge from sewage treatment plants and accidental spillage (Kootenai River Network 2000). Hydropower operations are also a potential source of toxins, including PCBs and other chemicals used to maintain power production equipment.

LINKS

For a list of currently listed impaired waters (303d) in the Idaho portion of the subbasin, go to: http://inside3.uidaho.edu/WebMapping/IDEQ/SelectHUC.asp?basin=Panhandle

Click Here

For the list of surface waters included in the Montana water quality assessment database go to the MTDEQ website at: http://www.deq.state.mt.us/ppa/mdm/303_d/303d_information.asp

Click Here

For the EPA Fact Sheets for Section 303(d) streams in the Kootenai Subbasin (ID and MT) go to: http://www.epa.gov/owow/tmdl/

Click Here

Water quality reports on the B.C. portion of the Kootenai Subbasin and other documents regarding B.C. water quality policies and objectives can be downloaded at: http://wlapwww.gov.bc.ca/wat/wq/wqhome.html#19

Click Here

Pollution control measures at industrial point sources and the closure of some pollution sources have substantially decreased the quantity of pollutants entering the river. In addition, Libby dam has resulted in less transport of pollutants and nutrients to the downstream portion of the river. However, toxic pollutants persist in the sediments and from bioaccumulation (PWI 1999).

In Montana and Idaho, assessed water bodies are designated in the states' respective 303(d)/305(b) reports as either supporting or not supporting water quality standards and beneficial uses. Water bodies that do not meet water quality standards are called "water quality limited" or "impaired," and require development of water quality management plans known as Total Maximum Daily Loads (TMDLs) to bring them back into compliance and protect their beneficial uses. To view the list of currently impaired waters in the U.S. portion of the subbasin, see the appropriate links in the links column. In British Columbia, the Provincial Ministry of Water, Land and Air Protection administers most water pollution control efforts with technical assistance from Environment Canada, a federal entity. For water quality reports for the B.C. portion of the subbasin, see the B.C. link in the links column.

LINKS

Appendix 9 contains spreadsheets with scores for a large number of watershed attributes (including water-quality limited segments) for Kootenai River tributaries in the Upper Kootenai in Montana and the lower Kootenai in Idaho.

Click Here

For water quality data for Trout and Parker Creeks, go to Appendix 100.

Click Here

Tributaries

Sedimentation from forestry practices and associated forestry activities impacts tributaries throughout the subbasin. Although current forestry practices have improved over those of past decades, water quality problems still occur in some streams mostly from the lingering results of past activities and the inconsistent application of best management practices. Several mines have also caused site-specific water quality impacts (USFWS 2002).

In 2000, the Kootenai Tribe of Idaho released a report on the results of a water quality investigation for twelve Kootenai River tributaries (Bauer 2000) that focused on the potential for heavy metal contamination and nutrient inputs to the Kootenai River.

Nutrients occur at low levels in the Kootenai River tributaries consistent with the nutrient concentrations observed in the Kootenai River. Dissolved phosphorus concentrations were, for the most part, below detection limits. Nitrates occur at low concentrations characteristic of oligotrophic systems.

Appendix 9 contains information on the water quality of Kootenai River tributaries in Montana and Idaho.

Kootenai River

Kinnee and others (1995) report on a study conducted between May 1994 and February 1995, by KTOI for water and sediment samples that indicated the presence and seasonal peaks of aluminum, arsenic, chromium, copper, iron, manganese, lead, and selenium. The study reported concentrations of arsenic, chromium, lead, and selenium exceeded EPA chronic or acute criteria for fresh water.

In 1999, the Kootenai Tribe of Idaho (KTOI) released the results of a water quality study for the mainstem Kootenai River (Bauer 1999) that evaluated the data set for metals and nutrients collected by KTOI during the period between April, 1997, and November, 1998, especially as it relates to recovery of the endangered white sturgeon (*Acipenser transmontanus*). Previous studies documented the occurrence of contaminants in the watershed from metals mining, milling, and coal mining. Cadmium, copper, lead, zinc, and selenium were associated with specific contaminant sources in the watershed. The most notable sources are mining areas in British Columbia in tributaries to the Kootenai River above Koocanusa Reservoir—specifically the St. Mary River and Elk River watersheds. Water quality samples for the 1997-1998 period indicate concentrations of arsenic, cadmium, copper, lead, mercury, selenium, and zinc were below acute and chronic U.S. EPA water quality criteria for freshwater biota. However, since water is only one of the several uptake routes for toxics, the results of this study do not rule out the potential for toxicity in the Kootenai River system (Bauer 1999). And because they are reported as total metals and not dissolved metals, these data do not show the true bioavailable portion. Also, sublethal effects (i.e. habitat avoidance, reproductive effects, other behavioral or physiological effects) cannot be ruled out, because these concentrations are not addressed.

Annual discharges from the Cominco, Ltd. phosphate plant in Kimberly, British Columbia, exceeded 7,257,472 kilograms (8,000 tons) of phosphorous in the middle to late 1960s (MBTSG 1996c). Pollution abatement measures were installed in 1975, and the plant eventually closed in 1987. Phosphorus levels in Koocanusa Reservoir are now much lower.

Results from another contaminant study performed in 1998 and 1999 showed that water concentrations of total iron, zinc, and manganese, and the PCB Arochlor 1260 exceeded suggested environmental background levels (Kruse 2000). PCB Aroclor concentrations exceeded the EPA freshwater quality criteria of 0.014 ug/L by about 40 times. Several metals, organochlorine pesticides, and the PCB Arochlor 1260 were found above laboratory detection limits in ova from adult female white sturgeon in the Kootenai River. Plasma steroid concentrations in adult female sturgeon showed a significant positive correlation with ovarian tissue concentrations of the PCB Arochlor 1260, zinc, DDT, and all organochlorine compounds combined, suggesting potential disruption of reproductive processes in adult white sturgeon. Results from this study also suggested a decrease in egg size and acetylcholinesterase concentrations due to bioaccumulated concentrations of metal and organochlorine compounds (Kruse and Scarnecchia 2002a).

1.1.7 Vegetation

Snapshot

The dominant vegetation in the subbasin is mixed conifer—at low/mid elevations mostly Douglas-fir, larch, and lodgepole and at higher elevations spruce, subalpine fir and lodgepole. Floodplains along the Kootenai River are for the most part narrow except from Bonners Ferry to the border with B.C. This area hosted primarily wetland/riparian vegetation during presettlement times, but is now cropland. The largest remaining wetland in this part of the subbasin is the 17,000 acre Creston Valley Wildlife Management Area.

Vegetation of the Kootenai Subbasin is typical of the Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow Province (Bailey et al. 1994). Engelmann spruce, subalpine fir, and lodgepole grow at higher elevations, giving way to forests of mostly Douglas-fir, lodgepole, and western larch, at mid to low elevations. Other common tree species include mountain hemlock, western hemlock, western redcedar, ponderosa pine, western white pine, and grand fir (figure 1.11). Some areas, like the Selkirk Mountains and portions of the Purcells and Rockies, also support whitebark pine, which is declining due to a combination of diseases, insect infestations and fire suppression. On river floodplains there is ponderosa pine, 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. Much of the valley bottom in the flood plain along the river from Bonners Ferry to Kootenay Lake has been converted to crop production.

Figure 1.12 presents a representative cross section showing elevational ranges of biogeoclimate zones (named for their dominant tree species) in the British Columbia portion of the province. In general, the interior cedar-hemlock and wet forest types occur in the Selkirks, Kootenay Lake and Purcell Trench areas and portions of the Purcell range, especially the west slope. Drier forest types occur though most of the remainder of the upper portion of the drainage.

Montana Natural Heritage Program and Idaho Conservation Data Center plant species of concern and USFWS listed species are listed in Appendix 13.

Grasslands

About 1 percent of the Montana portion of the subbasin is mountain grassland or sedge meadows (USDA USFS and NRCS 1995). The bulk of this is in the Tobacco River Valley and on steep south-facing slopes along the lower reaches of the Fisher River. Rough fescue, Idaho fescue, prairie junegrass, and bluebunch wheatgrass are the dominant species, although there is also a wide variety of forbs and shrubs. The Nature Conservancy's Dancing Prairie Preserve is located in the Tobacco River Valley. The preserve harbors the world's largest known population of Spalding's catchfly (*Silene Spaldingii*), which is listed as a threatened species by the USFWS.

Only small areas of true grassland occur in the Idaho portion of the subbasin. Virtually all of the valley floodplain was wetland, cottonwood stands and extensive seasonally flooded sedge meadows prior to its draining; protection from flooding by a system of ditches, pumps, and levees; and conversion to agriculture. About 68,000 acres, most of which are on the Kootenai River

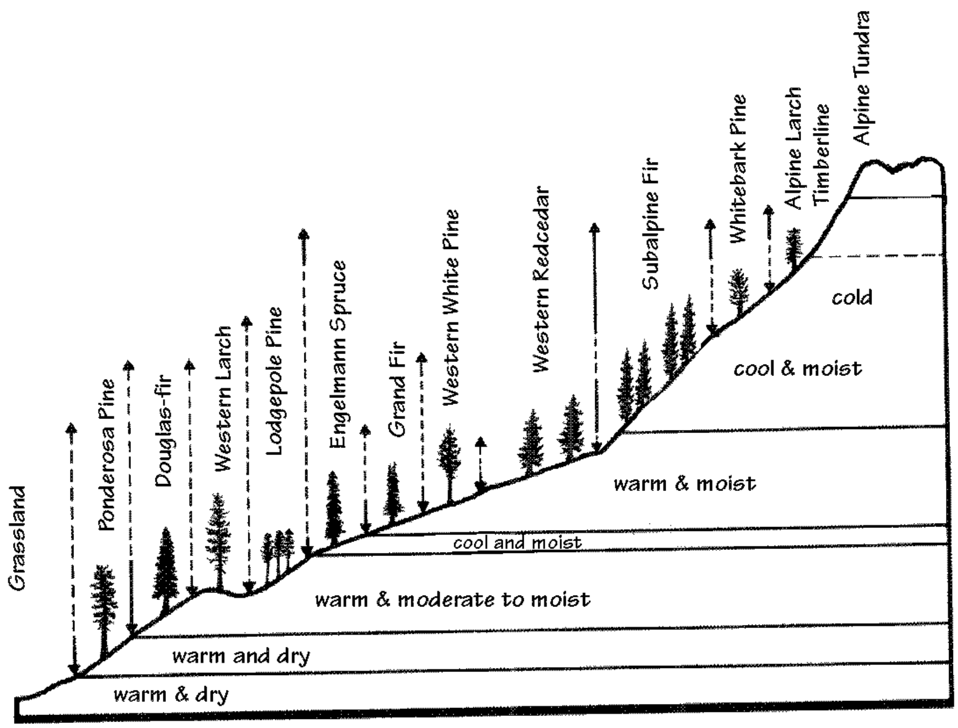

Figure 1.11. A generalized distribution of forest trees within the Kootenai Subbasin (after Pfister et al. 1977). The arrows show the relative elevational range of each species; the solid portion of each arrow indicates where a species is the potential climax and the dashed portion shows where it is seral.

LINKS

For special status plant species in the US and Canada portions of the subbasin, go to: Appendix 13

Click Here

B.C. plant species of concern can also be viewed at: http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm

Click Here

To search B.C. Red and Blue-listed species go to: http://srmwww.gov.bc.ca/atrisk/toolintro.html

Click Here

For B.C. Red and Blue-listed species, see also Appendix 14

Click Here

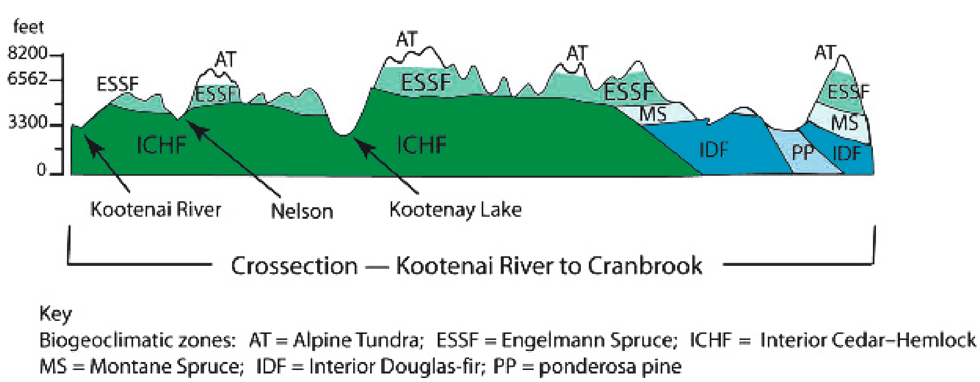

Figure 1.12. Representative crosssection of the B.C. portion of the Kootenai Subbasin showing elevational distribution of forest communities.

floodplain, are now used for crop production, and hay and pasture. The remainder of open agricultural land and pastureland is on high benches, which are cleared forestland (NRCS 2003). There are no grasslands in the B.C. portion of the subbasin downstream from Idaho, although extensive seasonally flooded sedge meadows occurred during presettlement times.

LINKS

For an interactive map of grassland areas in B.C. and other information pertaining to B.C. grasslands go to: http://www.bcgrasslands.org

Click Here

Grasslands in the B.C. portion of the subbasin upstream from Montana include the northern extension of the Tobacco Plains (primarily in the Tobacco Plains Indian Reserve) and grasslands in the Wycliffe and Skookumchuck Flats areas. Dominated by bunchgrasses, other grasses, and shrubs, they occur in valley bottoms and on several plateaus throughout the Kootenai Valley (Pojar and Meidinger 1991). *Agropyron spicatum* (bluebunch wheatgrass) is the most widespread and dominant species. Other abundant or frequent species include *Festuca scabrella* (rough fescue), *F. idahoensis* (Idaho fescue), *Poa sandbergii* (Sandberg's bluegrass), *Koeleria macrantha* (junegrass), *Bromus tectorum* (cheatgrass), *Stipa comata* (needle-and-thread grass), *S. richardsonii* (spreading needlegrass), *S. spartea* (porcupinegrass), *Poa pratensis* (Kentucky bluegrass), *Artemisia tridentata* (big sagebrush), *A. frigida* (pasture sage), and *Chrysothamnus nauseosus* (gray rabbitbrush) (Pojar and Meidinger 1991).

Wetland and Riparian areas

Sedge meadows are widely scattered in the major valleys in the Montana portion of the subbasin. Wet meadows are a complex of community types dominated by sedges, rushes, and other grasses and forbs that grow on moist or wet sites. Associated shrub and tree species include black cottonwood, quaking aspen, paper birch, Sitka alder, willow, red osier dogwood, and Rocky Mountain maple.

In the B.C. portion of the subbasin upstream from Montana, wetland grass types include several different kinds of marsh and fen vegetation. Freshwater marshes and fens are usually dominated by sedges or grasses. Some typical species include *Carex aquatilis* (water sedge), *C. rostrata* (beaked sedge), *C. vesicaria* (inflated sedge), *C. nigricans* (black alpine sedge), *Scirpus lacustris* (great bulrush), *Trichophorum caespitosum* (tufted clubrush), *Phalaris arundinacea* (reed canarygrass), and *Phragmites communis* (common reed), among many others. Wetlands in this section consist of pothole wetlands throughout the Trench, with some in larger, associated side drainages and some riparian wetlands along portions of the Kootenai River. The most extensive of these (Bummer's Flats and the Cherry Creek property) are managed by the Nature Trust of B.C. cooperatively with the B.C. Ministry of Land, Water and Air Protection.

Scattered small wetlands and riparian areas occur throughout the Idaho portion of the subbasin. These vegetation types are found distributed throughout forested parts of the Kootenai Subbasin and vary from expansive floodplains with wide channel bottoms to narrow, steep headwater rivulets. There is a noticeable vegetative transition from the steep headwater sections down into the low gradient depositional flats.

The floodplain from Bonners Ferry to Creston was once a vast complex mix of channels, wetlands and cottonwood stands prior to settlement—probably one of the largest and richest riparian forest and wetland complexes in the Pacific Northwest (Jamieson and Braatne 2001). In all, it is thought to have included approximately 70,000 acres of contiguous floodplain wetlands (Cole and Hanna 2001). Jamieson and Braatne (2001) suggest that, in form and function, this area was once similar to what occurs today in the Columbia Wetlands on the Upper Columbia River, with large seasonal wetland areas, sedge meadows, willow communities, and cottonwood stands along the natural levees of the river and on the alluvial fans of tributary streams. Today virtually all of this area has been converted to cropland. In the period between 1968 and 1991, some of these lands were converted from agricultural land back to wetlands and natural meadows as part of the Kootenai National Wildlife Refuge (KNWR).

The KNWR, located approximately 20 miles south of the Canadian border and 5 miles west of Bonners Ferry, Idaho, encompasses 2,774 acres. Composed of a variety of habitats, it includes wetlands, wet meadows, and riparian forests as well as cultivated agricultural fields. Refuge lands are interspersed in the valley bottom adjacent to the west banks of the Kootenai River. Wetlands include open-water ponds, seasonal cattail-bulrush marshes, tree-lined ponds and creeks.

On the Canadian side, a portion of the floodplain on the east side of the Kootenai River between the international border and the confluence with the Goat River is maintained as wetland habitat (DU projects) on Lower Kootenai Tribe reserve lands (Jamieson and Braatne 2001). Farther downstream, 17,000 acres are maintained as wetland and riparian habitat in the Creston Valley Wildlife Management Area (CVWMA).

The CVWMA is Provincial Crownland set aside for wildlife conservation and protection. The wetlands are maintained by a system of dikes, control structures, and pumps that have created a series of managed wetland compartments that control flood and drought cycles for wildlife production. At the south and upstream end of Duck Lake, the Kootenai River divides into two channels, and large artificial wetlands and shallow lakes are maintained above the dike to the east (Duck Lake) and between the forks of the river (Six Mile Slough). Extensive stands of older age cottonwood occur throughout. (Jamieson and Braatne 2001).

LINKS

Appendix 15 lists the habitat types that occur within each Habitat Group, VRU, and PVG in the subbasin.

Click Here

Appendix 16 provides more detailed VRU descriptions.

Click Here

For more detailed B.C. forest vegetation information see Appendix 17: Biogeoclimatic Field Guide and Biogeoclimatic Zones

Click Here

Coniferous Forest

Forest Vegetation Response Units (VRUs)[10] found in the Kootenai Subbasin are shown in Table 1.10[11]. VRUs 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 VRU is essentially a set of habitat types with similar species composition and successional pathways, and that are expected to respond similarly to disturbances. Appendix 15 lists the habitat types that occur within each VRU. The use of VRUs allows repeatable landscape patterns to be related to predictable ecological processes and makes it possible to project future landscape conditions. For analysis purposes we have further lumped VRUs into Potential Vegetation Groups (PVGs). The relationship of these to VRUs is shown in table 1.10. The table also shows how subbasin planning PVGs correspond to the PVGs used in the Upper Columbia River Basin EIS. Figure 1.13 shows the distribution of potential natural vegetation (which VRUs and PVGs are derived from) in the Montana and Idaho portions of the Kootenai Subbasin. Figure 1.14 shows cover types in the Canadian portion of the subbasin. PVGs for the U.S. portion of the subbasin are shown on maps included in Appendix 1.

The following descriptions of VRUs, excerpted from the Upper Kootenai Subbasin Review (USFS 2002), apply to both the Montana and Idaho portions of the Kootenai Subbasin. Appendix 16 (see Links column) provides more detailed descriptions of each VRU.

Warm Dry PVG

VRU 1: This VRU is a mix of forested and nonforest sites, characterized as a warm, dry setting. Where tree cover is present, it is ordinarily composed of open-grown parklike stands of mature, large diameter ponderosa pine at low stocking levels, with thickets of Douglas-fir and a bunchgrass understory. Trees tend to be clumped where soil development is adequate. The sites are well-drained mountain slopes and valleys or steep west and southerly aspects. Elevation ranges from 2,000 to 5,400 feet but averages 3,400 feet. Annual precipitation ranges from 14

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[10] The term Vegetation Response Unit or VRU as it is used here is essentially synonymous with the term Habitat Type Group or Habitat Group. IPNF uses HG; the KNF VRUs. We have chosen to use VRU.

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

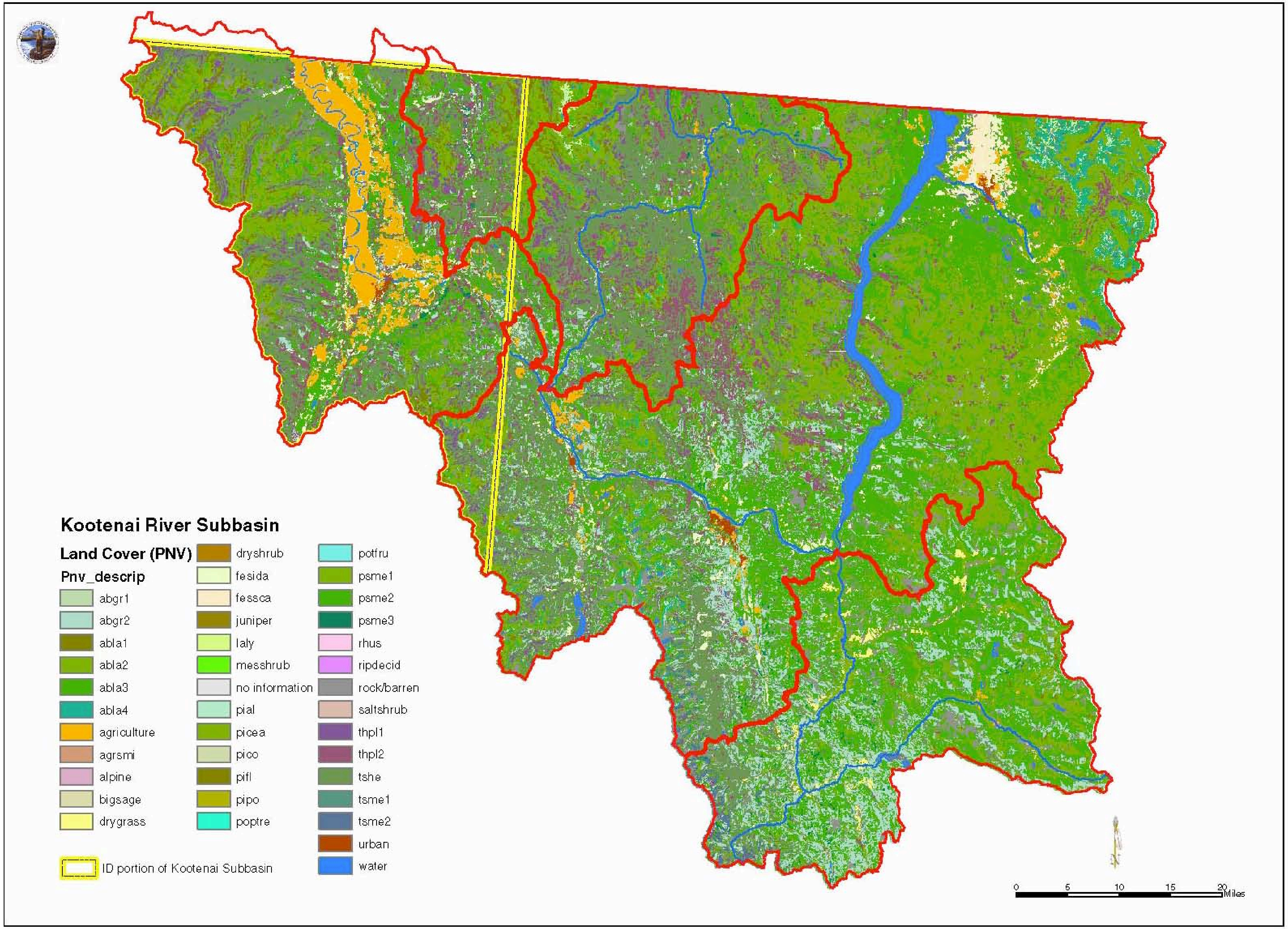

Figure 1.13. Potential Natural Vegetation of the U.S. portion of the Kootenai River Subbasin.

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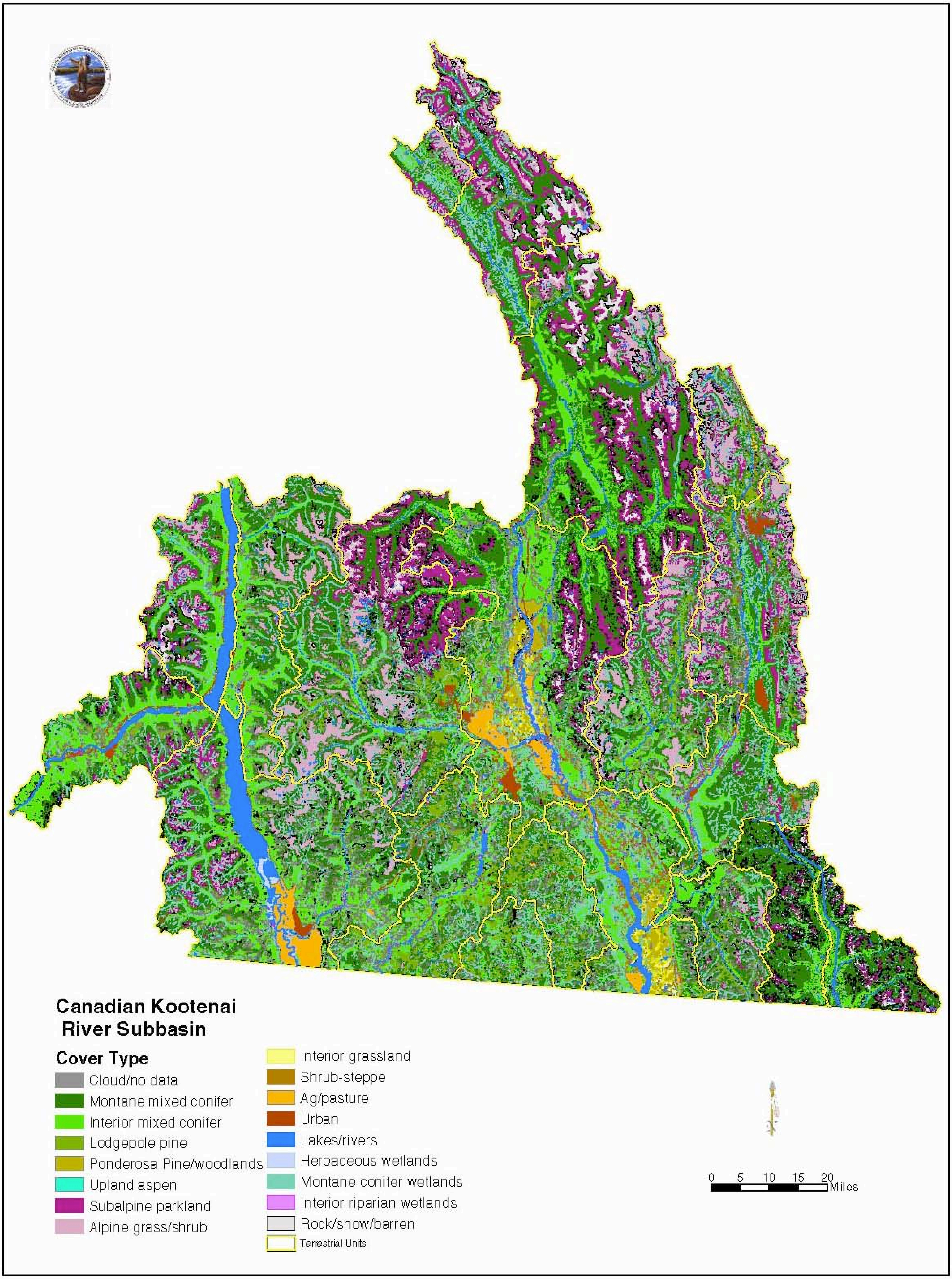

Figure 1.14. Cover types in the Canadian portion of the Kootenai River Subbasin.

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Table 1.10. Relationship of IPNF habitat groups to VRUs and PVGs.

Vegetation Response Units (VRUs)	IPNF Habitat Type Groups (HTGs)	Potential Vegetation Groups (PVGs)	Upper Columbia River Basin PVGs
VRUs 1, 2N, 2S, and 3	HTGs 1, 2 and 3	Warm Dry	Dry Forest
VRUs 4N, 4S, 5N, 5S, and 6	HTGs 4, 5 and 6	Moist	Moist Forest
VRUs 7N, 7S, and 8	HTGs 7 and 8	Cool Moist	
VRUs 9 and 10	HTGs 9, 10 and 11	Cool/Cold Dry	
VRU 11		Cold	Cold Forest

to 25 inches, with most of that falling as rain. While the growing season is fairly long, the high solar exposure and shallow soils result in soils that usually dry out early in the growing season. This lack of soil moisture can create harsh growing conditions in late summer. This portion of the landscape is considered very low in vegetative productivity. The predominant fire regime was nonlethal, low severity at a 5 to 25 year return interval. Douglas-fir and ponderosa pine are the dominant tree species.

VRU 2: This VRU is characterized as moderately warm and dry but is a transitional setting that includes warm, dry grasslands and moderately cool and dry upland sites. The dry, lower elevation open ridges are composed of mixed Douglas-fir and ponderosa pine in well-stocked and fairly open-grown conditions. Moist, upland sites and dense draws also include western larch and lodgepole pine, with lesser amounts of ponderosa pine. Tree regeneration occurs in patches and is largely absent in the understory. The sites are well-drained mountain slopes and valleys located on most topographic aspects at an average elevation of 3,600 feet, but ranging from 2,000 to 5,800 feet. Annual precipitation ranges from 16 to 30 inches, about 75 percent of that falling as rain. While the growing season is fairly long, high solar input and moderately shallow soils often result in soils that dry out early in the growing season. This lack of soil moisture and the general absence of volcanic ash influenced soils, results in low to moderate site productivity. Historic fire regimes in this VRU were predominantly nonlethal, low severity with 15 to 45 year return intervals. On cooler, northerly slopes, fires can be nonuniform, mixed severity with 15 to 45 year return interval. Occasionally, lethal, stand-replacing fires can occur at an average fire return interval of 225 years. Cover types in order of dominance include Douglas-fir, western larch, ponderosa pine, and lodgepole pine.

VRU 3: This VRU occupies a moderately warm and moderately dry habitat between the drier, warmer sites of VRU 2 and the more moist sites of VRU 5. Being a transitional setting, it includes characteristics of each. Often on moderately steep, northerly slopes and some lower valley sites, the elevation averages 3,800 feet but can range between 2,000 and 5,800 feet. Average precipitation is estimated to range from 18 to 30 inches; 70 percent of this is rain. Historically, fires were somewhat variable in this VRU. The predominant regime was most likely mixed lethal at a 70 to 250 year return interval on cool, wet sites, a 30-year return interval on warm, moist sites, and a 75 to 80 year return interval in lodgepole pine stands. Nonlethal fires also occurred at a 25 to 50 year return interval, particularly in drier sites. Nonuniform, lethal stand replacement fires also occurred at a 100 to 250 year return interval. The dominant trees are Douglas-fir, western larch, and lodgepole pine. Ponderosa pine is also present.

Moist PVG

VRU 4: This VRU occupies some of the moderately warm and moist sites along lower slopes and valley bottoms. VRU 4 is ecologically influenced by the moderating effects of the inland maritime climate. It is typically bounded by warmer and drier upland sites (VRUs 2 and 3), moderately cool and moist sites (VRU 5), and some cooler sites (VRUs 7 and 9). While very limited in scope, VRU 4 contains habitat conditions that are ordinarily drier and cooler than what is suitable for western hemlock and western redcedar. Elevation ranges from 2,000 to 6,400 feet, mostly around 3,700 feet. Average precipitation is 30+ inches and higher in some places. On south facing slopes historically, fires were typically nonuniform, mixed severity, with a fire return interval of 30 to 85 years. On north facing slopes, fires were more lethal with stand replacement at an average 200-year fire return interval. Douglas-fir and western larch/Douglas-fir cover types are most common. Lodgepole pine, ponderosa pine, grand fir, subalpine fir and western redcedar are also present.

VRU 5: This VRU occupies most of the moderately cool and moist sites along benches and stream bottoms of the Kootenai. VRU 5 is ecologically influenced by the moderating effects of the inland maritime climate and is typically bounded by the more moderate sites (VRUs 3 and 4), and some cooler sites (VRU 7). Some scattered riparian areas and wet site VRUs (6 and 8) are occasional intrusions. This VRU is widespread throughout the forest and has the most biological productivity. This VRU has been mapped at elevations that range from 1,800 to 6,400 feet, but is more common at an average elevation of 3,800 feet. Precipitation is moderate to high, ranging from 30 to 50 inches per year. Historic fire regimes were typically mixed lethal to lethal in this VRU. Mixed lethal fires were more common on southerly slopes at an average 75-year return interval (17 to 113 year range). Lethal, stand replacing fires were more common on northerly slopes at 250+ year return interval (110 to 340 year range). The most common tree species are Douglas-fir, western larch, subalpine fir, and lodgepole pine. Western redcedar and western hemlock were also present.

Cool Moist PVG[12]

VRU 7: This VRU occurs in the moist lower subalpine forest setting and is common on northwest to east facing slopes, riparian and poorly drained subalpine sites, and moist frost pockets. This landscape is typically bordered by warmer sites (VRU 5) and cool, drier subalpine sites (VRU 9). It includes characteristics of each. The mapped elevations range between 2,000 and 7,000 feet, but are more common at an average elevation of 4,800 feet. Average precipitation is estimated between 35 and 55 inches per year, less than half as rain. Vegetative productivity is moderate to high as a result of the high moisture-holding capacity and nutrient productivity of loess deposits, adequate precipitation, and a good growing season. The predominant historic fire regime is lethal and stand-replacing with a fire return interval of greater than 100 years in lodgepole pine/Douglas-fir, 120 to 268 years in western larch/Douglas-fir, and up to 300 years in spruce bottoms. Subalpine fir, lodgepole pine, western larch, and Douglas-fir are the most common tree species.

Cool/Cold Dry PVG

VRU 9: This VRU is typified by cool and moderately dry conditions with moderate solar input. The climate is characterized by a short growing season with early summer frosts. Annual precipitation ranges from 35 to 70 inches, mostly in the form of snow. Due to generally shallow soils (low water holding capacity), slope position, and aspect, soil moisture is often limited during late summer months. It is generally found on rolling ridges and upper reaches of convex mountain slopes generally above 5,400 feet in elevation. The predominant fire regime is stand replacement and the historic fire return interval is 100 to 115 years, with some nonuniform, mixed severity fires occurring at a fire return interval of 50 to 71 years. Lodgepole pine and subalpine fir are the most common species. Western larch, and Douglas-fir are also present.

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[12] VRUs 6 and 8 are very wet forest riparian areas, generally located along streams and associated with wetlands. In terms of the geographic area they cover, they are considered a minor component of the forested portion of the subbasin and will be treated in the wetland/riparian biome rather than here.

VRU 10: This VRU occurs in a transition zone between the forest and alpine tundra. It is typified by cold and moderately dry conditions with short day lengths, and low to moderate solar input. The climate is characterized by a short growing season with early summer frosts. Annual precipitation ranges from 50 to 80 inches, mostly in the form of snow. Soil moisture is often limited during the summer months due to the low water holding capacity of the shallow soils, and slope position. This setting occurs on most aspects and is generally found on upper reaches of fairly steep, convex mountain slopes. Elevations average 6,400 feet and range from 4,500 to 7,800 feet. The predominant fire regime was low to mixed severity at 35 to 300+ years. Stand replacement fires could also occur at 200+ year intervals. Cover types in order of dominance include subalpine fir, nonforest, lodgepole pine, and Douglas-fir. Whitebark pine is also present.

Cold PVG

VRU 11: This VRU occurs on high elevation cold sites near timberline. It is typified by cold and dry conditions with short day lengths, and low solar input. The climate is characterized by a short growing season with early summer frosts. Annual precipitation ranges from 60 to 90 inches, mostly in the form of snow. Soil moisture is generally limited during the summer months due to the low water holding capacity of the shallow soils, and slope position. This setting occurs across all aspects often on very steep alpine ridges and glacial cirque headwalls. Elevations average 6,900 feet and range from over 5,300 to 8,600 feet. The landforms within VRU 11 have been influenced by alpine glaciation and are a complex of forest, avalanche chutes, and rock outcrop. The predominant historic fire regime was low to mixed severity at 35-300+ years. Stand replacement fires could also occur at 200+ year intervals. Dominant cover types in order of dominance include subalpine fir, nonforest, and lodgepole pine. Whitebark pine is also present.

In the B.C. portion of the subbasin, biogeoclimatic zones are often used to characterize vegetation communities. The biogeoclimatic zones found in the B.C. portion of the Kootenai Subbasin are described in detail in Appendix 17.

1.2 The Subbasin in the Regional Context

1.2.1 Size, Placement, and Unique Qualities.

The Kootenai Subbasin, located in northwestern Montana, northern Idaho and southeastern British Columbia, is one of the northeastern-most drainages of the Columbia Basin (figure 1.15). In terms of runoff volume, the Kootenai River is the second largest Columbia River tributary. In terms of watershed area (10.4 million acres), the Kootenai Subbasin as a whole ranks third in the Columbia Basin (Knudson 1994). In addition to being an international subbasin with the U.S. portion being both downstream and upstream of the Canadian parts of the drainage, it is distinguished by the following features:

Montana

- Cabinet Mountains Wilderness, Ten Lakes Montana Wilderness Study Area, Ross Creek Cedars Scenic Area, Lower Ross Creek Research Natural Area (RNA), Norman Parmenter RNA and Big Creek RNA.
- Inventoried Roadless Areas – Robinson Mountain, Mt. Henry, Ten Lakes Additions, Tuchuck, Thompson-Seton, Marston Face, Zulu, Big Creek, Roderick Mountain, Gold Hill, Gold Hill West, Saddle Mountain, Flagstaff Mountain, Roberts Mountain, Willard-Lake Estelle, Cabinet Face West, Cabinet Face East, Scotchman Peak, and Alexander.
- Rivers and streams eligible for inclusion in the National Wild and Scenic River System: Kootenai River and Big Creek.
- Kootenai Falls, Little North Fork Falls, Pinkham Falls, Tenmile Falls, Bull Lake, Savage Lake, Spar Lake, many wilderness lakes (including Leigh and Granite), Sophie Lake, Tetrault Lake, Thirsty Lake, Alkali Lake, Frank Lake, Glen Lake, Dickie Lake, Murphy Lake, Big and Little Therriault Lakes.
- The Nature Conservancy's Dancing Prairie Preserve harbors the world's largest known population (90 percent of the species' entire population) of Spalding's catchfly (*Silene Spaldingii*), which is listed as a threatened species by the USFWS and is considered critically imperiled in Montana because of its extreme rarity.
- Wildlife species such as elk, moose, black bear, mountain goat and bighorn sheep. The Ural-Tweed sheep herd, whose range includes the rocky faces along the east side of Koocanusa Reservoir, are the last native bighorn sheep in northwestern Montana.

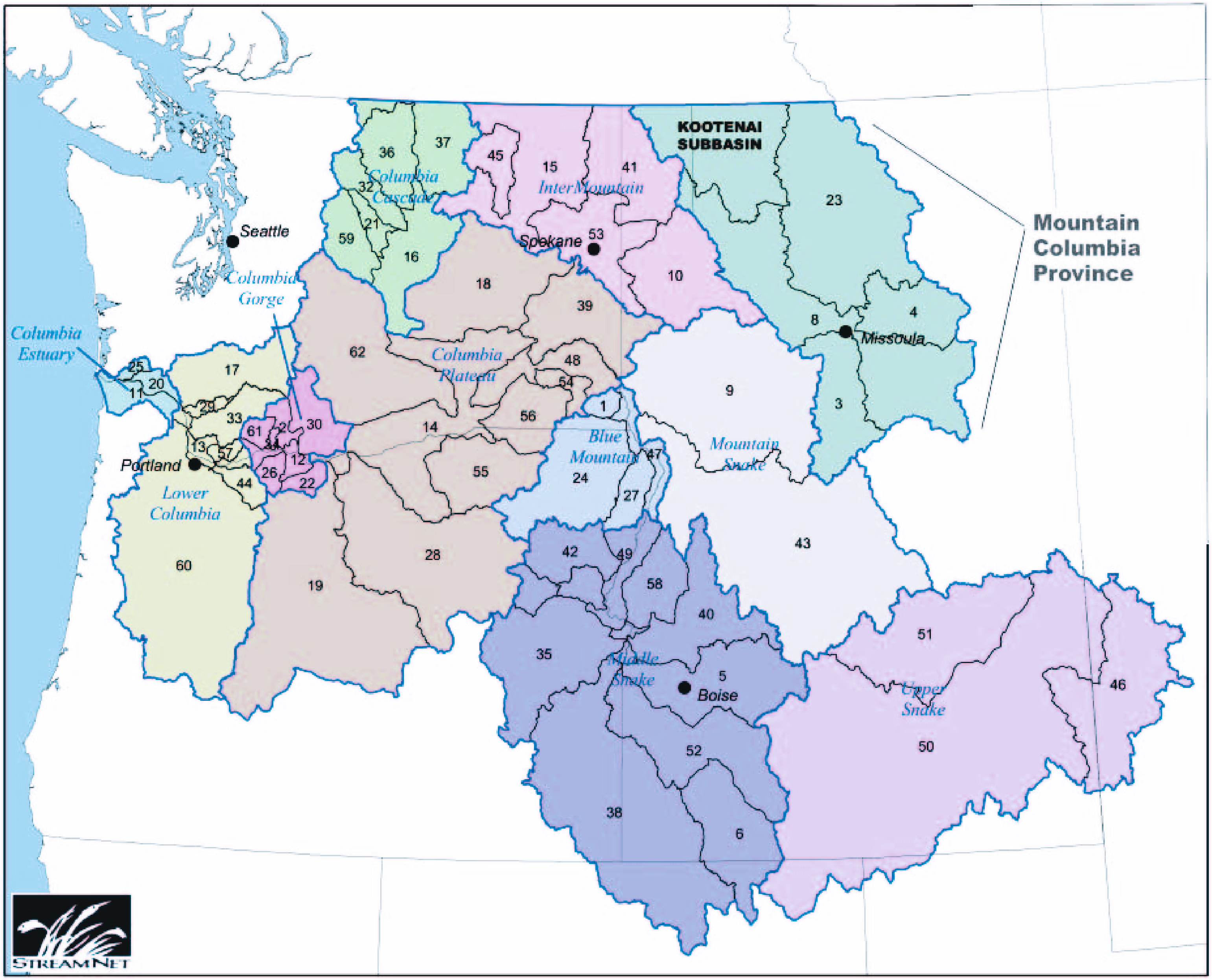

Figure 1.15. The Kootenai Subbasin is one of the northeastern-most drainages of the Columbia River.

- Populations of, or habitat for terrestrial threatened and endangered species, including gray wolf, grizzly bear, and lynx. The area contains most of the region's carnivore species including fisher and wolverine. Townsend's big-eared bat, northern bog-lemming, western toad and common loon are a few of the sensitive species that occur here (USFS IPNF 2003).
- The Kootenai River white sturgeon (*Acipenser transmontanus*), an endangered species, and burbot, the only freshwater member of the cod family.
- Populations of bull trout, a threatened species, and Columbia River redband trout (native rainbow), westslope cutthroat trout, and torrent sculpin, which is endemic to the Kootenai drainage.

Idaho

- Populations of, or habitat for, all big game species including mountain goat.
- Populations of, or habitat for terrestrial threatened and endangered species, including gray wolf, caribou, grizzly bear, and lynx. The area contains most of the region's carnivore species including fisher and wolverine. Townsend's big-eared bat, northern bog-lemming, western toad and common loon are a few of the sensitive species that occur here (USFS IPNF 2003).
- The Kootenai River white sturgeon (*Acipenser transmontanus*), an endangered species, and burbot, the only freshwater member of the cod family.
- Populations of bull trout, a threatened species, and Columbia River redband trout (native rainbow), westslope cutthroat trout, native kokanee salmon, and torrent sculpin, which is endemic to the Kootenai drainage.
- All or portions of eleven Inventoried Roadless Areas totaling approximately 151,000 acres or 37 percent of National Forest System lands in the area. The Proposed Selkirk Crest Wilderness Area is located here, along with three Research Natural Areas: Hunt Girl Creek, Three Ponds, and Smith Creek.
- Prior to European-American settlement, the floodplain from Bonners Ferry to Creston was one of the largest and richest riparian forest and wetland complexes in the Pacific Northwest (Jamieson and Braatne 2001).

1.2.2 Relationship of the Subbasin to ESA Planning Units[13]

Northern Rocky Mountain Wolf

The subbasin is included in the Northwestern Montana Recovery Area. In the 2001 Monitoring Report (USDA 2002b), the USFWS reported two packs living within the Kootenai National Forest, plus a pair of wolves, and a group of wolves that were relocated to the forest. Habitat for gray wolves includes a variety of forested and open conditions centered on ungulate winter ranges. Transient wolves are found throughout the subbasin. The recovery goal for gray wolves is thirty pair distributed across all three-recovery areas. Since 2000, the gray wolf population has exceeded that level and the USFWS has begun the process to reclassify the gray wolf.

LINKS

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

Click Here

For information on caribou in British Columbia, go to: http://www.cmiae.org/

Click Here

Woodland Caribou

Woodland caribou are listed as endangered in the Idaho portion of the subbasin. The only known population in the lower 48 states is located in the Selkirk Mountains of Idaho and Washington, which is the Recovery Area for the species. Between 1987 and 1990, there were three augmentations of this population with a total of 60 caribou from British Columbia. A second population augmentation effort was begun in 1996 and over the next three years an additional 43 caribou were released in the Recovery Zone. In Montana, they are identified as a sensitive species. Although historically caribou were found on the Kootenai National Forest, there are currently no known resident populations. Research in Idaho has identified woodland caribou habitat as mature and old growth subalpine fir and cedar/hemlock forest. Suitable early winter habitat is in shortest supply of all the seasonal caribou habitats. Currently, 31 percent of the potential caribou winter habitat in the North Zone on the Idaho Panhandle National Forest (IPNF) is suitable (North Zone GA of the IPNF). Currently, vegetation conditions are within the historic range of variability and habitat is not a limiting factor. The trend for caribou in the subbasin is one of decreasing population numbers. Mountain lion predation and reductions of mature/old growth forests and early-winter and low-elevation habitats have precipitated the decline.

Bald Eagle

The subbasin is located within the Upper Columbia Basin Bald Eagle Recovery Zone (Zone 7). Since coming under federal protection in 1986, both the number of nests and the wintering population have increased. Numbers have increased

[13] *Adapted from Technical Report: Analysis of Management Situation (2003)*

nationwide to a point that USFWS proposed delisting the species in 1999. Bald eagles nest within 1/4 mile of a large body of water in a large, open crowned tree, such as ponderosa pine, cottonwood, larch or Douglas-fir. Generally, nest trees are located in areas relatively free from human disturbance. They forage upon waterfowl, fish, and carrion.

Canada Lynx

Lynx are known to occur throughout the subbasin, however the population size is unknown. 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 Subbasin includes portions of the Northern Rocky Mountains Lynx Geographic Area. Lynx habitat within the geographic area is divided into smaller lynx management units (LAUs) for analysis purposes. Each LAU is managed for various habitat components as described in the Canada Lynx Conservation Assessment and Strategy (Ruediger et al. 2000). Canada lynx habitat has been identified as all lands above 4,000 feet elevation. Habitat requirements for lynx vary based on their activity. For denning habitat, they seek out mature forests of spruce, subalpine fir, lodgepole pine, cedar, and hemlock. Within these stands they seek out areas with a complex structure of downed trees that provide security cover for kittens. Canada lynx foraging habitat is dense, young stands (15 to 45 years of age) of coniferous forest. Within this type of forest, snowshoe hare, the primary prey of lynx, are most common. Snowshoe hare are also found in mature forest with a well-developed understory of young conifers and shrubs.

Grizzly Bear

The Subbasin includes all or portions of three grizzly recovery zones. The Cabinet/Yaak Grizzly Bear Ecosystem is located entirely within the Subbasin. Portions of the Selkirk and Northern Continental Divide Ecosystems are also within the Subbasin. Grizzly bear habitat within the Recovery Zones is divided in smaller bear management units (BMU), approximately the size of a female's home range, for analysis and monitoring. Each BMU is monitored for various habitat components identified as important for recovery of the species. In 1999, the USFWS determined that the Selkirk and Cabinet/Yaak ecosystems should be combined and the grizzly bears in both were warranted but precluded from reclassification as an endangered species (Federal Register Vol. 58, No. 28 1993, pp. 8250-8251). Grizzly bears are habitat generalists and use a variety of habitat from low elevation riparian areas to avalanche chutes as food availability changes.

Upon emerging from their den in the spring, grizzlies move to low elevations seeking carrion and green vegetation. As the snow line recedes, they follow the emergent vegetation to higher elevations until late summer when they focus on eating berries. Throughout the year, they prey on small mammals and occasionally ungulates when they are available.

Bull Trout

The U.S. Fish and Wildlife Service issued a final rule listing the Columbia River population of bull trout as a threatened species on June 10, 1998 (63 FR 31647). For listing purposes, the USFWS divided the range of bull trout into distinct population segments. The agency identified 27 recovery units. The Kootenai River Recovery Unit forms part of the range of the Columbia River population segment. The Kootenai River Recovery Unit is unique in its international configuration, and recovery will require strong international cooperative efforts. Within the Recovery Unit, the historic distribution of bull trout is relatively intact. But abundance of bull trout in portions of the watershed has been reduced, and remaining populations are fragmented. The Kootenai River Recovery Unit includes 4 core areas (Koocanusa Reservoir, Kootenay Lake and River, Sophie Lake, and Bull Lake) and about 10 currently identified local populations (USFWS 2002).

White Sturgeon

On September 6, 1994, the U.S. Fish and Wildlife Service listed the Kootenai River population of white sturgeon as an endangered species *(59* FR 45989) under the authority of the Endangered Species Act of 1973, as amended. The Kootenai River population is one of several land-locked populations of white sturgeon found in the Pacific Northwest. Although officially termed and listed as the "Kootenai River population of white sturgeon", this white sturgeon population is restricted to but migrates freely in the Kootenai River from Kootenai Falls in Montana downstream into Kootenay Lake, British Columbia, Canada, although it is uncommon upstream from Bonners Ferry. These fish have not successfully spawned in recent years.

1.2.3 External Environmental Conditions Impacting the Subbasin

The primary external factors impacting the Kootenai 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 from Libby Dam. 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:

LINKS

Appendix 18 has more complete information on the impacts to the subbasin from mainstem operations.

Click Here

- 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 much 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

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

1.2.4 Macroclimate trends

The Third Assessment Report of the Intergovernmental Panel on Climate Change concluded that the Earth is warming at a much accelerated rate relative to what has occurred at other times in Earth's history. The report also concludes a portion of the warming has been caused by humans—mostly from the burning of fossil fuels and deforestation. It predicts that climate change could result in increases in mean annual temperature for western North America of 3.6 to 7.2 °F above the range of temperatures that have occurred over the last 1000 years (for Idaho, the Panel's models predict an increase of 5 °F, with a range of 2 to 9 °F). There is also likely to be an increase in the amount of precipitation—10 percent in spring and fall and 20 percent in winter (with a range of 10 to 40 percent) (USEPA 1998). In Idaho, the amount of precipitation on extreme wet or snowy days in winter is likely to increase, as is the frequency of extreme hot days in summer. It is not clear how the severity of storms might be affected, although an increase in the frequency and intensity of winter storms is possible (USEPA 1998). The Environmental Protection Agency (1998) estimates that forest cover in Idaho could decrease by 15 to 30 percent over the next 100 years. However, predictions of biological change over the next century resulting from the rapid rate of climate change range from large-scale biome shifts to relatively less extensive disruptions in forest growth. Some of the predictions for the Kootenai Subbasin include[14]:

- Increases in the frequency, intensity and timing of disturbances such as fire and pests;
- Movement of species ranges northward and up in elevation and new assemblages of species will occur in space and time;
- Changes in habitat quality and availability that will adversely affect some sensitive species;
- Potential loss of specific types of ecosystems such as wetlands;
- More severe and frequent spring flood damage;
- Reduced stream flow in late summer and fall and increases in stream temperatures that will affect fish survivability;

[14] *Adapted from: B.C. Ministry of Water, Land, and Air Protection (2002).*

- Soil moisture reductions;

- Glacier reduction and disappearance and diminished flows in rivers and streams that depend on glacier water in the late summer and fall

In the Flathead Subbasin, which lies immediately to the east, Glacier National Park's glaciers already show evidence of global warming. 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).

Models developed by researchers at NASA and elsewhere are predicting that Glacier National Park will see a 30 percent increase in precipitation and a 0.9 °F 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 increase 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 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

1.3 Fish, Wildlife, and Plant Species[15]

1.3.1 Vertebrate Species

Thirty-nine species of fish (including hybrids) occur in the Kootenai Subbasin, 16 of which are native (Hutten 2003; USFWS 1999). The subbasin is also home to 364 terrestrial wildlife species. The list includes 11 amphibians, 10 reptiles, 273 birds, and 70 mammals. These are listed in Appendix 19 (see Links column).

LINKS

For the Idaho Conservation Data Center, which has information on species at risk in Idaho, go to http://fishandgame.idaho.gov/tech/CDC/

Click Here

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

Click Here

Appendix 19 lists aquatic and terrestrial vertebrate species occurrences for the Kootenai Subbasin.

Click Here

1.3.2 Species at Risk

The Federal government has classified nine species of plant and animals that occur within the Kootenai River Subbasin as threatened or endangered under the Endangered Species Act (table 1.11). The peregrine falcon was formerly listed as Endangered but was delisted in 1999. It is now considered recovered subject to five years of monitoring. Appendix 20 (see links column) lists plant and animal species of concern as reported by the Natural Heritage Program in Montana and the Idaho Conservation Data Center.

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. Terrestrial species and plant communities are also listed at the Provincial scale in B.C. as rare and endangered (red-listed), vulnerable (blue-listed) or species of regional management concern (yellow-listed) by the B.C. Conservation Data Centre. Red- and blue-listed vertebrate and vascular plant species in the Cranbrook Forest District and the Southern Rocky Mountain Management Plan Area are listed in Appendix 21.

1.3.3 Aquatic Focal Species and Terrestrial Target Species

Members of the Montana and Idaho Kootenai Subbasin Technical Teams have selected bull trout, westslope cutthroat trout, Columbia River redband trout, kokanee, burbot, and white sturgeon as the aquatic focal species for the Kootenai Subbasin Plan. The Team selected these 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

[15] *Unless otherwise noted, this section deals with the entire Kootenai River Subbasin (Idaho, Montana, and B.C. portions).*

Table 1.11. Species listed under the Endangered Species Act in the Kootenai River Subbasin.

Species Category	Common Name	Scientific Name	Status	Year Listed
Mammal	Gray Wolf	*Canis lupis*	T	2003
	Woodland Caribou	*Rangifer tarandus*	E	1983
	Grizzly Bear	*Ursus arctos horribilis*	T	1967
	Canada Lynx	*Lynx canadensis*	T	2000
Bird	Bald Eagle	*Haliaeetus leucocephalus*	T	1967
Fish	Bull Trout	*Salvelinus confluentus*	T	1998
	White Sturgeon	*Acipenser transmontanus*	E	1994
Flowering Plant	Water Howellia	*Howellia aquatilis*	T	1994
	Spalding's Cathfly	*Silene spaldingii*	T	2001

LINKS

For the Montana Heritage Program and Idaho Conservation Data Center ranks for plant and animal species of concern and species that are at risk go to Appendix 20.

Click Here

Appendix 21 lists British Columbian red- and blue-listed species.

Click Here

Information on critical functional link species and functional specialists in the Kootenai Subbasin can be found at the IBIS website: http://www.nwhi.org/ibis/subbasin/home.asp

Click Here

(table 1.12). 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 or as a critical functional link species (see the definitions that follow); or (3) they possess economic or cultural significance to the people of the Kootenai Subbasin.

Functional specialists are species that have only one or a very few number of key ecological functions. An example is the 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. Critical functional link species are species that are the only ones that perform a specific ecological function in a community. Their removal would result in a 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 to the use 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 1.12. Terrestrial target species.

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

[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.*

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 (figures 2.1 and 2.2). 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]

Landform and vegetation are the most important large-scale physical features that affect watershed function and process. Landforms determine how and where water travels across the landscape, while vegetation influences the erosional processes that occur within the landscape (USFWS 2000).

At finer spatial scales water, sediment, solutes, and organic matter from terrestrial systems flow into and through streams and rivers. The shape and character of stream channels is dynamic, constantly undergoing adjustments to the flow of these materials by forming distinctive patterns of pools and riffles, meanders, and braids (Leopold et al. 1964). The varied topography within the subbasin, along with channel-affecting processes and irregular disturbance (i.e. environmental stochasticity: fire, debris flows, landslides, drought, and extreme flood events) have resulted in a range of river and stream conditions that, under natural conditions, are constantly in flux (Reeves et al. 1995). Most of these disturbances result in pulses of sediment and large woody debris into streams. In response to these episodic inputs, the streams and rivers in the subbasin undergo cycles of channel change on a timescale ranging from years to hundreds of years. Having evolved under and adapted to such conditions, aquatic and riparian species are dependent on the dynamic nature of stream channels (USFS 2003).

Makepeace (2000) described how landforms affect channel and floodplain processes in watersheds like those found in the Kootenai. The descriptions of headwater and valley floor areas that follow are adapted from that discussion. Figure 2.3 shows general downstream trends for subbasin streams.

Snapshot

During presettlement times aquatic and hydrologic processes and functions were intact. Dams, dikes, diversions, groundwater withdrawls, roading, channelization, logging, agricultural and grazing practices, the introduction of non-native species, developments, and 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 fish species have declined.

[1] *Biophysical features and their associated processes are interrelated and interlinked; processes in one place or time may be influenced or controlled by adjacent processes (Stanford and Hauer 1992).*

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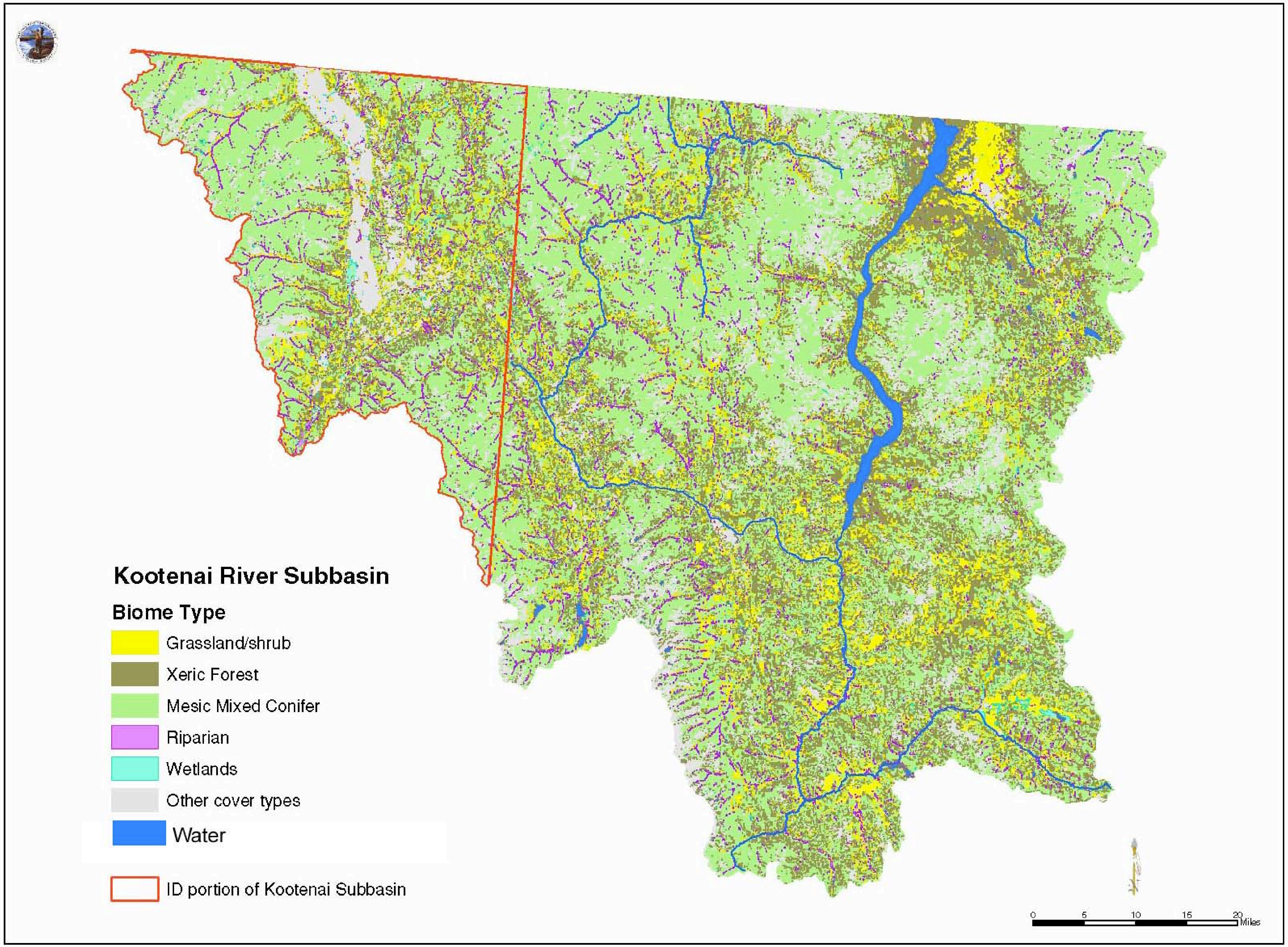

Figure 2.1. Biomes in the U.S. portion of the Kootenai River Subbasin.

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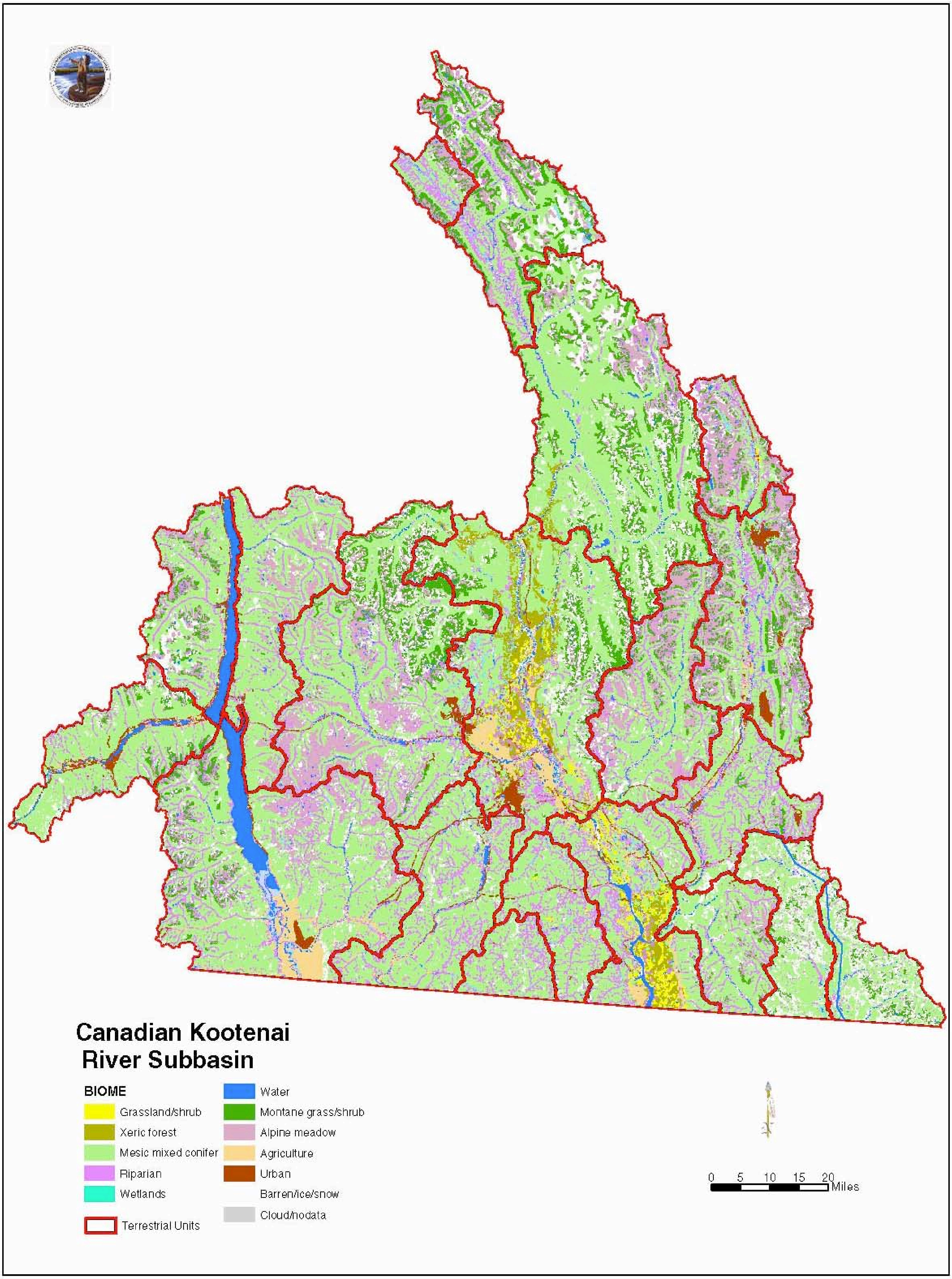

Figure 2.2. Biomes in the Canadian portion of the Kootenai River Subbasin.

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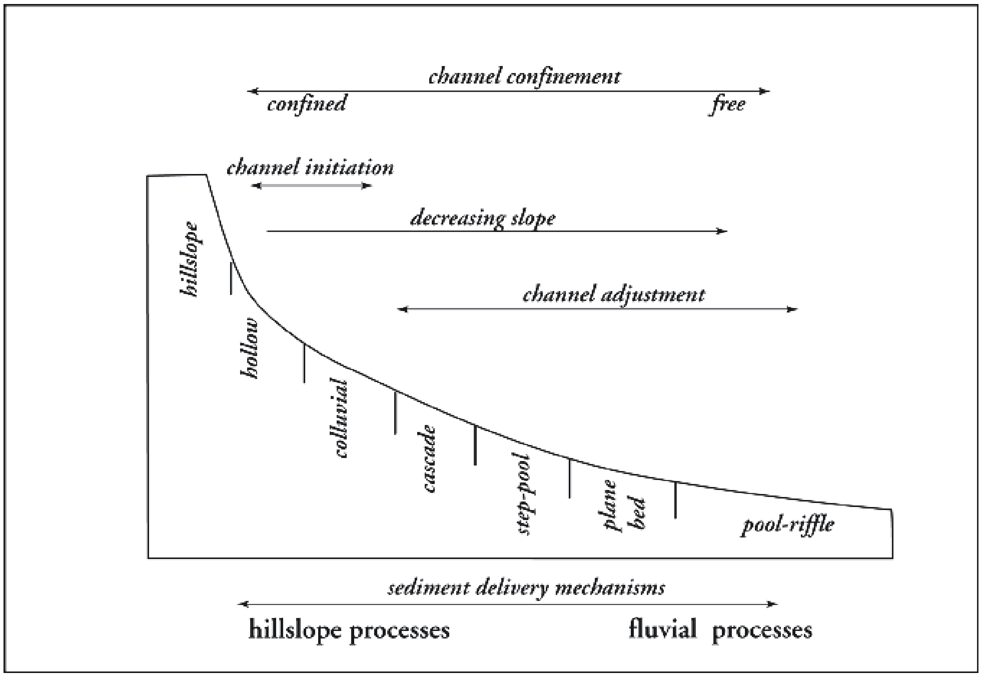

Figure 2.3. Idealized longitudinal profile through a channel network (redrawn from Makepeace 2000, after Montgomery and Buffington 1997).

Headwater Areas

Hillslope or terrestrial processes dominate water and sediment movement in the headwater portions of subbasin watersheds. Water flows beneath the surface and accumulates in depressions, 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).

Downslope, these channels combine, and the duration of streamflow increases. A more complex channel pattern, typically a cascade channel develops. Cascade and 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 of and are often separated by cascade reaches. They are composed of generally discrete, spaced accumulations of boulders and woody debris that form steps. The steps in turn are separated by lower gradient 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.

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 events. 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 often limited because of the dense vegetation growing along channel margins (Makepeace 1998).

It should be noted that even though most surface runoff in the subbasin results from annual spring peak discharges caused by melting snow, aquatic systems in the subbasin are also affected periodically by rapid snowmelt augmented by rain (rain-on-snow events). These events, a consequence of the warm, moist Pacific air masses that flow into the area in winter, can lead to sharp midwinter peak flows (USFS 2003).

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 floodplains, they develop a sinuous or meandering pattern characterized by alternating pools and riffles (Leopold et al. 1964). There are generally three end-member, pool-riffle stream types found within the subbasin:

- Laterally unconstrained gravel-bedded streams;
- Free meandering, fine bedded streams that flow through glacial lacustrine silts and other fines; and
- Gravel-bedded streams with well developed alluvial floodplains that are entrenched within wide canyons/valleys.

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.

Flooding, Floodplains and the Hyporheic Zone[2]

Flooding, a normal, natural, and necessary phenomenon and function in watershed systems, occurs when a stream or river flow exceeds the bed and banks that the stream normally occupies and spills over onto its surrounding lands. This flooded area, which should be viewed as a normal extension of the stream channel, is often called the floodplain or flood prone area. Generally, in the Kootenai, floods of some magnitude occur one to four times in any ten-year period. On a less frequent basis, larger runoff events fill greater proportions of the stream's flood prone areas. Flooding permits the stream system to adjust to changes in stream flow and sediment delivery, and remain in a dynamic equilibrium with its watershed.

Native flora and fauna of the Kootenai Subbasin evolved and adjusted to the natural flood history they experienced over many centuries. Larger scale floods in the basin are not unusual. They have occurred in 1894, 1903, 1913, 1916, 1927, 1928, 1933, 1938, 1947, 1948, 1950, 1954, 1956, 1959, 1961, 1964, 1966, 1967, 1971, 1974, 1976, 1981, 1987, 1996, and 1997—an average frequency of more than one every 10 years. The largest recorded floods occurred in 1894, 1916, 1933, 1948, 1954, 1956, 1961, 1974, and 1996. Large and frequent flooding has not been an unusual event in recent history, and the watershed systems (physical components) have subsequently been able to readjust toward a more steady state. Likewise, the aquatic systems and their biological and ecological communities have historically adjusted and persisted.

Thus, flooding is a fundamental aquatic system process in the Kootenai. Spring flushing flows sort river gravels, define channels, and remove tributary deltas. In so doing, they create a healthy environment for native fish and the food organisms they depend on. They also restore nutrient cycles and floodplain function. Black cottonwood is one of the primary species that benefit from floods, and black cottonwood galleries support many species. Floods alter channels and create backwater sloughs and log jams, providing resting areas and hiding cover for fish and other organisms. Floods also move fine sediments out of the river and onto floodplains where they alter the nutrient flux in riverside meadows and riparian communities used by foraging bears, deer, and elk. Floodplains are highly productive for small rodents such as deer mice, which in turn feed a variety of predators (Long 2000). The near-shore habitat is productive and critical to fish, and a healthy riparian zone substantially reduces the erosion of silt into the river in many systems.

However, 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

[2] *Paragraphs on flooding adapted from Deiter 2000.*

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LINKS

For fish and water information about the Kootenai 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 more information on critical functional processes of aquatic systems, see Appendix 22.

Click Here

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 an important ecological function in montane river systems like the Kootenai (Stanford and Ellis 2002). Studies in the Flathead system by Stanford and others on the Nyack floodplain have shown that as the river leaves the narrow part of a 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 as it is forced up 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 relatively infertile waters can become charged with bio-available 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 where there are 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 and help to shape wetland and riparian habitats for numerous terrestrial species.

Rain on Snow[3]

The Kootenai Subbasin is susceptible to rain-on-snow events. Basin-wide, the largest peak flows are related to spring snowmelt, or snowmelt supplemented by direct rainfall. However, in susceptible areas, midwinter rain-on-snow events result in stream flows that approach or exceed bank-full discharge during many years.

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[3] *Adapted from Deiter 2000.*

On several gauged streams, the largest floods on record are related to midwinter rain-on-snow events. North Idaho, from the North Fork of the Clearwater River to the Canadian border is under a strong maritime influence, where warm moist fronts invade in the winter from the Pacific coast. Because of the prevailing maritime influence on the winter air masses and storms of the region, the basin accumulates a deep, but often not a very cold, snowpack. Therefore, there is not often a great thermal deficit to overcome before the pack becomes isothermal, the free-water content of the pack to be satisfied, and for melt to begin. The results are that midwinter snowmelt and thaws and rainfall are common in the region, even during the times when a significant snow pack is established. Within the north Idaho Panhandle, the frequency and magnitude of these events tends to increase as the latitude decreases from the Canadian border.

In the subbasin, the snow pack that is most often susceptible to rain-on-snow[4] melt response appears to lie approximately in the 3,000 to 4,500 foot elevation range. Below 3,000 feet, the snow pack is often transitional during the winter—accumulating and dissipating several times during the season. At this elevation, snow pack may not be a significant contributor to overall basin runoff. In many years the snow pack above about 4,500 feet is usually "cold", with a large thermal deficit in the midwinter months. There are times when a significant proportion of some watersheds, or at least some tributary basins, are setup for rain-on-snow events.

Rain-on-snow response is a climate-dominated process under which the streams in the Kootenai Subbasin have historically developed. The percentage of a watershed that lie within the transient snow zone is an important factor of rain on snow flooding susceptibility (Kjelstrom and Moffatt 1981). Tables 2.1 and 2.2 show the portion of each of the watersheds in the Idaho and Montana portions of the Kootenai Subbasin (respectively) in the sensitive snow zone as defined by the Idaho Panhandle (elevations between 3,000 and 4,500 feet) and Kootenai (elevations below 4,500 feet) National Forests.

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[4] *Rain-on-snow is a bit of a misnomer because the phenomena is more complicated than the name implies. The energy transfer from warmer rain water to frozen snow, or from the change of state of liquid rain to ice does tend to raise the temperature of a snow pack. This transfer is greater than the energy transfer associated with the snow surface contact with a warm air mass. But, it is the change of state of water vapor (like fog) over snow that can have the most tremendous effect. In fact, the condensation, freezing, and sublimation associated with a moist air mass has perhaps seven times greater thermal energy available than just in rain.*

Table 2.1. The portion of each of the watersheds in the Idaho portion of the Kootenai Subbasin in the sensitive snow zone (the area more susceptible to rain on snow events).

Descriptive Name	% Watershed in Senstive Snow Zone	Descriptive Name	% Watershed in Senstive Snow Zone
Kootenai River blw Yaak River	**24%**	**Kootenai R blw Bonn Ferry (cont.)**	
Kootenai R abv Curley Cr	28%	Ball Cr	19%
Kootenai R abv Curley Cr	15%	Trout Cr	15%
Pine Cr	37%	Parker Cr	12%
Curley Cr	34%	Long Canyon Cr	18%
Boulder Cr	40%	**Mission Cr**	31%
Boulder Cr abv MF Boulder Cr	33%	**Smith Cr**	24%
Boulder Cr blw MF Boulder Cr (incl	52%	Smith Cr abv Cow Cr	17%
EF Boulder Cr	39%	Cow Cr	20%
Kootenai River abv Bonners Ferry	18%	Smith Cr blw Cow Cr	43%
Deep Cr	37%	**Boundary Cr**	16%
Deep Cr abv McArthur Lake outlet	40%	Boundary Cr abv Grass Cr	9%
Deep Cr abv Brown Cr	39%	Grass Cr	16%
Fall Cr	51%	Boundary Cr blw Grass Cr	20%
Ruby Cr	45%	**Moyie River**	
Deep Cr blw Brown Cr	7%	**Moyie River in Idaho**	34%
Brown Cr (incl Twentymile Cr)	31%	Hawkins Cr	5%
Caribou Cr	37%	Moyie River abv Placer Cr	34%
Snow Cr	39%	Round Prairie Cr	41%
Kootenai River blw Bonners Ferry	17%	Meadow Cr	61%
Kootenai Valley	14%	Lower Moyie River	37%
Myrtle Cr	28%	Deer Cr	36%

Table 2.2. The portion of each of the watersheds in the Upper Kootenai of the Montana portion of the Kootenai Subbasin in the sensitive snow zone (the area more susceptible to rain on snow events).

Subunit(s) within Watershed	Watershed Number & Name	% Watershed in Senstive Snow Zone	Subunit(s) within Watershed	Watershed Number & Name	Percent Sensitive Snow Zone	Subunit(s) within Watershed	Watershed Number & Name	% Watershed in Senstive Snow Zone
Wigwam	170101010101 Wigwam R	0	Ksanka	170101010406 Tobacco R	46	Crazy Treasure	170101010704 Big Cherry Cr	41
Dodge	170101010201 Bloom Cr	0	Boulder	170101010501 Boulder Cr	16	Crazy McSwede Treasure	170101010705 Lower Libby Cr	48
Dodge	170101010202 Sink Cr	53	McSutten	170101010502 Sutton Cr	19	Treasure	170101010801 Flower Cr	32
Dodge	170101010203 Young Cr	29	Ubig	170101010503 Up So Fk Big	2	Treasure	170101010802 Parmenter Cr	37
Dodge	170101010204 Dodge Cr	32	Big Ubig	170101010504 Low So Fk Big	27	Pipestone	170101010803 E Fork Pipe Cr	34
Ksanka	170101010205 Phillips Cr	10	Big	170101010505 Big Cr	27	Pipestone	170101010804 Up Pipe Cr	64
Boulder	170101010206 Sullivan Cr	26	McSutten	170101010506 McGuire Cr	20	Pipestone	170101010805 Low Pipe Cr	55
Pinkham	170101010207 Upper Pinkham	13	Parsnip	170101010508 Parsnip Cr	33	Pipestone	170101010806 Bobtail Cr	60
Pinkham	170101010208 Lower Pinkham	72	McSutten	170101010509 Tenmile Cr	19	Quartz	170101010807 Quartz Cr	47
Swamp	170101010301 Swamp Cr	42	Cripple	170101010601 Fivemile Cr	45	Spar	170101010901 Ross Cr	32
Fortine	170101010302 Upper Fortine Cr	47	Bristow	170101010602 Bristow Cr	55	Spar	170101010902 Stanley Cr	44
Swamp	170101010303 Edna Cr	60	Bristow	170101010603 Barron Cr	68	Lake Spar	170101010903 Upper Lake Cr	24
Swamp Trego	170101010304 Mid Fortine Cr	75	Cripple	170101010604 Warland Cr	66	Spar	170101010904 Keeler Cr	48
Murphy	170101010305 Deep Cr	39	Cripple	170101010605 Cripple Horse Cr	48	Lake Spar	170101010905 Lower Lake Cr	22
Meadow	170101010306 Meadow Cr	86	Bristow	170101010606 Jackson Cr	67	OBrien	170101011001 OBrien Cr	39
Meadow Murphy Swamp Trego	170101010307 Lower Fortine Cr	80	Cripple	170101010607 Canyon Cr	58	Callahan	170101011002 So Callahan Cr	31
Grave	170101010401 Upper Grave Cr	8	Cripple	170101010609 Dunn Cr	51	Callahan	170101011003 No Callahan Cr	33
Grave	170101010402 Lower Grave Cr	36	Alexander	170101010610 Rainy Cr	78	Callahan	170101011004 Callahan Cr	58
Ksanka	170101010403 Therriault Cr	42	Crazy	170101010701 Upper Libby Cr	56	Callahan	170101011005 Ruby Cr	61
Ksanka	170101010404 Sinclair Cr	40	McSwede	170101010702 Swamp Cr	65	Callahan	170101011006 Star Cr	40
Ksanka	170101010405 Indian Cr	32	Treasure	170101010703 Granite Cr	27			

Other Influences

Beaver damming of streams is a major natural process on many subbasin streams, both in headwater and valley-bottom areas. Historically, beaver dams occurred on river channels, perennial and intermittent streams, and ponds. The dams regulated runoff in watersheds and stored 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 become susceptible to rapid stream downcutting and water table lowering (USDA FNF 1995).

Large downed trees[5] 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, flow resistance and added nutrients (e.g., leaf litter), 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 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). Debris jams can 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.

LINKS

For a discussion of the importance of woody debris and groundwater upwellings to aquatic habitat, see Appendix 22.

Click Here

In naturally functioning large river-floodplain systems, sufficient hydraulic energy is periodically unleashed to produce significant parafluvial and orthofluvial avulsions (lateral and longitudinal movement of substrate materials and associated large woody debris and fine organic material). These physical habitat changes produce a shifting mosaic of habitat characteristics, and naturally increase structural complexity and diversity of habitats. It is this physical habitat diversity and its dynamic nature that provide for the increased biological diversity (biodiversity) associated with natural ecosystems. This biodiversity, along with its underlying genetic variation, provide the required base for adaptation, natural selection, and evolutionary change—mechanisms required for population viability and persistence over time and changing environmental conditions.

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

Geographic Area Descriptions[6]

For a thorough description of watershed process in the Upper Kootenai at the HUC-6 scale, see Appendix 23. Much of the information presented there, as well as additional information for the Idaho portion of the Kootenai, is consolidated into two spreadsheets, which are included as Appendix 9.

Confined Reaches Segment

The Confined Reaches (figure 2.4) are characterized by steeper gradients and narrower bedrock valleys relative to downstream segments of the river. The river is restricted by bedrock or narrow glacio-fluvial terraces. Kootenai Falls is the boundary between the two reaches in this segment. The curving valley wall imparts a moderate degree of sinuosity to the channel.

Downstream from Libby Dam, the Kootenai River flows generally east to west across the structural grain of the landscape. The valley becomes slightly wider, the inner gorge less deep. The narrow valley widens at Troy and Libby where tributary valleys cross the river. One-hundred to four-hundred foot high terraces of glacial silt and glaciofluvial deposits line the river valley in these embayments, but the river continues to be confined within an inner gorge inset between the terraces. Lacustrine silt terraces also line the south-side tributary valleys of the Fisher River, Libby Creek, and Lake Creek. Landslides and bank erosion of the terraces contribute a high fine sediment load to the Kootenai River. The Fisher River also is considered to have a high sediment load due to forest practices within that watershed (PWI 1999).

Where the valley broadens between Kootenai Falls to the Moyie River, the Kootenai River has access to small deposits of glacial outwash and lacustrine silts. In this reach, the channel widens and meander bends provide slower moving backwaters and eddies.

Kootenai River downcutting (postglacial and probably pre-glacial) has been faster than downcutting of the smaller tributaries. For instance, the Moyie River has a hanging valley with a high bedrock waterfall near the mainstem. This characteristic (falls creating migration barriers in their lower reaches) is typical of the larger tributaries. Libby Creek, Lake Creek, Callahan Creek and others flow across terraces before finally dropping down to the level of the Kootenai River. Gradual downcutting through the terraces destabilizes the banks and contributes to the sediment load.

In the Idaho portion of Confined Reach 2, the river flows generally northwest, parallel to the Belt Series bedrock structure along the Moyie-Leonia

LINKS

For a good description of the various functional and process measures of the Upper Kootenai at the HUC-6 scale, go to Appendix 23.

Click Here

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 24.

Click Here

Appendix 9 contains spreadsheets with scores for a large number of watershed attributes for Kootenai River tributaries in the Upper Kootenai in Montana and the lower Kootenai in Idaho.

Click Here

[6] *Reach/Segment descriptions are adapted from Tetra Tech (2003) and Pacific Watershed Institute (1999)*

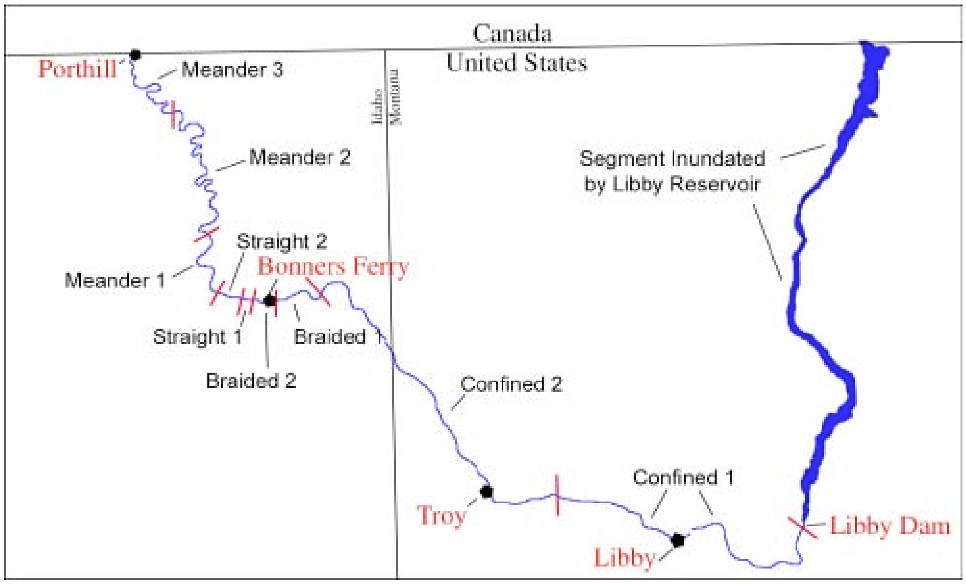

Figure 2.4 Reach delineations. After Tetra Tech (2003).

fault. The inner gorge is deep and narrow in this reach, just wide enough for the river. Boulder Creek, a steep south-side tributary at the Idaho-Montana line, reportedly has an elevated sediment load from erosion from past mines and, to a lesser extent, forest roads (PWI 1999).

Braided Reaches Segment

The Braided Reaches are characterized by multiple channels separated by gravel bars and vegetated islands. The floodplain shows numerous scars that are traces of braided channels. This short river reach is different from the other segments because of its lack of confinement either within natural levees or bedrock-controlled canyon walls. Here the river flows through Belt-rock geology and is reworking lacustrine deposits and routing glacial till deposits carried in by the Moyie River. Hence, there is an increased range of substrate particle sizes. The change in geomorphology and hydraulic character cause these braided reach segments to be natural sediment deposition zones. As it reworks this sediment, the channel widens, forming multiple channels somewhat like a braided channel. It is suspected that this is a "response reach" for upstream alterations, either in flow or sediment regime.

The first Braided Reach has a somewhat narrower floodplain than the second Braided Reach, and in places the river abuts the valley wall or the glacial terrace just south of the railroad grade. The channel pattern has been stable from 1928 through 2000, with a braided channel in some places and a single-thread channel in others. The high floodplain south of the railroad in Braided Reach 2 is believed to have been an active river channel during glacial recession and subsequent downcutting (Alden 1953). The lack of channel scars suggests that it has not been occupied by the river since glacial recession except for over-bank flooding.

The second braided reach has a wider, more active set of channels with higher rates of bank erosion. The river has a mile-wide valley, but is moderately confined by setback levees on the north side and a railroad embankment on the south side. The river cut through a large bend sometime between 1928 and 1963. This reduced channel sinuosity and was followed by lateral bank erosion as the new channel adjusted its course. The former bend, on the north side of the floodplain, still carries flow in several narrow channels.

Straight Reaches Segment

Between the sand-bedded, gravel-bedded braided reaches and the meander reaches, which stretch to Canadian border, the river enters a transition zone that consists of two short straight reaches. Both have man-made levees. In the first, the floodplain necks down between highlands formed by glacial deposits underlain in places by bedrock. The reach includes the City of Bonners Ferry and the highway and railroad bridges. The second reach flows east to west across the Purcell Trench, where the river has broad natural levees formed by thousands of years of fine sediment deposition from flows that overtopped the banks. The presence of these natural levees suggests that little or no channel migration occurred in this reach under presettlement conditions. The broad floodplain (the former bed of the glacial lake) is up to 10 feet lower than the natural levees. There are well-established flood channels that run parallel to the river and also have natural levees.

Meander Reaches Segment

Tributaries on the west side of the valley are high gradient and flow through granitic substrate until they reach the valley. There they change to low gradient, meandering streams with lacustrine substrate. Eastside tributaries are mostly moderate gradient with glacial till, Belt Series metasedimentary, and granitic substrates with some low-gradient terrain in the uppermost reaches. Eastside tributaries have downcut through a high lacustrine terrace above the valley floor where substrates are mixed with fine sediment and gravel/cobble. The lowest reaches are similar to westside valley floor reaches. Falls and cascades are common on most east and westside tributaries. These are migration barriers to fish. Deep Creek is a unique and very important tributary in that it provides approximately 10-15 times more of the continuous low-gradient habitat than any of the other tributaries. Substrates are a mosaic of sandy glaciolacustrine and ancestral shoreline materials and Belt Series and granitic gravels and cobbles that would be more favorable to redd development than the silty substrates in the valley floor.

The first 7.9 miles of the Kootenai River downstream of Deep Creek are somewhat less sinuous than downstream reaches. There is a split channel around Shorty's Island. Well-developed scrollbars exist on the west side of the floodplain, but are mostly lacking on the east side that has a wide natural levee. In the upstream half of this reach, there is no historic or geomorphic evidence of channel migration. The floodplain is dominated by large sloughs that carried a large portion of the river's floodwaters prior to Libby Dam. The next 22.4 miles have the highest sinuosity and well-developed scrollbars corresponding with higher rates of lateral channel migration, possibly a result of the slightly higher bed gradient. A cutoff occurred sometime between 1965 and 1983, reducing the sinuosity and increasing the bed gradient. The meander belt occupies over half the floodplain in most locations. The last 14.5 miles to the border are almost without bars, and scrollbar topography is lacking due to lower channel migration rates. In addition, channel migration processes have probably been operating for a shorter length of time, since this area was more recently a lake bed.

Table 2.3 shows the various aquatic habitat types found on the Kootenai River between Libby Dam and Kootenay Lake.

Table 2.3. Total distance (miles) and percentages of various habitat types in the Kootenai River between Libby Dam and Kootenay Lake. Source: Hoffman, et al. 2002.

	Libby Dam to Kootenai Falls		Kootenai Falls to Bonners Ferry		Bonners Ferry to Kootenay Lake	
	Distance	Percent	Distance	Percent	Distance	Percent
Pools	5.87	23.3	10.87	31.8	28.02	31.8
Riffles	0.4		1.82	5.3	0.17	0.2
Glides	7.18	28.5	12.6	36.9	50.39	57.2
Runs	3.87	15.4	4.16	12.2	0	0
Rapids	1.89	7.5	1.29	3.8	0	0
Side Channel	4.4	17.5	1.6	4.7	0	0
Excluded	1.56	6.2	1.85	5.4	9.55	10.8
Totals	**25.17**		**34.19**		**88.13**	

2.1.2 Human Alterations to Critical Aquatic Functional Processes

In a geomorphic assessment of the Kootenai River below Libby Dam, Tetra Tech (2003), identified the primary human alterations affecting Kootenai River fluvial geomorphic processes as diking and dam operations (both Corra Linn and Libby Dams). Not surprisingly, these factors have also had some of the most significant impacts on biological processes associated with the river.

From a purely physical standpoint, diking has resulted in confinement of flows to the main channel, an increase in the water surface elevation for floods (because post-dam flood waters can no longer spread out onto the floodplain), an increase in energy in the main channel during floods, an increase in sediment transport and erosion during floods, and the elimination of the transfer of sediments from the main channel to the floodplain for deposition (Tetra Tech 2003). The bank stabilization that has occurred to protect the dikes has also changed the dynamics of the system by preventing the river from continuing to meander, the processes that in the past reworked the floodplain and created the diverse over-bank topography containing sloughs, oxbows, wetlands and marshes (Tetra Tech 2003).

During flood-rise and recession, which occurred on a regular and periodic basis during presettlement times, the floodplain and extensive wetland system contributed substantial amounts of nutrients and carbon to the river. The impact to floodplain wetland and riparian areas from flood control and river operations and diking and bank stabilization has substantially impaired this dynamic ecosystem, lowering the productivity of the river downstream from Bonners Ferry (PWI 1999).

Tetra Tech (2003) found that the primary changes in hydrology from Libby Dam included a decrease in annual peak discharges on the order of 50 percent, a decrease in the duration of high and low flows, an increase in the duration of moderate flows, and a redistribution of seasonal flow characteristics. Together, these changes have affected the stage, velocity, depth and shear stress within the river, which in turn have altered sediment transport conditions. Corra Linn Dam has also impacted the hydraulics and sediment transport conditions in the Kootenai River as far upstream as Bonners Ferry (Tetra Tech 2003).

Libby Dam operations have influenced biological processes in the Kootenai River by affecting nutrient and carbon transport, altering thermal regimes, causing rapid changes in water levels, diminishing hydrological connectivity, and altering natural hydrographs. Koocanusa Reservoir has acted as a nutrient sink, decreasing the productivity and overall carrying capacity of the system downstream (Tetra Tech 2003). Dam operations have drastically altered natural down-river discharge patterns on a seasonal and sometimes daily basis.

LINKS

See Appendix 25 for a concise summary of Libby Dam impacts on Kootenai River macrozoobenthos.

Click Here

The lack of seasonal peak flows has allowed delta formation at the mouths of some tributaries, and that has impeded fish movement (USFWS 2002). It has also allowed fine sediments to deposit over the cobble and gravel substrates, affecting fish spawning. Wider varial zones caused by dam operations have further diminished overall system health in the Kootenai. 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. The result of all these changes has been significant impacts to periphyton, aquatic insects, and fish populations (USFWS 2002). See Appendix 25 for a concise summary of Libby Dam impacts on Kootenai River macrozoobenthos.

These and other activities that have altered the function of aquatic biome processes in the Kootenai River and its tributaries are summarized in table 2.4 (PWI 1999).

Table 2.4. Major human activities that have altered ecosystem processes in the aquatic biome of the Kootenai Subbasin. Source: Pacific Watershed Institute (1999)

Human actions	Date	Alteration	Effect
Beaver trapping	late 1800s	Removal of beaver ponds	Modified flow regime Reduced hydrologic storage & retention Reduction in pond habitat Reduction in trout habitat Reduced nutrient & carbon storage & cycling
Wetland drainage and conversion to agriculture	early 1900s	Removed approx. 5000 acres of wetland Increase in pollutants from agricultural runoff	Reduction in nutrient and carbon storage exchange Reduction in slough habitat Increase in non-point pollution e.g. sediment, fertilizer residue, pesticides, herbicides Decrease in groundwater recharge Decrease in flood storage
Floodplain diking below Bonners Ferry	early 1900	Removed the interaction between the floodplain and the channel. Confined river to a static meander pattern Confined tributaries to a static channel Removed riparian vegetation.	Reduction in allocthonous inputs Reduction in nutrient and carbon storage & inflow Reduction in side-channel habitat Reduction in lateral migration and associated inputs from migration Decreased channel complexity Increased channel incision Increased temperature in channelized tributaries Reduced aquatic habitat structure
Cominco Fertilizer plant	1952	High influx of phosphorus	Created an imbalance in nutrient relationships and created nitrogen limitations Increased algal growth and lead to shift in fish populations
Libby Dam, construction phase	1968 - 1972	Increased levels of sedimentation Rerouting of transportation corridors into lacustrine deposits along Fisher River	Increase in fine sediments in channel Increase in fine sediment levels in Fisher River & Kootenai
Libby Dam regulation	1972-1976	Impoundment and hypolimnion release Artificial barrier to upstream migration	Fish kills from Gas Bubble Disease Altered flow regime Altered thermal regime Retained some sediment and dissolved constituents Isolated fish populations, changing gene pool Reproductive isolation Restricted access to spawning Eliminated the dominant discharge function

Table 2.4 (cont.). Major human activities that have altered ecosystem processes in the aquatic biome of the Kootenai Subbasin. Source: Pacific Watershed Institute (1999)

Human actions	Date	Alteration	Effect
Libby Dam regulation	1976 - present	Impoundment selective release Hydropeaking operation during winter. Artificial barrier to upstream migration	Reversed river hydrograph Large, unpredictable fluctuations in winter discharge leading to increased macroinvertebrate drift and fish egg dewatering Improved thermal regime over hypolimion release, but warmer in winter Retained more sediment & dissolved constituents Isolated fish populations, changing gene pool Reproductive isolation Restricted access to spawning Temporal effects of gas bubble disease
Mining	Late 1800s to 1970s	Unregulated release of heavy metals and other toxins in water column and in sediments	Mortality of vulnerable aquatic species exposed to toxic levels near the source. Reduced resistance in aquatics species exposed to chronic levels near source and downstream. Bioaccumulation effecting the food web.
Mining	1980s to present	Residual chronic levels in sediments Regulated release of heavy metals and other toxins	Co-mingling of residual metals and organic compounds, creating new toxic compounds in water column. Regulated releases reducing resistance of less tolerant aquatic species. Bioaccumulation affecting the food web. Localized mortality of aquatic species exposed to toxic levels from unmitigated acid mine drainage from small mines in tributary streams.
Introduction of non-native aquatic species	Late 1800s to 1960s	Stocking of Mysis shrimp Stocking of various strains of rainbow trout, kokanee, and brook trout	Increased competition for habitat and foodbase. Dilution of gene pool through hybridization Increased predation.
Commercial harvest of aquatic species	1900 to 1960s	Reduce population base of burbot and sturgeon	Dilution of gene pool. Reduced numbers for reproduction Change balance in population dynamics.
Forest Practices (extraction and milling)	Early 1900s to present	Removal of riparian vegetation Increased sedimentation Polluted runoff and infusion into groundwater from millsites Historic delivery systems (e.g. splash dams) and road systems within channel migration zones	Decrease in habitat complexity. Increased water temperature. Increased fine sediment embedded in substrates. Local but dispersed barriers to fish migration from stream crossings. Degradation of stream margin habitat. Reduced long-term recruitment of large woody debris important to tributary habitat. Periodic or chronic levels of phenolic compounds released to aquatic habitat.

2.1.3 Presettlement Aquatic Conditions[7]

Prior to dam construction, the Kootenai 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 (except during the spring freshet), and stream substrates consisted of clean, stable, and permeable gravels. Non-native species were absent.

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. High springtime flows flushed fine sediments from river gravels creating interstitial habitat for insects and improving conditions for fish spawning.

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 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. Beaver dams were a way to store water in river systems without disrupting watershed connectivity. 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.

LINKS

The QHA assessment estimates presettlement (reference) conditions for eleven stream and thirteen lake habitat attributes at the 6th-code HUC scale. Go to Appendix 32 and 33.

Click Here

Riparian areas were intact and fully functional. In a natural stream environment, the near-shore habitat provides food and security cover critical to fish. 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, dropping water velocities, creating natural levees (e.g., sediments buildup where riparian vegetation slows water), and reducing erosion of silt into the river. Fluctuating or abnormally frequent high discharges disrupt this natural floodplain process. (Marotz et al. 2002)

Since glacial times, aquatic communities of the Kootenai River have adapted to consistent, temporal variations in flow and temperature regime that

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

changed with climatic patterns. These variations, in conjunction with underlying geomorphic features, played a fundamental role in nutrient distribution, population dynamics, and habitat conditions. In most winters, cold water temperatures slowly increased in the spring, favoring winter spawning for burbot in stable baseflows. High spring flows from snowmelt runoff flushed nutrients stored in riparian areas and flushed fine sediments from spawning gravels depositing onto floodplains. Stable, cool, temperatures during summer and winter low-flow periods sustained fall spawning and enabled aquatic communities to recover from flood disturbances and benefit from increasing flow of nutrients, ambient temperatures and light.

It is thought that the Kootenai River in presettlement times had two barriers to upstream and downstream fish passage: (1) Bonnington Falls is a major fish barrier on the Kootenai River a short distance upstream from the confluence with the Columbia River, and (2) Kootenai Falls, located in northwest Montana 13.7 miles upstream of the Idaho border. The historical importance of Kootenai Falls as a barrier to fish movement is unknown, although recent radio telemetry information indicates that this series of falls is traversed by adult bull trout at certain flows (USFWS 2002). Alternatively, during periods of historical highwater (> 100 kcfs), Kootenai Falls was undoubtedly more submerged and to an unknown degree perhaps resembled more of a riffle than falls, which are currently observed under post-dam hydraulic conditions, during which < 50 kcfs may constitute (post-dam) flooding.

Brief descriptions[8] of presettlement conditions on individual river segments (figure 2.4) follow:

River Segment now Inundated by Koocanusa Reservoir

The river in this segment was characterized by a single-thread channel in a steep valley with few side channels from Rexford to Libby, with a braided alluvial floodplain above Rexford up into Canada to the inflow of the Elk River. Above the Elk River it was a multichannel system with many forested islands (B. Jamieson, pers. comm. 2004). Pre-dam, this segment was described as prime cutthroat trout habitat, and even in historic times it supported one of the most productive cutthroat fisheries in North America (Knudson 1994). The segment also provided high quality bull trout and Mountain whitefish habitat.

[8] *Reach/Segment descriptions are adapted primarily from Pacific Watershed Institute (1999)*

Confined Reaches Segment

Prior to settlement, the habitat in this segment and the Braided Reaches Segment had more overhanging vegetation along its banks and large trees providing recruitment of large woody debris from the riparian areas and hillsides. Large debris probably only offered habitat structure in side channels and along slower moving eddies and backwaters of the mainstem while overhanging vegetation offered the majority of margin cover for aquatic species. Habitat characteristics along with a high diversity of macroinvertebrates in the reach from the Moyie River to Kootenai Falls suggest that it was very productive for burbot, bull trout, rainbow trout, and westslope cutthroat trout. White sturgeon were also found in the reach (Moyie River confluence to Kootenai Falls).

Braided Reaches Segment

During presettlement times, this reach likely have had an unstable channel and a high degree of lateral migration and bedload movement. Much of the bedload is stored in the channel as the channel migrates laterally to maintain its capacity. If the rate of change was high every year, spawning substrate would have been vulnerable to scour or dewatering. If the rate of change was low, spawning substrate would have been relatively stable and would only have been vulnerable during high flow years when bedload movement was greater.

Meander Reaches Segment

Prior to European-American settlement, this river segment had the highest habitat and aquatic species diversity. The river meanders across the nearly-flat Purcell Trench, a former glacial lake bed. The river's 2- to 3-mile-wide floodplain is situated between terraces of lacustrine silt. The river is very sinuous and has high-amplitude meander bends that migrate laterally. Cutoffs occur occasionally when a migrating bend cuts through the neck of the next bend downstream. These processes left behind a scrollbar topography and oxbow lakes on the floodplain. Thousands of years of fluvial deposition have built the meander belt up to about elevation 1,760, feet, which is the height of natural levees and presumably about the pre-dam bank-full elevation. These river deposits are at least 3 feet higher than the former lake bed that comprises the rest of the floodplain.

Prior to settlement, the river underwent frequent flood events, and shallow groundwater supported wetlands that extended across the valley floor. The large expanses of wetlands, sloughs, and meandering, low-gradient reaches of tributaries provided a diversity of habitat from the mainstem that supported the specific needs of different life stages and species. Channels through wetlands and

LINKS

For a general discussion of how reservoir storage and dam operations affect aquatic habitats, see Appendix 22.

Click Here

For a description of current conditions of aquatic habitats on the Kootenai National Forest, go to Appendix 23.

Click Here

For a description of current conditions of aquatic habitats on the Idaho Panhandle National Forests, go to Appendix 26.

Click Here

For the list of surface waters included in the Montana and Idaho 303(d) water quality assessment databases go to: http://www.epa.gov/owow/tmdl/

Click Here

For summaries of hydrologic data showing 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 fourteen USGS gaging stations in the subbasin, go to Appendix 8.

Click Here

meandering tributaries with overhanging shrubs along the banks favored bull trout, cutthroat trout, kokanee (Bursik and Moseley 1995) and probably Columbia River redband trout and other natives. These populations were likely distinct from populations that exist today in the upper, steeper gradient portions of tributary streams (Behnke 1992). Slow moving, deep waters of sloughs with overhanging shrubs and continual recruitment of deciduous and coniferous trees favored burbot and juveniles of numerous species including white sturgeon.

LINKS

To skip ahead to presettlement riparian and wetland conditions, go to:

Click Here

To gain a more complete picture of presettlement conditions, some readers may want to skip ahead to the section on riparian and wetland presettlement conditions (see the link in the links column).

2.1.4 Present Condition

Two key measures of the present condition of the aquatic biome in Kootenai River are the status of zoobenthos and fish species. Hauer and Stanford (1997) reported that most macroinvertebrates in the Kootenai river have reduced abundance compared to the long-term or to other rivers in the region. Kootenai River fish populations have also declined over the past several decades (Duke et al. 1999; USFWS 1999; Paragamian 2002; Anders et al 2002; Hammond and Anders 2003; Soults and Anders 2003; Paragamian et al. In Press). See focal species accounts in this assessment for more detailed discussions of native fish populations declines in the Kootenai River Subbasin. Bull trout in the subbasin are part of the Columbia River population, listed as threatened under the Endangered Species Act (ESA). According to the Bull Trout Draft Recovery Plan (USFWS 2002), the historic distribution of bull trout is relatively intact within the Kootenai River Recovery Unit, but the abundance of the species in portions of the watershed has been reduced, and remaining populations are fragmented. Native kokanee salmon (*Oncorhynchus nerka*) runs in lower Kootenai River tributaries in Idaho have experienced dramatic population declines during the past several decades (Partridge 1983; Ashley and Thompson 1993;). Total population numbers of native Columbia River redband trout are thought to be down from pre-Libby Dam years (Hoffman et al. 2002). The burbot population has also declined during recent decades (Hoffman et al. 2002; Hammond and Anders 2003). Due to low population abundance and failing natural recruitment, Kootenai River burbot in the Idaho portion of the Kootenai Subbasin were petitioned as threatened under the U.S. Endangered Species Act (http://www.wildlands.org/w_burbot_pet.html). However, the USFWS 12-month finding for the petition reported that: "After reviewing the best available scientific and commercial information, we find that the petitioned action [listing] is not warranted, because the petitioned entity is not a distinct population segment (DPS) and, therefore, is not a listable entity" (http://a257.g.akamaitech.net/7/257/2422/14mar20010800/edocket.access.gpo.gov/2003/pdf/03-5737.pdf). Burbot have been extirpated from Kootenay Lake's West Arm, and are not abundant enough in other riverine portions of the subbasin to be reliably estimated. The lower Kootenai River population is estimated at between 50 and 500 fish (KVRI Burbot Committee 2004). The Kootenai River population of white sturgeon was listed as endangered under the ESA on September 6, 1994 (59 FR 45989). The population has been in general decline since the mid-1960s (Duke et al. 1999; USFWS 1999; Anders et al. 2002; Paragamian et al. In Review). In 1997 the population was estimated to be approximately 1,468 wild fish with few individuals less than 25 years of age (USFWS 1999). The most robust and current (2003) population abundance estimate for the adult population is approximately 600 individuals, following an average aging correction factor of 1.6 (Paragamian et al. In Press). Table 2.5 reports the estimated abundance of native species in the Kootenai River (Hoffman et al. 2002).

LINKS

For a description of the various functional and process measures of the Upper Kootenai at the HUC-6 scale, go to Appendix 23.

Click Here

Appendix 9 contains spreadsheets with scores for a large number of watershed attributes for Kootenai River tributaries in the Upper Kootenai in Montana and the lower Kootenai in Idaho.

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 32 and 33.

Click Here

Table 2.5. Fish species in the Kootenai River and their general, river-wide abundances (A=abundant, C=common, R=rare). Abundances vary by river segement and reach. Source: Hoffman et al. (2002)

Common Name	Scientific Name	Abundance
Native Species		
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	C
Columbia River redband trout	*Oncorhynchus mykiss gairdneri*	R
Bull trout	*Salvelinus confluentus*	C
Kokanee (Kootenay Lk & tribs)	*Oncorhynchus nerka*	C
Mountain whitefish	*Prosopium williamsoni*	A
Burbot	*Lota lota*	R
Redside shiner	*Richardsonius balteatus*	C
Peamouth chub	*Mylocheilus caurinus*	A
Northern pikeminnow	*Ptychocheilus oregonensis*	A
Largescale sucker	*Catostomus macrocheilus*	A
Longnose sucker	*Catostomus catostomus*	R
Longnose dace	*Rhinichthys cataractae*	R
Torrent sculpin	*Cottus rhotheus*	R
Slimy sculpin	*Cottus cognatus*	C
White sturgeon	*Acipenser transmontanus*	R
Non-Native Species		
Brook trout	*Salvelinus fontinalis*	R
Rainbow trout	*Onchorynchus mykiss*	A
Kokanee (Koocanusa Res.)	*Oncorhynchus nerka*	A
Brown trout	*Salmo trutta*	R
Largemouth bass	*Micropterus salmoides*	R
Northern pike	*Esox lucius*	R
Brown bullhead	*Ictalurus nebulosus*	R
Black bullhead	*Ictalurus melas*	R
Pumpkinseed sunfish	*Lepomis gibbosus*	R
Yellow perch	*Perca flavescens*	R

LINKS

For a brief discussion of the biological effects of Libby dam operations[†], see Appendix 27.

Click Here

[†] The Kootenai Tribal Council has not approved the Fisheries Mitigation and Implementation Plan for Losses Attributable to the Construction and Operations of Libby Dam (1998) (Libby Loss Statement). Specifically, the Tribe maintains that the quantification methodology used to estimate annual fish production losses had not been approved by the regional fish and wildlife managers before being accepted. The lack of consensus for the Libby Loss Statement, however, does not modify the measures, strategies and objectives included in the Kootenai Subbasin Plan. While the precise amount of losses attributable to the construction and operation of Libby Dam may lead to differing levels of restoration in the Kootenai Subbasin, sufficient data exists to address the limiting factors in the subbasin and chart the path toward restoration. See also, Reservation of Rights, p. iii.

Tributaries

Aquatic habitats in headwater reaches of the subbasin have been impacted to varying degrees by the cumulative effects of logging, road building, dams, diking, irrigation and cropland agriculture, and urban, suburban and rural development. The magnitude and persistence of these impacts varies widely.

In its assessment of the entire Kootenai River Subbasin, the Pacific Watershed Institute (1999) characterized tributary aquatic habitat conditions as ranging from moderately altered to highly altered. This conclusion was based on qualitative observations.

In 2002, the Kootenai National Forest finished its assessment of the Upper Kootenai in Montana (defined as the 2,250 square mile Kootenai River drainage extending from the Canadian border south-southwest to the Idaho border, but excluding the Fisher and Yaak watersheds). The assessment rated the watershed condition or integrity[9] of sixty-two 6th-field HUCs and found that six HUCs (10%) had high integrity, twenty-three (37%) moderate integrity, and thirty-three (53%) low integrity. See Appendix 9 for the spreadsheet showing scores for all the watershed evaluation factors.

In its 2003 *Analysis of the Management Situation for Revision of the Kootenai and Idaho Panhandle Forest Plans* (AMS), the USFS described the condition of HUC-6 watersheds in the Kootenai: " … human activity has extensively altered stream channels by direct modification such as canalization, wood removal, diversion, dams, log drives, and encroaching structures such as roads, railways, bridges, and culverts. Humans have also indirectly affected the incidence, frequency, and magnitude of disturbance events. This has affected inputs and outputs of sediment, water, and vegetation. These factors have combined to cause pervasive changes in channel conditions throughout many parts of the Kootenai and Idaho Panhandle National Forests (KIPNF), resulting in aquatic and riparian habitat conditions measurably different from those that existed prior to human development. Natural (primarily wildfire) and human-caused (timber harvest and road construction, mining, dams, introduction of non-native species, recreation, and grazing) disturbances over the last century have led to changes in the physical watersheds and in the fish and amphibians dependent on them (Lee et al. 1997). Roads can have some of the greatest effects to watersheds and aquatic biota … Although current BMPs for road construction are designed to minimize the damage to watersheds, many miles of road existing on the landscape were not built to these standards or are no longer maintained. As a result, these roads

---

[9] Watershed condition or integrity is based on six factors: percent equivalent clearcut area, percent intact riparian area, stream crossing density (number/mi^2 of watershed), percent detrimental compaction, riparian area road density, and mean annual precipitation.

either continue to degrade watersheds through chronic erosion or are at risk for mass failure from crossings or locations on sensitive landtypes."

In their AMS, the Kootenai and Panhandle National Forests *estimate* the expected or apparent watershed condition[10] of the 166 sub-watersheds in the Kootenai River Subbasin. In the Idaho portion, 69% were functioning at risk or not properly functioning; in Montana the number was 83% (table 2.6 and figure 2.5).

LINKS

Appendix 28 describes watershed and stream characteristics for major upper Kootenai River tributaries (in the Montana portion of the subbasin).

Click Here

Table 2.6. Apparent or expected watershed condition for the ID and MT portions of the subbasin. Source: USFS KIPNF (2003)

Watershed Condition	Idaho (32 watersheds)	Montana (144 watersheds)
Properly Functioning	31%	17%
Functioning at Risk	53%	61%
Not Properly Functioning	16%	22%

Appendix 23 summarizes Kootenai National Forest fisheries information for tributaries of the upper Kootenai.

Click Here

The EPA lists 31 impaired waterbodies in the US portion of the Kootenai Subbasin (Figure 2.6). Table 2.7 summarizes the probable sources of impairment for each of those streams. Information on probable sources and causes is available for the upper Kootenai by mile of stream impaired. That information is presented in tables 2.8 and 2.9. Note that in these two tables, causes and sources are related but are not linked. Together, the three tables are generally representative of the sources and causes of aquatic habitat impairment across the subbasin when viewed on a broad scale (i.e., percentages would not reflect the situation on specific reaches or individual streams).

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[10] *A variety of physical measures that reflect the inherent (i.e., natural) sensitivity and resiliency of watersheds, combined with measures based on human-caused disturbance histories of those watersheds were used to estimate the overall condition at the sub-watershed (6th- code hydrologic unit) scale. The measures focus on slopes (the land system), riparian areas, and streams and lakes within the watershed. This information is further refined using additional field measurements, monitoring, and professional judgment. "Properly functioning condition" means watersheds are in good condition in terms of physical, hydrologic, and water quality characteristics and function, adjusting to disturbances within their apparent natural ranges of variability. Watersheds defined as "functioning at risk" have adequate physical, hydrologic and water quality integrity; however, present or ongoing adverse disturbances are likely to compromise that integrity if not modified or corrected. They have at least moderate physical, hydrologic, and water quality integrity even though they may have been substantially compromised by adverse disturbances. "Not properly functioning" watersheds are operating and adjusting outside what can be considered dynamic equilibrium. Physical, hydrologic, or water quality integrity has been so compromised that restoration efforts may be difficult without significant funding and very long recovery time periods. They are not physically capable of fully supporting beneficial uses and will likely require substantial intervention and/or extremely long recovery periods to restore their capability to fully support beneficial uses. They may contain aquatic resources that are seriously degraded or that are not likely to sustain themselves over time.*

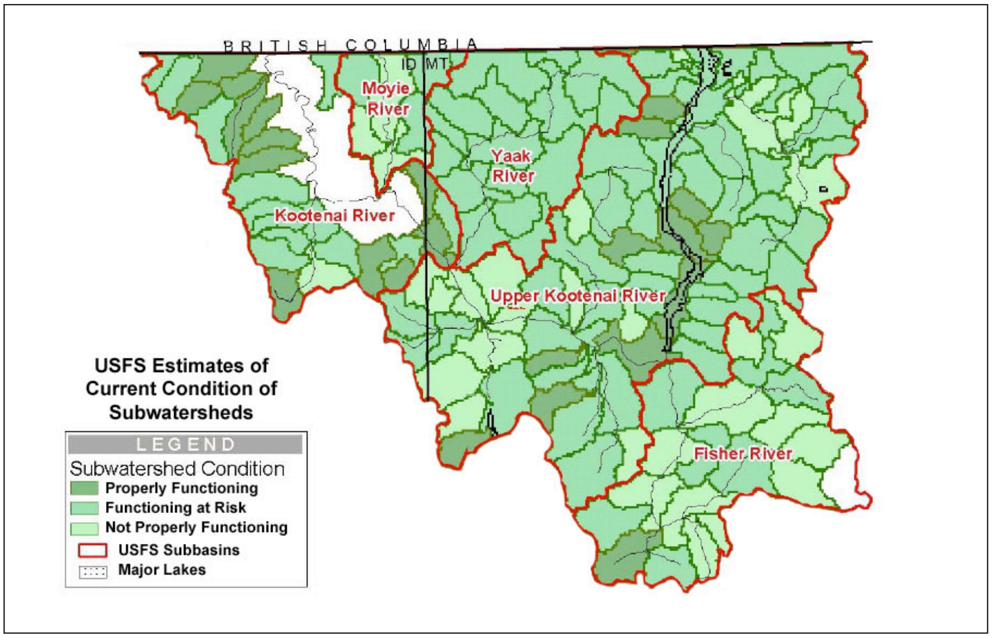

Figure 2.5. Estimated Current Condition of Sub-Watersheds as determined by the USFS. Source: USFS KIPNF (2003).

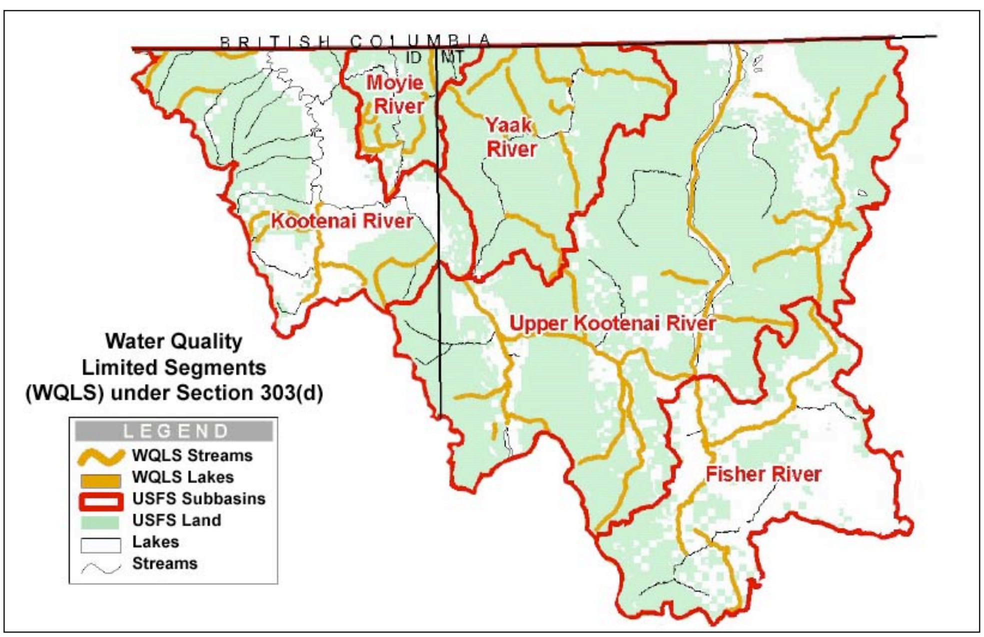

Figure 2.6. Section 303(d) Water Quality Limited Segments in the Kootenai Subbasin. Source: USFS KIPNF (2003).

Table 2.7. Probable sources of impairment for 303(d) impaired waterbodies in the Kootenai Subbasin. Source: http://www.epa.gov/owow/tmdl/

Impairment	# of Impairments	% of Impairments
Other Habitat Alterations	16	52%
Siltation	11	35%
Fish Habitat Degradation	10	32%
Flow Alteration	10	32%
Metals	7	23%
Sediment	7	23%
Streambank Destabilization	5	16%
Nutrients	4	13%
Flow Modifcation/Regulation	3	10%
Thermal Modifications	3	10%
Temperature	2	6%
Nitrogen	1	3%
Turbidity	1	3%
Zinc	1	3%
Riparian Habitat Alteration	1	3%
Lead	1	3%
Other	1	3%
Salinity/TDS/Chlorides	1	3%
pH	1	3%

Table 2.8. Probable sources of impairment for the Upper Kootenai (this is a subset of table 20). Source: http://nris.state.mt.

Source	Miles
Other habitat alterations	162
Flow alteration	124
Siltation	113
Fish habitat degradation	98
Bank erosion	83
Dewatering	47
Thermal modifications	45
Metals	38
Nutrients	28
Nitrogen	18
Zinc	13
Turbidity	10

Forestry and forestry-related activities have had a major impact on the aquatic habitats of tributaries in the Kootenai River Subbasin. Although current forestry practices have improved, impacts continue because of the existing road system, mixed land ownership, lingering results of past activities, and inconsistent application of best management practices (MBTSG 1996c). One of the chief

Table 2.9. Probable causes of impairment for the Upper Kootenai. Source: NRIS

Cause	Miles
Silviculture	129
Flow Regulation/Modification	91
Hydromodification	91
Logging Road Construction/Maintenance	86
Agriculture	73
Grazing Related Sources	73
Resource Extraction	50
Upstream Impoundment	45
Mine Tailings	35
Abandoned Mining	29
Range Grazing - Riparian	29
Habitat Modification-other than Hydromodification	28
Construction	16
Dam Construction	16
Bank or Shoreline Modification/Destabilization	15
Land Development	15
Source Unknown	15
Pasture grazing - Riparian and/or Upland	14
Placer Mining	12
Other	10
Highway/Road/Bridge Construction	1

forestry-related 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 success of natural 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 (NWPPC 2001).

Extensive forestry-related road construction in both the Grave Creek and Wigwam River drainages has resulted in increased water and sediment yields (MBTSG 1996c). Sediment from roads and logging sites was so severe in the Elk River watershed in British Columbia that for a while water quality investigators thought settling basins would be necessary to protect the river's water quality (USFWS 2002). However, new logging practices in British Columbia, conducted under the current Forest Practices Code, are much more stringent than they were 25 years ago and conditions have improved. High-water events continue to cause sedimentation, and new roads and harvest blocks are planned (USFWS 2002).

In the Montana portion of the subbasin, there are substantial areas of land owned by Plum Creek Timber Company (formerly timberlands of Champion

International), much of which have been heavily roaded and logged. This is especially true in the Fisher River drainage in Montana, the largest tributary drainage in the reach between Libby Dam and Kootenai Falls, and the Lake and O'Brien Creek watersheds (MBTSG 1996c). Plum Creek lands are now covered by the Native Fish Habitat Conservation Plan, which the U.S. Fish and Wildlife Service agreed to with Plum Creek Timber Company in 2000. Conditions in these aquatic habitats are expected to improve.

Libby Creek the second largest tributary between Libby Dam and Kootenai Falls, has been altered by logging and roads, and is often dewatered during crucial summer months due to channel aggradation. Other large tributaries in this reach include Dunn Creek, Pipe Creek, Bobtail Creek, Cedar Creek and Quartz Creek, which all have experienced varying levels of alteration (Hoffman et al. 2002). The channel of Keeler Creek, in Montana, is in a destabilized condition because of extensive timber harvesting activities and poorly constructed roads, built primarily between 1941 and 1970 (MBTSG 1996c). During that period, over 100 million board feet were clear-cut from 23 square kilometers (5,780 acres). Serious flooding occurred during 1974 and 1980 (USFWS 2002). Almost two-thirds of the Kootenai National Forest has problems with watershed instability, resulting infrequent flooding and concentrated high water yields, sedimentation, and small slumps below clear-cuts and roads (MBTSG 1996a).

A 1998 study of watersheds important to bull trout in the Idaho portion of the Kootenai Subbasin found road densities averaged 2.4 miles per square mile, and 2.8 miles per square mile in riparian areas and with about 1.8 road crossings per mile of stream (Panhandle Basin Bull Trout Technical Advisory Team 1998). A total of 16 percent of the watersheds had been logged.

Mining and related activities in the subbasin have also degraded aquatic habitats, although active mining was more of a problem in the past than it is today. The Cominco, Ltd. phosphate plant in Kimberly, British Columbia, closed in 1987, and phosphorus levels in Koocanusa Reservoir are now much lower (USFWS 2002). Until 1979, acid mine drainage and heavy metals from the Sullivan Mine and concentrator at Kimberly, British Columbia, were discharged untreated into Mark, Kimberly, and James Creeks, tributaries of the St. Mary River (MBTSG 1996c). In 1979, wastewater treatment facilities significantly decreased the discharges, and the Sullivan Mine is now closed. The mining company is committed under Canadian law to a long term monitoring and waste water management regime to ensure that acid mine drainage and heavy metals do not enter these creeks in the future (B. Jamieson, pers. comm. 2004).

Five open-pit coal mines operate in the Elk River drainage in British Columbia, and they contribute nitrogen residuals from explosives and increase

LINKS

For a Biological Assessment of Trout Creek go to Appendix 104.

Click Here

For an interim monitoring report on Trout Creek, go to Appendix 105.

Click Here

For a biological Assessment of Parker Creek, go to Appendix 106.

Click Here

the amount of suspended sediment entering the Elk River and its tributaries. Levels of both have been reduced in recent years, but impacts are likely to continue, at least on a localized scale (USFWS 2002).

Some small, private mining operations continue in the Lake Creek drainage and in some tributaries in Canada. Water quality impairment in Lake Creek is the result of the now-closed ASARCO, Inc. copper and silver mine, mill, and tailings impoundment (USFWS 2002). Acid mine drainage from the Snowshoe Mine in the Libby Creek drainage has affected trout populations in 3 miles of Snowshoe Creek and 15 miles of Big Cherry Creek for over 70 years (MBTSG 1996a). Historic mining operations in the Fisher River drainage have contributed to channel degradation. Several other drainages in the basin have historical impacts from small mining operations (USFWS 2002). Two streams in Idaho—Boulder Creek, and Blue Joe Creek—have suffered impacts from mining activities, and Blue Joe and Boundary Creeks experience periodic episodes of toxic runoff from the Continental Mine (USFWS 2002).

LINKS

For a discussion of the impacts of Libby Dam operations on the geomorphology of the Kootenai River, go to Appendix 29.

Click Here

Residential development has also been a problem on tributaries. Many streams flow through private land, especially in the valley bottoms, and the human population in Canadian and U.S. portions of the subbasin have been increasing. Domestic sewage and changes to stream morphology caused by building in the floodplain has reduced the quality of aquatic habitats' (USFWS 2002). In some streams, human-caused barriers such as road culverts, dewatered stream reaches, and irrigation diversions have blocked fish migrations.

Another major 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 Kootenai Basin (Hammond 1999).

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 (NWPPC 2001).

Habitat conditions in specific tributaries, including the distribution of non-natives, are assessed later in this document as part of the QHA habitat assessment.

Koocanusa Reservoir and Mainstem Kootenai

In a review and synthesis of Kootenai River studies, the Pacific Watershed Institute (1999) identified the following changes as the most significant to the sustainability of aquatic life in the basin:

- Loss of fisheries habitat structure and area;
- A broad swing in nutrient levels brought on by artificially elevated levels of phosphorous and reduction of retention area throughout the subbasin;
- Alteration of flow by the operation of Libby Dam caused stranding or flushing of redds and fry;
- Alteration of temperature and discharge from Libby Dam disrupting natural patterns of winter spawning and spring rearing, and;
- Heavy metals contamination and effects of sublethal amounts on aquatic life cycles.

Other changes identified by the Institute as being significant to fish population dynamics and that are considered to have an effect on biological integrity include:

- Introduction of nonnative species and stocks that compete for similar foodbase and habitat or contaminate the native gene pool;
- Reduced availability and overall quality of habitat in the mainstem and tributary streams;
- Lack of recovery from large fisheries harvest levels of the mid-century.

For a discussion of the impacts of Libby Dam operations on the geomorphology of the Kootenai River, see Appendix 29.

In their loss statement[11], Montana Fish, Wildlife & Parks and the Confederated Salish and Kootenai Tribes quantified the following changes to fisheries habitats caused by the construction and operation of Libby Dam:

Koocanusa Reservoir

- 109 miles (175 km) of the Kootenai River lost to inundation by the reservoir
- An annual loss of 15,000 trout and 377,000 mountain whitefish from the inundated river

LINKS

Appendix 8 summarizes hydrologic data from 14 Canadian and USGS gauging stations in the subbasin.

Click Here

Appendix 18 is MFWP comments on the Draft Mainstem Amendments Document 2002-16

Click Here

[11] *The Kootenai Tribal Council has not approved the Fisheries Mitigation and Implementation Plan for Losses Attributable to the Construction and Operations of Libby Dam (1998) (Libby Loss Statement). Specifically, the Tribe maintains that the quantification methodology used to estimate annual fish production losses had not been approved by the regional fish and wildlife managers before being accepted. The lack of consensus for the Libby Loss Statement, however, does not modify the measures, strategies and objectives included in the Kootenai Subbasin Plan. While the precise amount of losses attributable to the construction and operation of Libby Dam may lead to differing levels of restoration in the Kootenai Subbasin, sufficient data exists to address the limiting factors in the subbasin and chart the path toward restoration. See also, Reservation of Rights, p. iii.*

LINKS

For a maps showing road densities throughout the subbasin see figure 2.16 and 2.17.
Click Here

Environmental baseline conditions for bull trout are summarized in Appendix 31.
Click Here

The Kootenai Subbasin Aquatic Technical Team scored aquatic habitat attributes for streams at the HUC-6 scale and results are presented in Appendix 32.
Click Here

The Kootenai Subbasin Aquatic Technical Team scored aquatic habitat attributes for selected lakes. Results are presented in Appendix 33.
Click Here

- 83 miles (134 km) of tributary stream habitat lost to inundation
- An annual loss of 57,000 juvenile *Oncorhynchus* spp from inundated tributaries
- 15.5 miles (25 km) blocked by road construction around the reservoir
- An annual loss of 5,990 juvenile *Oncorhynchus* spp from blocked tributaries

Kootenai River (downstream of the dam)

- An annual loss of 2,100 juvenile westslope cutthroat trout
- A 90 percent reduction in the burbot fishery.
- An endangered listing under the ESA for the white sturgeon
- An threatened listing under the ESA for the bull trout

MFWP (2000d) also noted that a major change occurred when British Columbia Ministry of Environment personnel from the Wardner Fish Hatchery inadvertently released kokanee salmon (*Oncorhynchus nerka*) into Koocanusa Reservoir between 1975 and 1979. Kokanee have since become well established in Koocanusa Reservoir. By 1997, this non-native population, (accidentally) founded from an admixed Okanagan stock) sustained a 48,000 angler-day/year fishery. In addition, more than 1 million kokanee (age 0+ to 2+) may be entrained through Libby Dam each year. Based on expansions of empirical entrainment studies, most of these kokanee (79%) survive (Skaar et al. 1996). Kokanee are the main food source for a trophy rainbow trout fishery (up to 33 pounds) in Koocanusa Reservoir, and for bull trout as far as four miles downstream from Libby Dam.

A description of the present condition of each of the mainstem segments follows[12].

Confined Reaches Segment

The most significant changes in the condition of the reach from Libby Dam to Kootenai Falls result from Libby Dam altering water temperatures and creating extreme flow fluctuations. These changes are: (1) altered water quality, and (2) the magnitude and shape of the annual hydrograph. Water chemistry has improved in recent decades because Libby Dam retains contaminated sediments from upstream sources, and because contaminated sediments deposited prior to the dam have likely been transported downstream. Channel bank erosion and other upstream sources of erosion in lacustrine deposits in the Fisher River continue to contribute significant sources of fine sediment to the mainstem. Because of Libby

[12] *Adapted and condensed from Pacific Watershed Institute (1999).*

Dam, fish in this reach have been isolated. Also, the effects of dam construction and operations (e.g., gas bubble disease, temperature alterations, and flow fluctuation) remain more pronounced in this segment than in downstream river segments.

In the reach from Kootenai Falls to the Moyie River confluence, the river has been constricted by railroad and road alignments in several locations, but the ecological effects of these changes are likely insignificant. Industrial and mining pollution from sources miles upstream have been transported to this reach and to downstream segments, although the influx of those pollutants has been greatly reduced by more stringent regulation of effluent and the construction of Libby Dam. Riparian vegetation and stream margin habitat is recovering from scour during log-drive days. Similar to the reach above Kootenai Falls, the alteration of temperature and flow regime by Libby Dam has also had a major influence. In the past, flow fluctuations from hydropeaking during fall spawning stranded or flushed redds, causing devastating declines in populations of affected species. These fluctuations still occur, but not at the magnitude or over as short a duration as in the past. Regulated flows have eliminated channel maintenance flows, which creates conditions for embedded spawning gravels and macroinvertebrate habitat quality. The elevation of the mouths of tributaries has increased as well; with lower discharge, tributary bedload deposits at the confluence with the mainstem are not transported downstream.

Hauer and Stanford (1997) reported that river regulation by Libby Dam has had numerous deleterious effects on Kootenai River zoobenthos. With the exception of the density of net-spinning caddisflies and blackflies in the dam tail waters, most species declined in abundance after the dam. Below the dam is a wide varial zone essentially devoid of zoobenthos whenever the dam is operated with dramatic flow fluctuation. The dominant species in this zone are those that emerge as adults off the surface of the water column (e.g., trichoptera, diptera), rather than crawling out on the lateral margins of the river (e.g., plecoptera), where they must deal with the harsh varial zone environment created by Libby Dam operations (Hauer and Stanford 1997).

Studies on fish populations in the reach from Kootenai Falls to the Moyie River confluence have found a shift in species abundance (PWI 1999). Both cutthroat and bull trout were displaced from this reach early on when rainbow and brook trout were introduced (PWI 1999). They were undoubtedly affected by contaminants prior to the dam. Neither species is tolerant of large changes in water quality, temperature, or habitat complexity. Log drives in tributaries and the mainstem probably simplified and or eliminated the complex edge habitat that juveniles rely on for refugia and feeding stations. Neither of these species tends to

LINKS

For the USGS report summarizing lower Kootenai River channel conditions and changes in suspended-sediment transport and geometery in white sturgeon habitat, go to: http://id.water.usgs.gov/PDF/wri034324/index.html

Click Here

For the USGS surveys of lower Kootenai River cross sections, go to: http://id.water.usgs.gov/PDF/ofr041045/index.html

Click Here

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

rebound once habitat is degraded and more tolerant species such as rainbow expand into their range. For the small populations of cutthroat and bull trout that remain, there is little connectivity to headwater populations, reducing the influx and/or exchange of genetic material between resident and fluvial populations. It is not known if these fish are adfluvial (lake population) or fluvial (mainstem migratory). There is probably some limited downstream recruitment from tributaries and accidental dispersal through Libby Dam and over Kootenai Falls.

Throughout this river segment there has been a decrease in the amount of overhanging vegetation along the river's banks and a loss of large trees, which provide a source of large woody debris. Overall habitat structure has been simplified. Large fluctuations in discharge from Libby Dam have created detrimental elevation changes in water levels along stream margins, stranding spawning habitat and disrupting rearing and escapement habitat. Changing water levels along stream banks creates a swing in soil moisture and erodes banks, which has hampered riparian habitat recovery. Today's habitat provides less security cover in the mainstem for juveniles and less protection from stream margin stranding or flushing.

Braided Reaches Segment

The current habitat and sediment conditions in this segment are maintained and controlled by: (1) natural geomorphic constriction at Bonners Ferry and a sharp 90 degree constriction upstream just above the Moyie River; (2) a backwater effect from Lake Kootenay during high flow and times of water storage; (3) the first major depositional environment below the canyon reaches; and (4) artificial confinement by levees and the railroad.

Construction of dikes near Bonners Ferry and construction of a rail line have confined channel migration to a minor degree. The most significant changes include removal of riparian vegetation, changes in flow/temperature from Libby Dam operations, and possible contamination by metals. An influx of sediment over natural background probably occurred shortly after the wildfires in the early 1900s during recovery and salvage logging operations. As forest extraction began in higher portions of the basin and roads became a major part of the forest landscape, sediment influx probably increased. A slight decline in sediment influx is shown with less harvest, retention by Libby Dam, and recovery from the initial road construction phase in more recent years.

Traditionally, a braided reach would have unstable channels and high degree of lateral migration and bedload movement. Much of the bedload is stored in the channel as the channel migrates laterally to maintain its capacity. If the rate of change was high every year, spawning substrate would be vulnerable to scour or dewatering. If the rate of change was low, spawning substrate would be relatively stable and only be vulnerable during high flow years when bedload movement was greater. Although one might think that regulated flow regimes from Libby Dam operations might reduce the rate of change in this segment, this does not appear to be the case. The gravel bars and side channel areas are still continually shifting probably due to the backwater influence of Kootenay Lake and reduction in the active floodplain by dikes on the north side. This latter factor could lead to increased aggradation since the channel no longer can migrate to the north.

Riparian vegetation and stream banks are easily eroded and frequent channel migration limits species succession and growth. The most likely change as a result of regulated flows is that gravel/cobble substrate has been covered by incoming gravel/sand substrate, which would be more mobile under the reduced flood regime than larger substrate. Despite the instability and potential for fine sediment deposition and embedded substrates, this reach may provide the only remaining "slough-like" habitat that used to occur downstream in the Meander Segment. The large abandoned meanders and split channels in this reach still provide juvenile rearing habitat and refugia. Unfortunately, the retention of nutrients and debris is probably not near what it would have been in the sloughs downstream in the Meander Segment due to the instability of these features. Macroinvertebrate sampling indicates a fairly diverse community, but low densities and a lack of long-lived and scour-resistant species. The lack of channel maintenance flows may be a substantial factor in increasing embeddedness or changing the size of streambed particles in spawning habitat, which would affect survival of larvae and benthic food base (PWI 1999).

Meander Reaches Segment

This segment shows the most significant changes in aquatic habitat, wetland/riparian vegetation, nutrient function, temperature, and hydraulic and channel characteristics.

Dikes line the mainstem channel of the lower Kootenai River where larger stream beds pass through constructed openings, and smaller tributaries and canals are completely disconnected from the river (e.g., drainage pipes and pumping stations). Levees confine the river to a narrow corridor. Alterations made at the Creston Valley Wildlife Management Area in British Columbia and the Kootenai National Wildlife Refuge in Idaho have also reduced the abundance of side-channel slough habitats and isolated floodplains from connection with the main channel (Tetra Tech 2003).

Lower reaches of tributary streams have been straightened and cleared reducing their length and changing channel hydraulics and retention capacity.

Extensive forested and shrub/sedge wetlands, now drained, provided extensive meandering off channel habitat for trout species, kokanee, burbot and possibly sturgeon. Natural processes have been disrupted such as groundwater recharge, side channel habitat maintenance and rejuvenation, and nutrient production and exchange. Sloughs and wetlands provided low velocity, deep-water habitat with a high amount of security cover for juvenile fish as well as slow water for burbot and white sturgeon larvae.

Indications from water column and sediment testing are that industrial and mining pollution from sources miles upstream has been transported to this segment (PWI 1999). The influx of this pollution has been greatly reduced by stricter regulation of mining effluent. Also, Libby Dam probably retains metal-laden sediments from upstream sources. Although water quality is most likely recovering, wastewater from sewage treatment facilities, streamside industry, and abandoned mines probably maintain water pollution levels higher than natural background. Habitat availability may be limited locally near effluent outflows where concentrations are highest. It is not well understood what effects residual metal-laden sediments may be having on important food web biota that exist in substrate sediments.

LINKS

The declining population of Kootenai River white sturgeon has prompted an assessment of the feasibility of various habitat enhancement scenarios to reestablish white sturgeon populations. For the first phase in this assessment, go to Appendix 95.

Click Here

Temperature and flow regimes changed abruptly with the onset of Libby Dam. The change from hypolimnetic release to selective release in 1976 have moderated the dramatic effects on the temperature regime. Although, winter temperatures remain higher than historic levels (figure 2.7).

The greatest change to the aquatic biome in this segment has been caused by the removal of sloughs and wetlands, the elimination of the flood pulse, debris removal, and the channelization of tributaries. The effect of reducing nutrient exchange by these alterations has affected not only this segment but also downstream, particularly Kootenay Lake. When comparing the other factors, it appears that the change in fish habitat has been acute, while other departures from the reference condition have been incremental. Changes in temperature and flow appear to have been acute following construction and operation of Libby Dam. Temperature has been moderated somewhat by adjustment to the rule curve and releasing water from higher in the lake water column.

2.1.5 Potential Aquatic Habitat Condition[13]

Under this scenario, Libby Dam would be operated in a manner that would restore and maintain normative hydrologic conditions (conditions that mimic natural

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

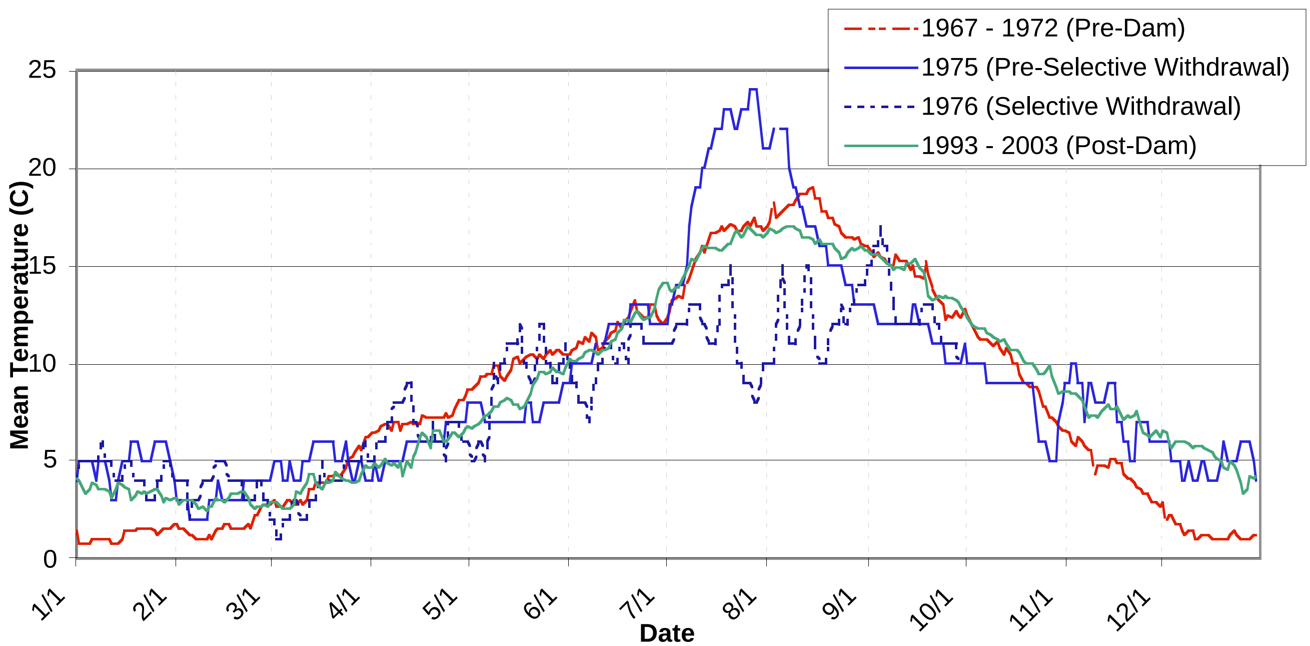

Figure 2.7. Kootenai River temperatures in Meander Reach in Idaho Pre- and Post- Libby Dam.

processes and minimize impacts on fish and wildlife). Reservoir refill would promote biological productivity in the reservoirs, and downstream there would be 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 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. 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. 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 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, and 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.

Nonnative 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 nonnatives through the installation of barriers to upstream invasion by nonnative species. Negative nonnative species interactions will have been substantially reduced wherever possible.

TMDL goals will have been reached throughout the subbasin, and 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[14]

Under this scenario headwater aquatic habitats 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.

Between 2004 and 2050, the population of Lincoln County in Montana and Boundary County in Idaho will continue to grow, and many of the people moving in 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

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

building in floodplains will have further reduced the quality of aquatic habitats from their current (2004) conditions. Significant amounts of riparian areas will have been converted to other uses, potentially altering stream-water temperatures.

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 outpaced by impacts caused by residential developments and other human disturbances.

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

Libby Dam will be operated in a manner that will more closely 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.

Due to the cumulative impacts of various human activities, populations of the species most highly adapted to a narrow range of conditions—white sturgeon, burbot, and bull trout—will have continued to decline and may in fact have become extinct. Other species that are slightly more tolerant—westslope cutthroat trout, Columbia River redband trout, and kokanee—will also have declined.

2.2 Riparian and Wetland Systems

SNAPSHOT

Prior to European settlement, ecological functions and processes in riparian and wetland areas were intact. Over the past 100 years humans have reduced beaver populations; logged, cleared, and grazed riparian zones; filled wetlands; built dams and dikes; 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 fish and wildlife species that use these areas.

2.2.1 Critical Riparian and Wetland Functional Processes[15]

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.

The health of riverine floodplains can be linked to the integrity of numerous processes and functions including, but is not limited to, hydrological connectivity, flooding, nutrient cycling, retention of organic and inorganic particles, generation and export of organic carbon, and groundwater processes (Hauer et al. 2002; Heiler 2003).

Floodplain woodlands depend on broadscale interactions of channel movement, flooding, creation of depositional sites, recharge and decline rates of water tables, and temporal changes in seedling regeneration events (Hughes 2001; Amlin and Rood 2002). Winward (2000) describes riverine riparian areas in their natural state as being subject to continual change as river channels migrate within a valley floor. These fluctuations in river channels, along with flow levels, drive successional processes and create opportunities for early pioneering species like cottonwood and willow to become established on areas of open ground and bare mineral soils.

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).

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

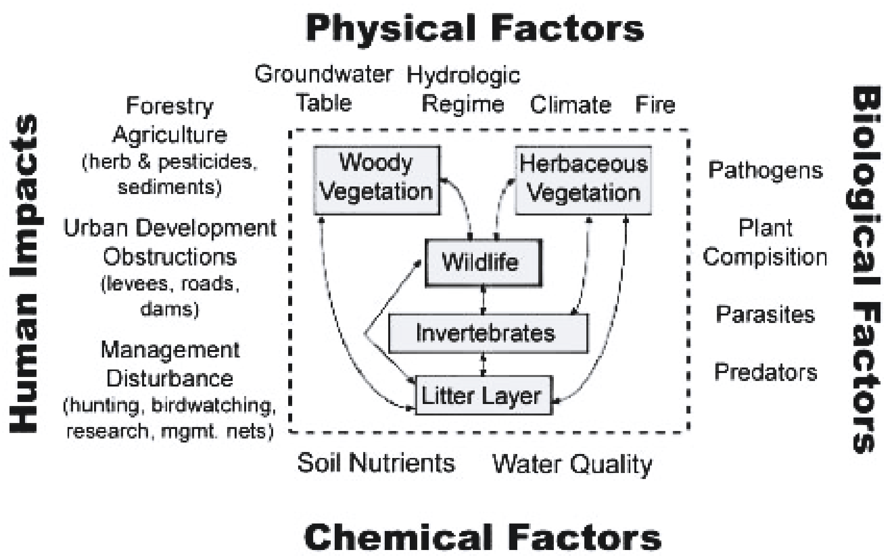

Figure 2.8. Wetland model depicting the influence of physical, chemical, and biological factors and human impacts that affect wetland function (Arkansas Wetland Strategy 1997).

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). In addition, the expansive floodplain system in the lower Kootenai (estimated by Cole and Hanna (2000) to cover approximately 70,000 acres prior to European settlement) probably contributed substantially to the influx of carbon and nutrients to the Kootenai River, increasing the system's overall productivity (PWI 1999). Figure 2.8 summarizes the physical, chemical, and biological factors and human impacts that affect wetland function.

Riparian and wetland ecosystems are likely the most productive wildlife habitats in the subbasin, benefiting the greatest number of species. Many wildlife species reach their highest densities in these habitats (Braumandl and Curran 2002). 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). In the Kootenai Subbasin, it is estimated that wetland and riparian areas in general contain 75 percent of the total plant and animal diversity. Lower elevation floodplain sites are particularly productive (NWPPC 2000). 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 Idaho's and 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, 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.

Riparian and wetland habitats are important to wildlife because they provide lush vegetation for forage and cover, invertebrate populations important as forage for many bird and mammal species, a water source for drinking, and a more moderate and stable microclimate than the surrounding upland habitats (Doyle 1990). As shown in table 2.10, riparian zones also provide horizontal and vertical diversity with abundant niches for wildlife, and they serve as naturally diverse and highly productive travel corridors (Malanson 1993). For example, low elevation riparian systems are especially important for nesting songbirds due to the complexity and diversity of habitats provided and to migrating songbirds since they provide insect food sources later and earlier in the season than are provided at higher elevations.

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 provide important habitat to fish, as well. In the Kootenai 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

Table 2.10. Riparian features important to wildlife (after Malanson 1993).

Riparian features valuable for wildlife habitat:
Woody plant communities
- structural variation
- woody debris
Surface water and soil moisture
- Increased productivity
Spatial heterogeneity
- Edges/ecotones
Corridors
- Migration/dispersal
Riparian features that would differentiate among wildlife species:
Vegetation type
- food availability
Size and shape
- interior and edge
Hydrological regime
- flooding disturbances (food/cover)
Adjacent land use
- food in adjacent areas
Elevation
Climate and topography

from macroinvertebrates to fish (Meehan et al. 1977). It also helps to moderate water temperature extremes during winter. 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 (biological) 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).

Sloughs, wetlands, and side channels provide deep-water habitats with a high amount of security cover, critical for juvenile fish. Additionally, off channel habitats provide refuge from unmanageable high water velocities typical of the Kootenai River mainstem. These habitats allow for nutrient assimilation and provide optimal habitat for aquatic invertebrates. Primary and secondary production is relatively high in sloughs versus the river mainstem (Soults 2002). Productive sloughs allow juvenile fish, specifically sturgeon, to achieve relatively high growth rates and prepare them for a successful transition to mainstem habitats (Partridge 1983; Paragamian et al. 1995; PWI 1999; and USFWS 1999).

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).

2.2.2 Human Alterations to Critical Riparian and Wetland Functional Processes

LINKS

For a summary of the effects of various human activities on riparian and wetland areas and their key ecological functions see Appendix 22.

Click Here

The TBA assessment estimates changes to riparian and wetland biomes, many of which affect functional processes. Go to Appendix 80.

Click Here

Council document 2000-12 *Return to the River* (Williams et al. 2000), summarizes the effects of various human activities on riparian and wetland areas and their key ecological functions (see Appendix 22). Many of these directly apply to the Kootenai 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, the indirect effects of river diking, and the clearing of floodplains and bottomlands has eliminated wildlife 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, non-native noxious weeds, and reduced canopy cover over the channel. Snyder (2002) states that "extensive stands of black cottonwood were once present throughout the [Kootenai River] floodplain, but have been virtually eliminated due to grazing in riparian areas and channel and flood control," and the floodplain shows a reduction of native species. Out of one hundred plant species identified, ninety-three were identified to the species level, 61 percent of those were non-native, and 39 percent native. On tributaries, these changes have often 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, created unvegetated varial zones and altered the natural hydrograph. Snyder (2002) reports in her assessment of dike riparian vegetation: "Because (dikes) are constantly being eroded and reshaped, bank faces and boundaries of designated landforms can change significantly in a very short period of time. Significant changes were noted between the 2001 and 2002 field seasons, after just one winter season of high flow levels. Lower and mid-elevation riparian areas have also been impacted by the pressures of erosion control efforts, irrigation withdrawals, and road building.

The loss of riparian habitats and the associated decline in the amount of large, instream woody debris has directly impacted bull trout in the subbasin (USFWS 2002; McPhail and Baxter 1996). Nakano and others (1992) report that focal sites for juvenile bull trout are strongly associated with overhanging vegetation, and woody debris provides cover for juveniles, stream-resident adults, and migratory spawners. In addition, the loss of riparian vegetation shade can increase summer water temperatures to above 59 °F because of the loss of shade. The importance of vegetation and large wood debris for maintaining the physical channel form varies by stream type (Rosgen 1996), but riparian vegetation and instream woody debris can influence stream bank protection, channel grade, sediment storage, and energy dissipation (Deiter 2000). The loss of riparian vegetation can result in increased variation in flow, resulting in low flows in summer and fall, scouring flash floods in spring, and substrate freezing in winter (McPhail and Baxter 1996).

LINKS

For summaries of hydrologic data showing pre and post-dam flow duration charts and pre and post-dam peak flow values charts for USGS gaging stations in the subbasin, go to Appendix 8.

Click Here

According to Jamieson and Braatne (2001), the lower Kootenai River floodplain probably supported one of the largest and richest riparian-forest and wetland complexes in the Pacific Northwest. In the mainstem and valley tributaries of Idaho, approximately 50,000 acres of lowland floodplain have been lost (EPA 2004). Twenty-three thousand acres of ephemeral and perennial wetlands have been lost since 1890 (EPA 2004). The substantial wetland losses are attributed to a combination of factors that include the operations of Libby Dam, reductions in hydrologic connectivity (diking and land leveling), draining associated with agricultural development, and tributary channelization (Richards 1997). KTOI has documented the changes in waterway distribution in the Kootenai River floodplain that have occurred since 1928 by tracking increases in stream miles, which correlates with wetland draining (e.g., new drainage ditches included in waterway miles, table 2.11 and figure 2.9) and by tracking channelization (stream straightening), which has resulted in lower "natural" stream miles (KTOI unpublished).

Similar losses and alterations of riparian and wetland areas elsewhere have decreased plant and wildlife diversity (Gresswell et al. 1989; Ebert and Balko 1987; Hodorff et al. 1988; Naiman et al. 1993; Wiggins et al. 1980). The Kootenai River valley as well as surrounding mid-high ecosystems are considered historic ranges for woodland caribou and grizzly (Soults pers. comm. 2004). As an example, woodland caribou historically used the lowland floodplains for early winter habitat in the lower Kootenai portion of the subbasin. Additionally, significant grizzly bear use of the floodplain in the lower Kootenai River drainage has been detected during the spring. Bears move to low-elevation areas immediately upon exiting the den to feed on the relatively high-protein succulents and to search for winter-killed ungulates (NWPPC 2000).

Table 2.11. Changes in waterway distribution in the Kootenai River floodplain 1928 to 1985.

TYPE	Function	Modified	1928	1985
Dtiches				
Ditch	Intermittent	manmade	64.66	91.99
Ditch	Perennial	manmade	7.81	51.75
Subtotal Ditches			**72.47**	**143.74**
Intermittent Streams				
Stream	Intermittent	modified natural	50.49	77.66
Stream	Intermittent	natural	24.67	5.6
Subtotal Int. Streams			75.16	83.26
Perennial Streams				
Stream	Perennial	modified natural	20.01	23.02
Stream	Perennial	natural	14.53	15.29
Subtotal Per. Streams			**34.54**	**38.31**
Subtotal Natural Streams			**39.2**	**20.89**
Subtotal Modified Natural Streams			**70.5**	**100.68**
Total Stream Length			**109.7**	**121.57**
Waterway Miles			**182.17**	**265.31**

LINKS

Appendix 34, A Conservation Strategy for Northern Idaho Wetlands (Jankovsky-Jones 1997) summarizes the status of wetlands in northern Idaho as well as how various impairments and type changes affect wetland function.

Click Here

In its geomorphic assessment of the Kootenai River, Tetra Tech (2003) summarizes the impacts that diking and stabilization efforts along the lower Kootenai have had on key geomorphic processes and how diking diminished floodplain connectivity. From a hydraulic and sediment transport point of view, this results in confinement of flows to the main channel, an increase in the water surface elevation for floods when they cannot spread out onto the floodplain, an increase in energy in the main channel during floods, increased sediment transport and erosion during floods and the elimination of the transfer of sediments from the main channel to the floodplain for deposition. Bank stabilization also changes the dynamics of the system where the meandering channel no longer meanders. This eliminates the processes that in the past reworked the floodplain and created the diverse over-bank topography containing sloughs, wetlands, and marshes.

Similar to other large river-floodplain ecosystems, the Kootenai River was historically characterized by seasonal flood pulses that promoted the nutrient exchange among a mosaic of habitats. This nutrient exchange enhances biological productivity and habitat diversity (BPA 2003). Prior to the construction of Libby Dam, diking alone could not contain frequent high spring flows along the Kootenai River. Those overland flows supplied a natural source of river nutrient inputs created low velocity, backwater, and side-channel habitats and non-native pioneering riparian species (Johnson et al. 1976; Miller et al. 1995). The flood

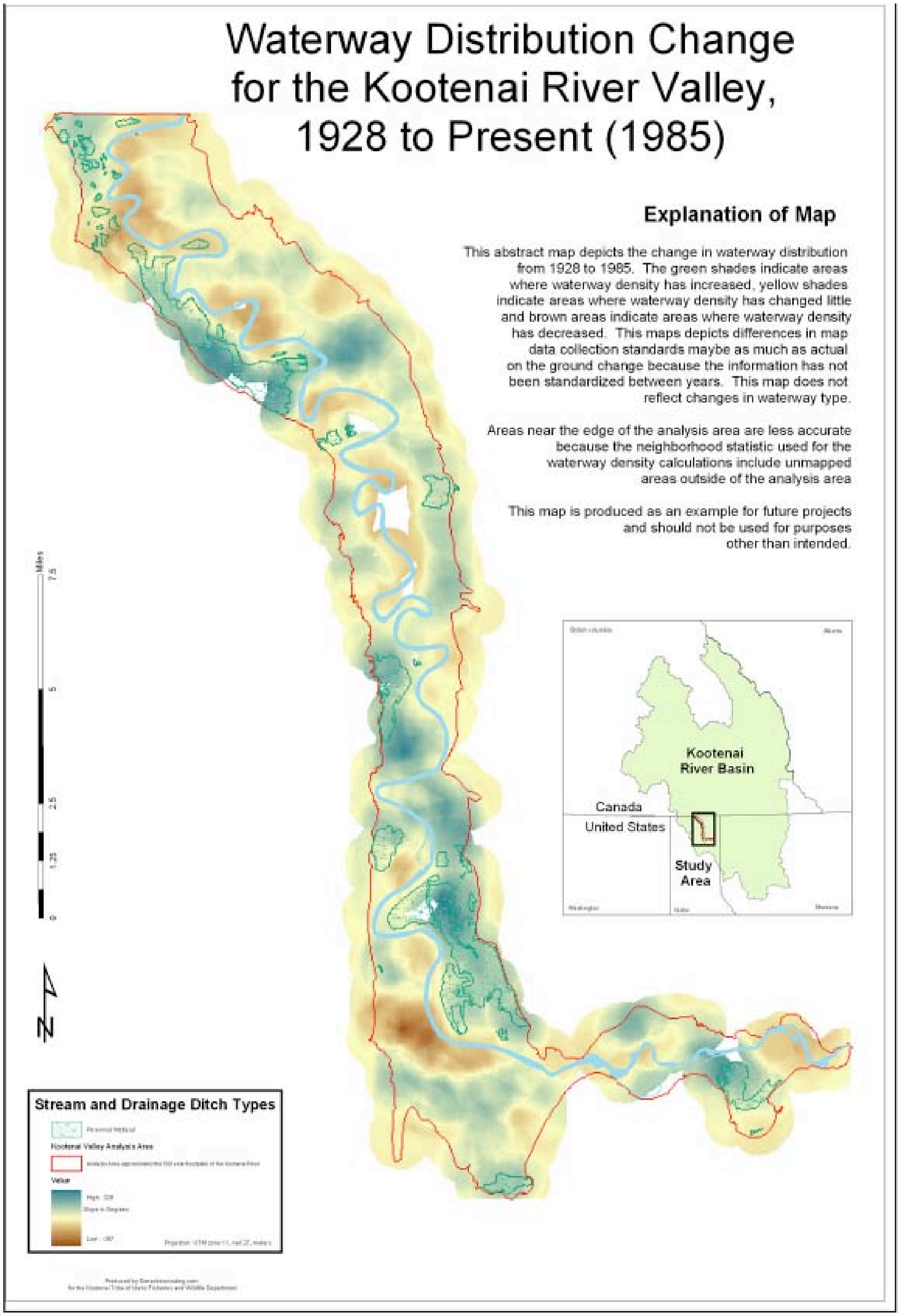

Figure 2.9. Waterway distribution change, Kootenai River Valley, 1928 to present.

pulses and overland flows ended when the dam was built. And just as dam operations have had dramatic impacts on aquatic habitat structure, so, too, do they effect adjacent riparian habitats and successional processes in those communities. Sediments that are building up in river cobbles were normally deposited 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. Of the two species of cottonwood present within the Kootenai River ecosystem—plains cottonwood (non-native) and black cottonwood (native)—the latter is considered the largest native broadleaf tree in Idaho. The Forest Service has identified the lack of cottonwood in riparian areas as a problem in the subbasin (USFS KIPNF 2003).

In their study of the impacts of flow regulation on Kootenai River riparian cottonwood forests, Jamieson and Braatne (2001) found that relatively minor land use changes have occurred in an upstream alluvial reach of the Kootenai River in B.C., but that major impacts have resulted from the operations of Libby Dam, diking, and agricultural development of the floodplain in downstream reaches in the U.S. For the Skookumchuck to Wardner alluvial reach in B.C., Jamieson and Braatne report that the Kootenai River is in a relatively natural condition, and while some clearing occurred in the past for agriculture, there is relatively little human settlement on the floodplain and natural fluvial processes are intact. Regular flood events are resulting in cottonwood and willow recruitment throughout the reach. The reach from Wardner to Libby Dam, which once supported significant areas of alluvial floodplain and cottonwood stands, is now inundated. The canyon area downstream of Libby Dam to the confluence with the Moyie River historically supported few cottonwood stands because of its relatively narrow floodplain. The reach between the confluence of the Moyie River and Bonners Ferry has dikes, but the river is able to migrate between them. In this reach, Jamieson and Braatne found large stands of mature cottonwood. They also found that the recruitment of new cottonwood stands had occurred in recent years as a result of the spring flow releases for white sturgeon in the 1990-2000 period. In the reach between Bonners Ferry and Kootenay Lake, where the river is restricted by dikes for most of its length, they found that there has been little recruitment since the construction of Libby Dam (though this reach once supported extensive cottonwood stands). Some cottonwood recruitment has occurred on point bars below the dikes where the dikes cut across the neck of meander loops. Their conclusion is that diking for agricultural use has severely restricted the hydrological connectivity between the river and the active floodplain, but the operation of Libby Dam has been the major factor affecting cottonwood recruitment. Other studies express similar conclusions, but historical information shows that the hydrologic disconnection of the floodplain is more related to Libby Dam flood control than dike construction. As an example, Snyder states "The process of diking was completed, in large part, by 1947, (Richards 1997; EPA 2004; BCHS 1987), but spring flooding continued to occur until the construction of Montana's Libby Hydroelectric Dam in 1972." History of Boundary County (1987) states there were multiple accounts of dike breaching, topping, and related overland flows, for example: "Several districts flooded each high water year by spring runoffs over the next forty years" page 43; " … in seven days all the districts and the town were flooded" page 43; "Drainage District #5 - Year after year we fought the high waters, then in 1948 it flooded and wiped us out" page 46; "District #6 went out in 1948" page 37; "Dike in District #11 breaks" page 33; and "May, 1956 the river … was topping from Irvings to Harts, a distance of about a mile" page 31 (figure 2.10).

In its assessment of the Kootenai River, the Pacific Watershed Institute (1999) hypothesizes that the wetland system in the lower Kootenai probably contributed substantially to the influx of carbon and nutrients to the river. Under unaltered conditions, nutrients and carbon would be added to the river from the adjacent wetlands and floodplain during flood and recession. They conclude that human activities such as the draining of wetlands, the diking of the floodplain, the straightening of stream channels, the clearing of vegetation, and other alterations such as those caused by log drives have probably contributed as much as Libby Dam to the reduced productivity in the aquatic ecosystem downstream of Bonners Ferry.

Riparian and wetland habitat-forming processes affected by Libby Dam operations 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 and Stanford 1997). When the Kootenai River was unregulated, the 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. Snyder (2002) reports that the dikes are "colonized in a seemingly homogenous manner by aggressive, pioneering, weedy plant species."

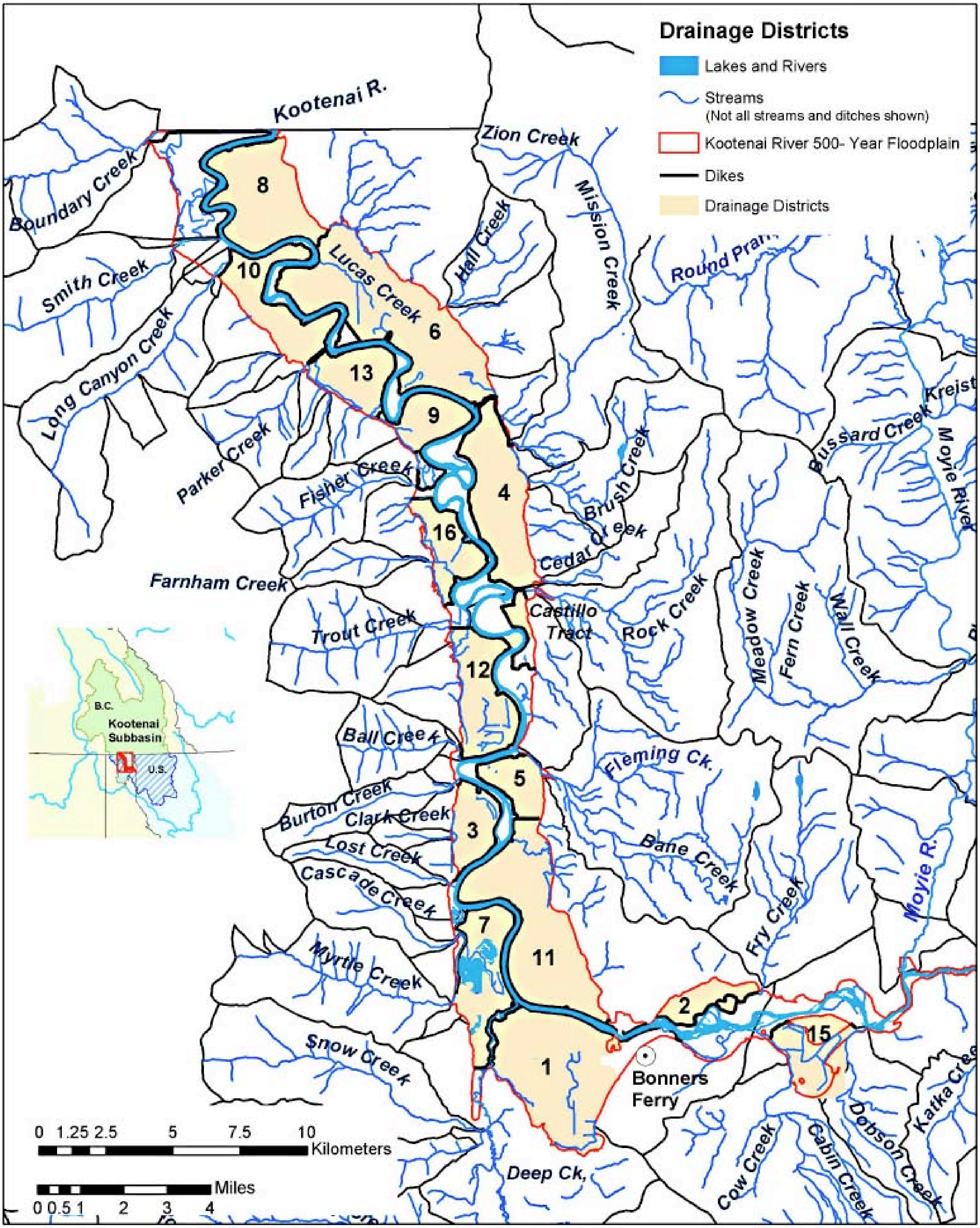

Figure 2.10. Drainage Districts along the lower Kootenai. Source: EPA (2004).

Young cottonwood and willow 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.

2.2.3 Presettlement Riparian and Wetland Habitat Conditions[16]

During presettlement times, riparian and wetland plant and animal communities in the Kootenai 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.

LINKS

The TBA assessment estimates presettlement riparian and wetland biome acres. Go to Appendix 80.

Click Here

During presettlement times the floodplain of the lower Kootenai River[17] (the portion of the subbasin in Idaho and downstream in British Columbia) included approximately 70,000 acres of contiguous floodplain ecosystem and related wetlands. This expanse of wetlands was created and maintained by spring floodwaters from the Kootenai River watershed. The magnitude and duration of the annual flooding depended on the accumulation of snow at high elevations. First, low-elevation snowmelt and rainfall partially filled depressions on the floodplain. Then, in May, flows in tributary streams peaked. When they reached the relatively flat floodplain, their rates of flow diminished and they lost energy. Large boulders, gravel and sand accumulated in alluvial fans at the foot of the mountains, while in the floodplain, tributary flows swelled to fill the deeply incised stream channels and overtopped their banks. They spread out across the floodplain, depositing silt along the stream banks and forming natural levees of higher ground. In mid May of 1808, David Thompson described the annual flood event: "The water from the melting snow in the mountains had risen upwards of six feet and overflowed all the extensive fine meadows of this country" (Rockwell 1984).

Tributary flows throughout the watershed were still very high in June, and they would eventually bring the Kootenai River to its maximum annual elevation. The flows filled Kootenay Lake due to the restriction at Grohmann Narrows and backed up the Kootenai River to Bonners Ferry. Floodwaters spread across the floodplain in what was a still-water segment of the river, depositing silt on the river banks, forming natural levees higher than the adjacent floodplain (B. Jamieson pers. comm. 2004). The finest material, high in clay content, was

[16] *Presettlement conditions are defined as the state of the environment at the time of European settlement or 1850.*
[17] *Adapted from Cole and Hanna (2000).*

deposited on the floodplain farthest from the river's channel. Over thousands of years, this cycle of annual river flooding resulted in deep accumulations of rich alluvial soil on the floodplain.

In July, the annual flooding receded and the wetland basins on the floodplain were left filled with water but isolated from the tributary streams and the main river by the natural levees built up by the deposition of sediments. The length of time the wetland basins retained water varied annually depending upon summer temperatures, precipitation, and the depth of the wetland basins.

The natural hydrodynamics and the resultant floodplain landscape created diverse plant communities and habitats. Amos D. Robinson, a surveyor for the General Land Office (now the Bureau of Land Management), a branch of the US Department of the Interior, provided a basic description of the Boundary Creek area in August 1894: "The body of this township is composed of marsh lands and a narrow strip of rich alluvial bottom along the Kootenai River slightly above ordinary high water … Land, level bottom, and marsh; soil, alluvial, first rate; timber, cottonwood with dense brush" (GLO Notes 1894).

LINKS

For an assessment of Kootenai River dike vegetation, go to Appendix 102.

Click Here

The General Land Office survey of the Boundary Creek property was completed by A.W. Barber in December 1898 (GLO Notes 1898). Barber noted that higher land in the floodplain was occupied by cottonwoods, some as large as three to four feet in diameter, aspen, "dense snowy brush" (probably snowberry), "bearberry" (?), "thorn" (probably hawthorn), and willow. Timber and brush varied from "dense" and "heavy" to "a scattering." Lower portions of the floodplain were described as "meadow", "marshy meadow," "wet marsh," "tule marsh" (probably cattails), "tules and deepmarsh," and "open slough." According to Barber, the steep, forested land adjacent to the floodplain at Boundary Creek was composed of heavy timber including cedar, larch, pine, fir and cottonwood.

A US Forest Service (USFS) photograph taken near Smith Creek prior to 1916 provides documentation of what the natural vegetation of the Kootenai River floodplain looked like over 80 years ago (figure 2.11). The coarse material of the Smith Creek alluvial fan (lower right portion of the photograph) was densely forested and included cottonwoods and conifers. Wetland basins were vegetated by herbaceous species. The natural levee associated with Long Canyon Creek, the next drainage upstream from Smith Creek, runs across the center of the photograph while the natural levee associated with the Kootenai River occurs farther out on the floodplain. These natural levees were vegetated by stringers of cottonwoods and shrubs.

LINKS

To skip ahead to presettlement grassland conditions, go to:

Click Here

To gain a more complete picture of presettlement conditions, some readers may want to skip ahead to the section on grassland presettlement conditions (see the link in the links column).

Figure 2.11. US Forest Service photograph of the Kootenai River floodplain near Smith Creek prior to 1916.

2.2.4 Present Riparian/Wetland Habitat Conditions

General

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, river diking, stream channel straightening, wetland draining, 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. Wetlands and riparian areas have also been impacted by the development of surrounding uplands (especially cabins and rural subdivisions along shorelines), contaminants, invasion of nonnative and noxious plants, introduction of nonnative animals, livestock grazing, and disturbance from increasing recreational use (NWPPC 2000).

LINKS

The TBA assessment estimates riparian and wetland biome acres and assesses various impacts by subunit. Go to Appendix 80.

Click Here

Upper Kootenai[18]

The Kootenai National forest has developed an Aquatic Response Unit (ARU) classification system to characterize and inventory the composition, structure,

[18] *The first two paragraphs of this section are adapted from USFS KIPNF (2003).*

LINKS

Appendix 35, The Impact of Flow Regulation on Riparian Cottonwood Forests along the Kootenai River in Idaho, Montana, And British Columbia, describes how Libby Dam and other human impacts to the floodplain affect riparian communities.

Click Here

Appendix 29, Kootenai River Geomorphic Assessment (2003) discusses the impacts that diking and flow regulation have had on lower Kootenai River wetlands.

Click Here

Appendix 23, excerpted from the Kootenai National Forest's Upper Kootenai River Subbasin Review assesses riparian and channel disturbances on tributary streams in Montana.

Click Here

and function of riparian vegetation. ARUs are determined by temporal and spatial patterns of hydrologic and geomorphic processes within defined valley bottoms of predetermined widths. Departure from a range of variability and/or a proper functioning condition can be determined by either comparison to reference stream reaches within a given valley bottom type (or ARU) undisturbed by human influence or from an understanding of aquatic processes developed through ARUs.

Table 2.12 is a summary description of ARUs on the forest. Additional information can be found in the draft ARU document on file at the Supervisor's Office in Libby. The ARUs have been grouped based on overall similar descriptive characteristics. Each ARU is coded so the first number reflects the dominant stream order. The second and third letters reflect the overall gradient (stream gradient) where "A" is the highest gradient and "C" is the lowest gradient (these classes follow the Rosgen system gradient breaks).

Humans have introduced a number of non-native grasses and forbs within riparian shrublands of the subbasin, (USFS KIPNF 2003). Extensive populations of non-native species—mainly reed canary grass and common tansy—border the Kootenai River. The invasions reduce the value of the areas as wildlife habitat and displace native plants. These non-native species are also common along other riparian systems where exposure is relatively open. Flower Creek has an infestation of Japanese knotweed along the portion that flows through Libby (USFS KIPNF 2003).

Road construction and development has caused a reduction in riparian, wetland and lakeshore habitat as well as vegetation-composition changes in riparian areas, some of which is due to the noxious weeds that typically accompany roads.

Other riparian and wetland losses occurred from the construction (as opposed to the operations) of Libby Dam.

Lower Kootenai[19]

Semipermanent to permanent emergent wetlands, poor to rich fens, paludified forests, and ombotrophic bogs in the subbasin harbor some of the region's rarest wetland-associated plants and animals. Acres of wetland as inventoried by the National Wetland Inventory (NWI) are presented in Table 2.13. This includes 800 acres that have been rehabilitated on the 2,774 acres Kootenai Refuge (Marotz et al. 2000). In her summary of ownership and protection status of northern Idaho (Bonner and Boundary Counties) wetlands, including deepwater habitat, Jankovsky-Jones (1997) found that nearly 25 percent of wetlands are in private ownership. Seventy–one percent are classified open water and fall under the jurisdiction of the state of Idaho. The USFS is the largest public land manager of

[19] *Adapted from USFS KIPNF (2003).*

Table 2.12. Summary of ARUs on the Kootenai National Forest. The Idaho Panhandle National Forest does not have an ARU classification and inventory at this time.

Group	ARU	Proportion of the KNF	Description	Vegetation
1	1A	33%	First and some second order, very steep streams. Commonly found at elevations between 3000-5500 . Major landtype groups are 300 and 400 series. Valley bottoms are narrow.	Grand fir, Black Cottonwood, Western Redcedar, Western Hemlock, Common Snowberry,
1	1AB	19%	First and 2nd order, steep streams. Commonly found at elevations between 2500-5500 . Major landtype group is 300 series. Valley bottoms are fairly narrow.	Western Redcedar, Mountain Alder, Sitka Alder, Fools's Huckleberry, Drummond Willow, Arnica
1	3AB	1%	Third order, steep streams. Commonly found at elevations below 4500 . Major landtype groups are 300 and 400 series, followed by 100 series. Valley bottoms are fairly narrow.	Grand fir, Western Redcedar, Rocky Mountain Maple, Common Prince s-pine, Twinflower, Thimbleberry
2	1B	17%	First and second order, moderate gradient streams. Mainly found at elevations between 2500-5000 . Most common landtype group is 300 series, followed by the 100 then the 400 series. Valley bottoms are moderately wide.	Engelmann Spruce, Western Redcedar, Sitka Alder, *Sphagnum sp.*, Ticklegrass, Oak-fern
2	1B	17%	First and second order, moderate gradient streams. Mainly found at elevations between 2500-5000 . Most common landtype group is 300 series, followed by the 100 then the 400 series. Valley bottoms are moderately wide.	Engelmann Spruce, Western Redcedar, Sitka Alder, *Sphagnum sp.*, Ticklegrass, Oak-fern
2	3B	4%	Third order, moderate gradient streams. Mainly found at elevations between 2500-4500 . Most common landtype group is the 300 series, followed by the 100 and 400 series. Valley bottoms are moderately wide.	Grand fir, Paper Birch, Western Redcedar, Western Hemlock, Sitka Alder, Fools's Huckleberry, Devil's Club,

LINKS

Appendix 36 describes Kootenai National Forest peatlands and assesses the effects of forest management activities on these areas.

Click Here

Appendix 37 is an Ecological Inventory of Wetland Sites in the Thompson-Fisher Conservation Easement.

Click Here

Appendix 38 reports on rare wetland plants of the Bonners Ferry Ranger District.

Click Here

Appendix 39 lists Wetland and Riparian Plant Species of the Kootenai River Valley.

Click Here

Appendix 40 is a report on moonworts of the Kootenai National Forest.

Click Here

Table 2.12 (cont.). Summary of ARUs on the Kootenai National Forest. The Idaho Panhandle National Forest does not have an ARU classification and inventory at this time.

Group	ARU	Proportion of the KNF	Description	Vegetation
2	4B		Characteristics of this group include 1st, 2nd, and 3rd order streams with low gradient, higher sinuosity, and wide valley bottoms.	
3	1C	7%	First and second order, low gradient streams. Commonly found at elevations between 2000-4000 . Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Spruce, Sitka Alder, Thimbleberry, Reedgrass, Ladyfern,
3	3C	5%	Third order, low gradient streams. Commonly found at elevations between 2000-4500 . Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Grand fir, Engelmann Spruce, Black Cottonwood, Red-osier Dogwood, Douglas Spiraea, Ticklegrass,
4	4C	6%	Fourth order, low gradient streams. Mainly found at elevations below 4000 . Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Paper Birch, Paper Birch, Balsam Poplar, Scouler Willow, Bentgrass, Beaked Sedge, Reed Canarygrass, Fowl Bluegrass

Table 2.13. National Wetlands Inventory acres of wetland in the Lower Kootenai.

Lentic Environments	Total Acres	0 - 2500 ft	2500 - 4500 ft	4500+ ft
NWI-Palustrine	6002.9	3199.00	2257.6	546.3
NWI-Lacustrine	1044	635.10	303.8	105.9
Total	**7046.9**	**3834.10**	**2561.4**	**652.2**

wetland habitat at 2.9 percent. Jankovsky-Jones found that only about 3.3 percent of wetland and deepwater habitats are currently protected in a manner intended to maintain natural resource values.

In the lower Kootenai River system, roughly 50,000 acres of lowland floodplain and 23,000 acres of ephemeral and perennial wetlands in the U.S. have been converted into agricultural row crop and pastureland (EPA in press

2004; Richards 1997). Jankovsky-Jones (1997) writes: "Prior to settlement the Kootenai River spread across the wide valley bottom between the Purcell and Selkirk Mountains and supported forested and shrub wetlands, ponds, wet meadows, and marshes. In the 1920s dikes were created to contain spring floods. Cottonwood forests were removed and wetlands were filled for agriculture development. Cottonwoods forests and shrublands along the Kootenai River are currently restricted to streamside bands within the levees and to islands. Loss to road construction and home building has surpassed agricultural loss in recent years." Smaller wetland communities can be found in Idaho and Montana along the canyon and braided reaches of the Kootenai River system and on geologic features such as cirques, kettles, scours, and outwash channels. The 1992 National Resource Inventory indicated that in all, nearly 60 percent of non-federal wetlands in the Kootenai-Pend Oreille-Spokane subbasins are now used for cropland and pastureland (Jankovsky-Jones 1997). Losses of perennial wetlands along the Lower Kootenai River are shown in figure 2.12.

The river often topped dikes and flooded agricultural grounds. These overland flows supplied a natural source of river nutrient inputs and created low velocity, backwater and side-channel habitat (PWI 1999). Additionally, flood events increased the diversity of the riparian community by creating shallow-water areas with high concentrations of hydrophilic plants, both emergent and submerged. The events also created areas of fluvial deposition for cottonwood and willow recruitment. Today, the Kootenai Tribe of Idaho and the Idaho Department of Fish and Game are forming partnerships with local communities and state and federal agencies to design projects which mitigate hydropower losses in the Kootenai Subbasin, in addition to protecting and enhancing critical wildlife habitat for species dependent on wetland and riparian habitats. Tables in Appendix 34 give the percentage of different wetland types in Boundary County, Idaho and list wetland sites in Boundary County and wetland and deepwater habitat for the lower Kootenai River drainage (Idaho portion of the Kootenai Subbasin).

2.2.5 Potential Riparian/Wetland Habitat Condition[20]

Under this scenario, Libby Dam would be operated in a manner that would substantially restore normative hydrologic conditions (conditions that mimic natural processes and minimize impacts on fish and wildlife). Stabilizing summer flows will have allowed some reestablishment of riparian vegetation in the varial zones of regulated rivers. An operational impact assessment and plans to mitigate

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

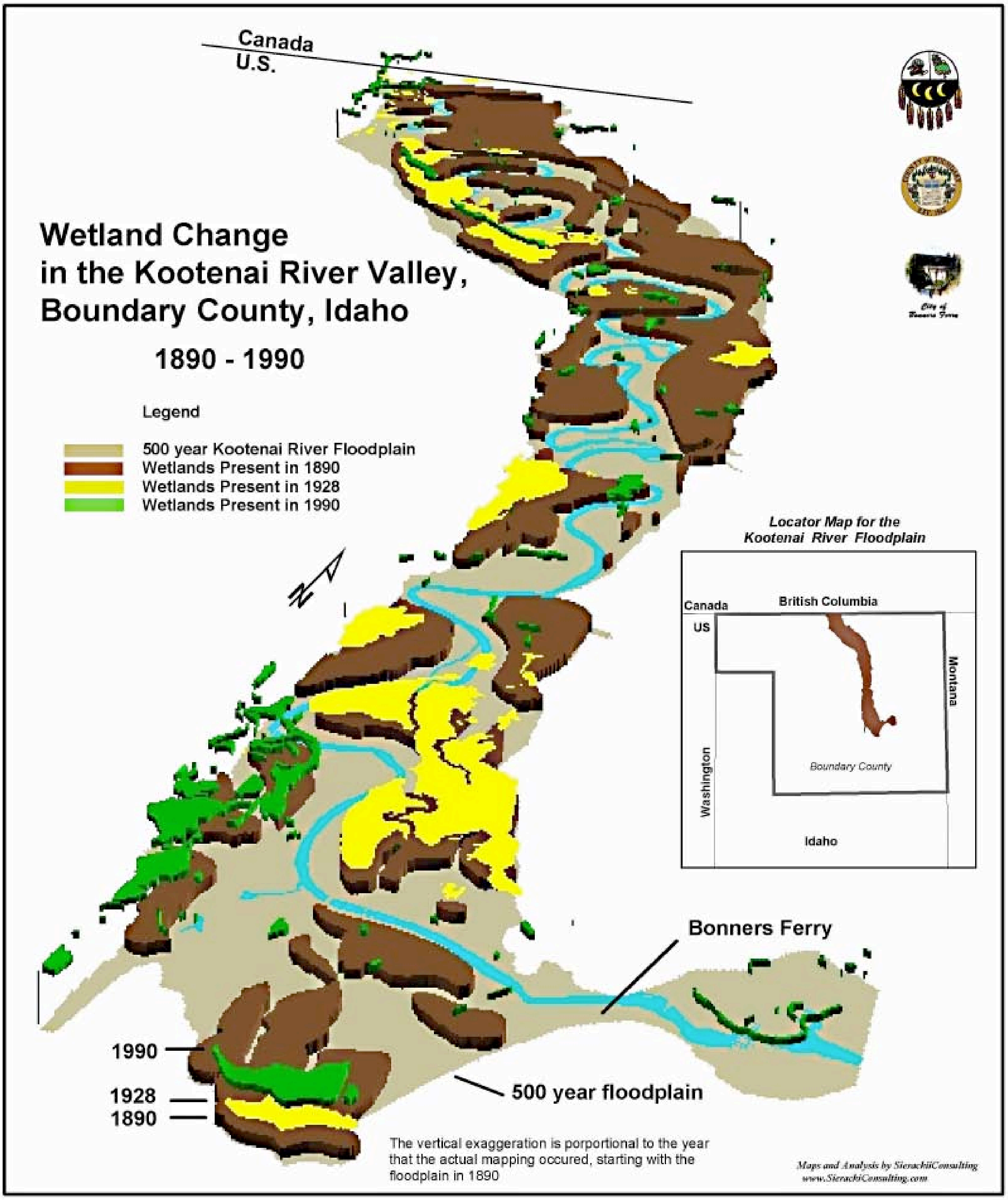

Figure 2.12. Time-series analysis of wetland change, 1890-1990. Source: EPA (2004).

for ecological impacts caused by the operations of Libby Dam, including but not limited to successional riparian wildlife habitats and their associated aquatic components, will have been completed and fully implemented. Off-channel floodplain habitats in the lower Kootenai River ecosystem critical to the survival of white sturgeon will have been identified and reconnected to the river.

Across the subbasin, the best available remaining riparian and wetland habitats will have been identified and protected through the use of conservation easements 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.

2.2.6 Future/No New Action Riparian and Wetland Habitat Condition[21]

Riparian and wetland habitats will 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, agricultural practices, and hydropower operations. 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, nutrient retention, and fish and wildlife habitat. Disconnected wetland habitats such as sloughs will, for the most part, remain disconnected, further threatening the survival of white sturgeon.

Human populations will have continued to grow, and many more people will have built first and second homes along streams. These and other recreational

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

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, which also reduce the value of these key habitats to native fish and wildlife species.

2.3 Grassland Systems

2.3.1 Critical Grassland Functional Processes

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—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).

Grasslands evolved with frequent disturbances. Prior to European settlement, fire and drought were the major forces shaping and maintaining Columbia Basin grasslands. The mean presettlement fire-return interval for fires on western Montana grasslands was under 9 years (Barrett and Arno, 1982). 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). 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.

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, there have been invasions of woody and non-native plant species. Areas have been overgrazed and converted to cropland or other uses. Soils 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.

LINKS

The TBA assessment estimates changes to the grassland biome, many of which affect functional processes. Go to Appendix 80.

Click Here

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).

2.3.2 Human Alterations to Critical Grassland Functional Processes

Wood and Manley (1993) found the greatest losses of native grasslands within the Tobacco Valley (the largest area of grassland in the U.S. portion of the Kootenai) were from conversion to agricultural uses and development. Conversion has also had the greatest impact on critical functional processes. 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 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, the utilization of coarse grasses, and the availability of forage; and improve habitat for some wildlife species (Paysen et al. 2000). 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 nonnative 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 decline in species diversity and native threatened rare plants. Spotted Knapweed is a major problem in the remaining grasslands in the Tobacco plains area. Lesser infestations occur in grasslands in the Canadian portion of the basin (B. Jamieson pers. comm. 2004).

2.3.3 Presettlement Grassland Habitat Condition[22]

Except in certain areas (for example, the Tobacco Valley and southerly aspects of the lower Fisher in Montana and places such as Wycliffe and Skookumchuck Flats in B.C.) grasslands were not a major component of the Kootenai Subbasin during presettlement times. They accounted for probably less than one percent of the total subbasin landscape (IBIS 2003). However, in the 1930s, following logging and large fires in valley-bottom open-canopy ponderosa pine and Douglas fir forests, large areas of the Trench were converted to seral grasslands with trees as a minor component of the system. This conversion resulted in an expansion of ungulate, wild horse and cattle numbers that has subsequently declined as a result of regrowth of forests on these landscapes. This was a factor from the Tobaccco Plains and Tobacco River areas north to Invermere in B.C. (B. Jamieson, pers. comm. 2004)

LINKS

The TBA assessment estimates presettlement grassland biome acres. Go to Appendix 80.

Click Here

Presettlement grasslands in the U.S. portion of the subbasin were similar to the fescue-wheatgrass-needlegrass community that occurs today in the Tobacco Plains. This type of grassland is transitional between Palouse Prairie typical of eastern Washington and Oregon and native grasslands of the Northern Great Plains (Antos, McCune, and Bara, 1983). Lesica (1996) found native grasslands were dominated by rough fescue *(Festuca scabrella)* and needle and thread grass (*Stipa comata*) . Other native grasses included bluebunch wheatgrass (Agropyron *spicatum),* Idaho fescue *(Festuca idahoensis),* and Sandberg bluegrass *(poasandbernii).* Grasslands in the B.C. part of the subbasin upstream from Montana, include the northern extension of the Tobacco Plains, which is primarily in the Tobacco Plains Reserve and the Wycliffe and Skookumchuck Flats. These areas are dominated by bunchgrasses and other grasses; shrubs occur in valley bottoms and on several plateaus throughout the Kootenai Valley (Meidinger and Pojar 1991). *Agropyron spicatum* (bluebunch wheatgrass) is the most widespread

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

and dominant species. Other abundant or frequent species include *Festuca scabrella* (rough fescue), *F. idahoensis* (Idaho fescue), *Poa sandbergii* (Sandberg's bluegrass), *Koeleria macrantha* (junegrass), *Bromus tectorum* (cheatgrass), *Stipa comata* (needle-and-thread grass), *S. richardsonii* (spreading needlegrass), *S. spartea* (porcupinegrass), *Poa pratensis* (Kentucky bluegrass), *Artemisia tridentata, A. frigida* (pasture sage), and *Chrysothamnus nauseosus* (Meidinger and Pojar 1991).

During presettlement times, fire and drought were the major disturbance forces shaping grasslands in the subbasin. Fires, ignited by lightning as well as Native Americans, played a key role in structuring grassland vegetation by preventing the establishment of woody vegetation (Koterba and Habeck 1971; Dorey 1979; Barrett and Arno 1982). Mean presettlement fire-return interval for western Montana valleys was about 9 years (Barrett and Arno 1982) and was estimated to be 6.4 years (range of 2–13 years) for the north end of the Tobacco Valley in southeast British Columbia (Dorey 1979).

In spite of their limited extent, grassland habitats in the subbasin provided important wildlife habitat, including spring nesting habitat for ground-nesting waterfowl, raptors, and songbirds and winter range for bighorn sheep, elk, mule deer, and white-tailed deer. Columbian sharp-tailed grouse (*Tympanuchus phasianellus*) and trumpeter swan (*Cygnus buccinator*), both later extirpated from the subbasin, used grassland habitats and associated wetlands. Grasslands are also essential for the survival of species such as burrowing owl, Brewer's sparrow, badger, and Great Basin pocket mouse, which are unusual or rare in much of the subbasin.

To gain a more complete picture of presettlement conditions, some readers may want to skip ahead to the section on forest presettlement conditions (see the link in the links column).

LINKS

To skip ahead to presettlement forest conditions, go to:

Click Here

2.3.4 Present Grassland Habitat Condition

The grasslands of the western United States have undergone tremendous changes since European settlement began, with corresponding changes in the habitats and the wildlife species that inhabit them. The same has been true in the Kootenai Subbasin where native grassland areas have been lost due to subdivision and other developments, inundation by Libby Dam, intensive use by livestock, conversion to cropland, forest encroachment, and invasive nonnative species. As a result, populations of many grassland-dependent wildlife species, such as the Columbian sharp-tailed grouse, have been severely impacted.

LINKS

The TBA assessment estimates grassland biome acres and assesses various impacts by subunit. Go to Appendix 80.

Click Here

Threats and impacts to grasslands in B.C. have been very similar to those in the U.S. Less than 1 percent of B.C. grasslands have any protection, although the Nature Trust of British Columbia has purchased grassland for conservation in the East Kootenay (Living Landscapes 2003). In some areas, overgrazing of grasslands has reduced the highly nutritious native perennial bunchgrasses and promoted less nutritious, weedy (often non-native) annual grasses and forbs. Trampling by cattle has damaged the surface soil cover of lichens, bryophytes, and cyanobacteria, which has promoted germination of weed seeds and resulted in loss of soil moisture, further stressing native vegetation. Overgrazing by livestock (first horses and later sheep and cattle) was serious in the early settlement period, and by 1900 had resulted in considerable damage to rangelands (Pitt and Hooper 1994). Since the 1940s, grassland range conditions in British Columbia have generally improved because of better management (Living Landscape 2003).

Throughout the subbasin, but especially in B.C., there here has been a considerable loss of grassland by forest encroachment (Ministry of Forests, 1995). While difficult to quantify, it is estimated that 30% of the Kootenai grasslands in B.C. have been lost to forest encroachment. Weeds have affected grassland health. The Kootenai National Forest reports that the primary causes for decline of native grassland habitats on the forest has been the invasion of non-native plants. Non-native species have reduced the value of wildlife and rare plant habitat (USFS KIPNF 2003). The rare perennial forb, Spalding's catchfly (*Silene spaldingii*), listed as a threatened species under the Endangered Species Act, is found within the Tobacco Plains and may be the largest population known. It occurs in the bottom of shallow swales and on cool slope exposures with relatively deep soil (Lesica 1997).

Another factor affecting the extent of grasslands in the subbasin was the construction of Libby Dam, which inundated important segments of the Ural-Tweed bighorn sheep spring and winter range. The resulting formation of Koocanusa Reservoir inundated approximately 4,350 acres of crucial winter and spring ranges for this species, the last remnant native bighorn sheep population in northwest Montana.

LINKS

For a list of grassland/ rangeland areas in the BC portion of the Kootenai and monitoring activities in each, go to: http://www.for.gov.bc.ca/nelson/research/rra/intro.htm

Click Here

Appendix 41 gives an overview of history of open forest and grassland habitat in East Kootenay.

Click Here

2.3.5 Potential Grassland Condition[23]

Under this scenario, the best remaining tracts of grassland will have been protected from subdivision and conversion to other vegetation types through conservation easements, purchase, and restoration. 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.

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

Public education efforts and incentive programs will have improved land use practices on remaining grasslands. These efforts will have substantially reduced the conversion of native grasslands to other land cover types. Management agencies will have used 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.

2.3.5 Future/No New Action Grassland Condition[24]

The small pockets of grassland currently under protection by federal, Tribal, state, or provincial governments and organizations like The Nature Conservancy will remain protected, although expanding weed infestations will likely continue to degrade many of them. Some of these 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. 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 invasive and nonnative 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. In Canada, in the Tobacco Plains, Wycliffe and Skookumchuck grasslands, it is unlikely that sufficient native grassland will remain to support any of the larger grassland animals of concern (badger, sharp-tailed grouse) (B. Jamieson, pers. comm. 2004).

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

2.4 Coniferous Forest Systems

2.4.1 Critical Coniferous Forest Functional Processes

Table 2.14 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. Both fire by itself and the interplay of fire and insects can affect forest communities by delaying or redirecting succession, which in turn affects 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. Wildlife 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 2.14. 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 from 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/ Landslide	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 42.

LINKS

Generalized plant succession patterns in western Montana following fires and the effect of fire on other key ecological process are summarized in Appendix 42

Click Here

For detailed descriptions of disturbance processes and functions of the habitat groups in the Kootenai Subbasin, go to Appendix 43.

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 Kootenai Subbasin are the *stand-replacement*, the *mixed* and the *low severity or nonlethal*. Understanding these three fire regimes is critical to understanding fundamental ecological processes in Kootenai Subbasin forests. The following descriptions of the fires that dominated each regime are excerpted from USFS KIPNF (2003). Figures 2.13 and 2.14 show historic fire regimes.

Stand-Replacement Fires

Stand-replacing fires remove more than 90 percent of overstory tree canopy over a significant area and restart the successional sequence. Historically, on landscapes dominated by moist habitat types (as found on the Kootenai National Forest (KNF) and Idaho Panhandle National Forests (IPNFs), the mean fire return interval was approximately 200 years, with drier sites burning more frequently and wetter sites burning less frequently (Smith and Fischer 1997; Zack and Morgan 1994).

Major fire years occur most commonly during regional summer droughts. Lightning storms and wind contribute to the likelihood of a major fire year.

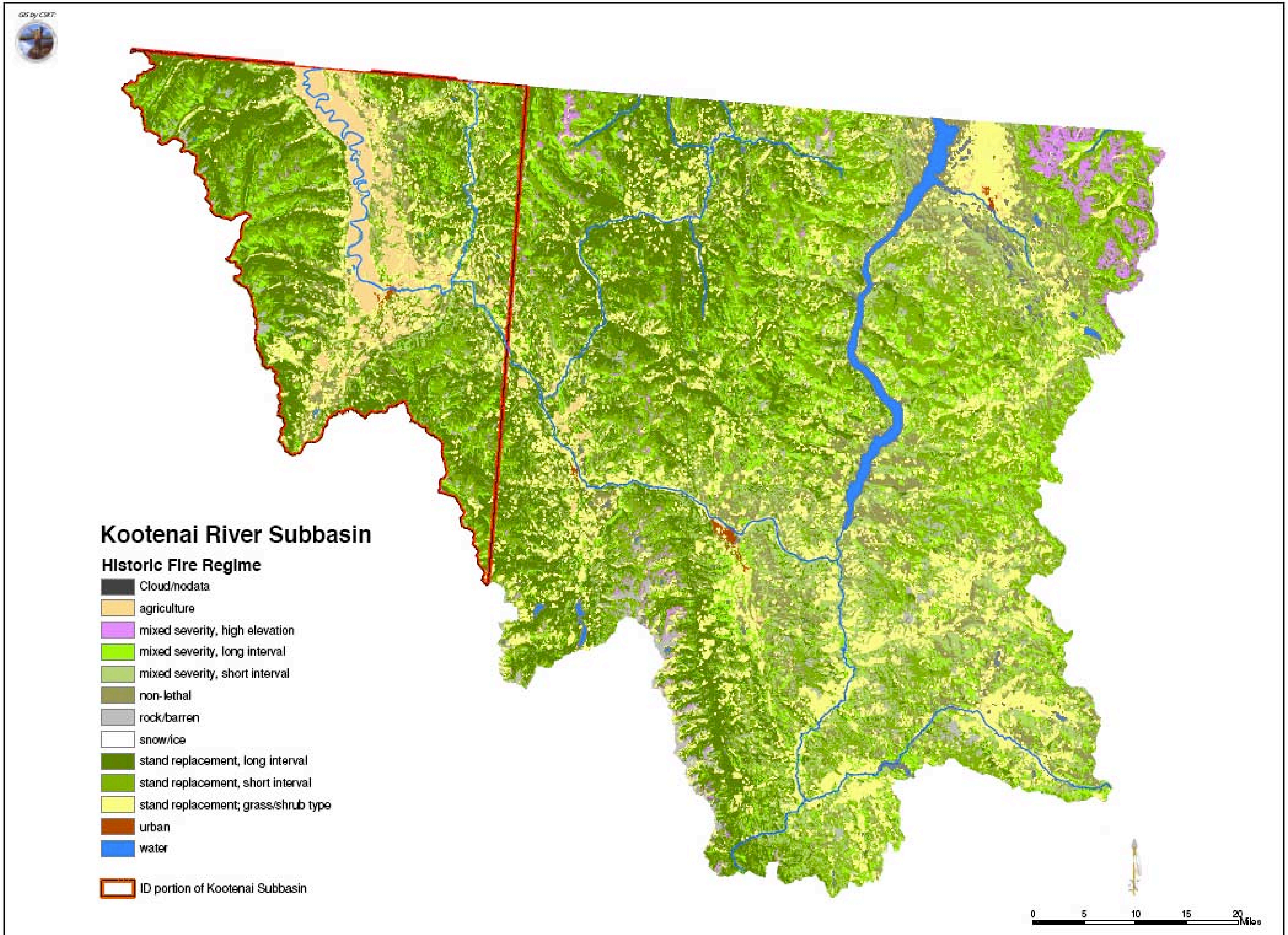

Figure 2.13. Historic fire regimes in the U.S. portion of the Kootenai River Subbasin.

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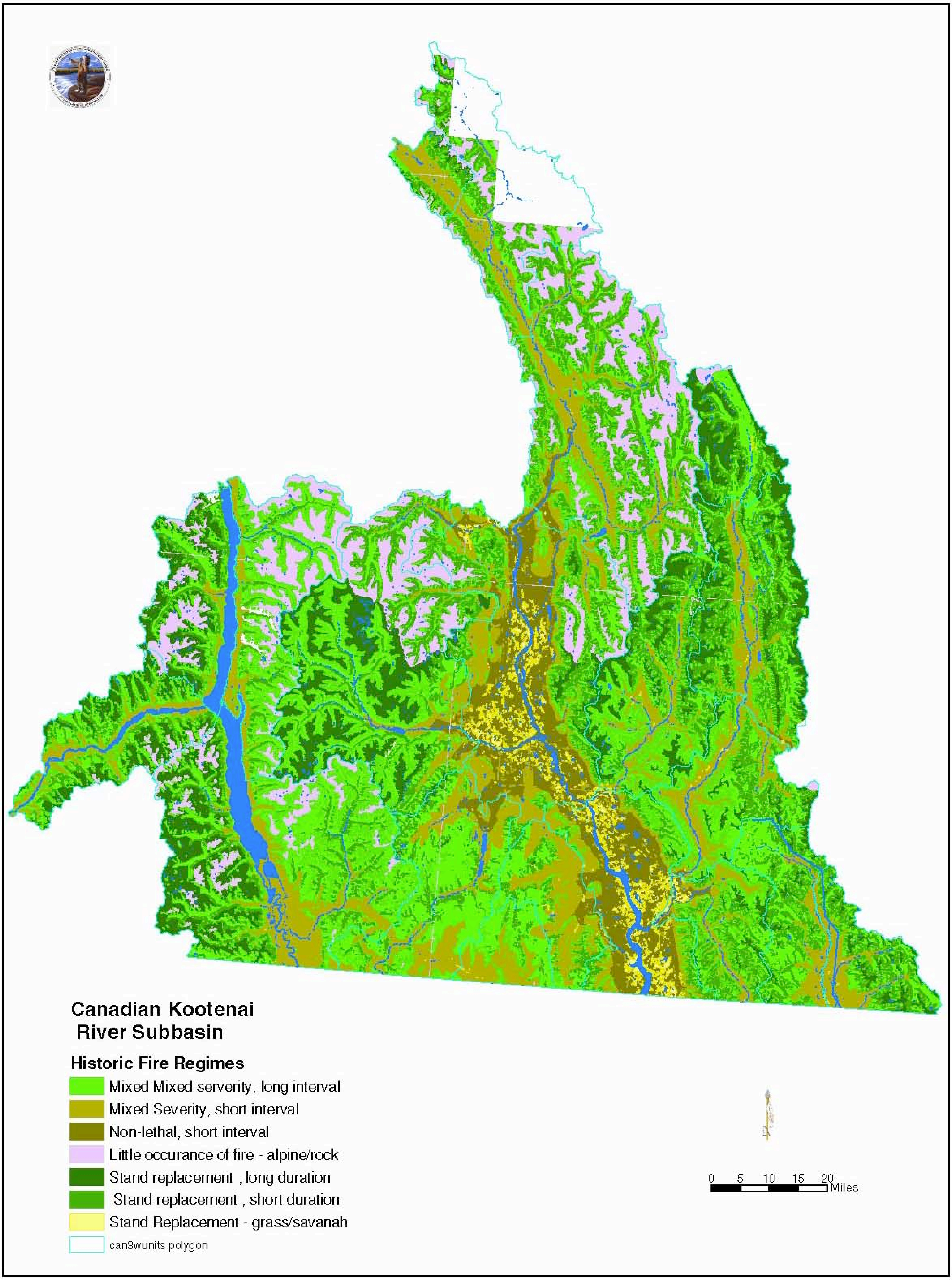

Figure 2.14. Historic fire regimes in the Canadian portion of the Kootenai River Subbasin.

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During major fire years, stand-replacing fires were commonly on the order of tens of thousands of acres, with some individual fire patches at 50,000 acres or larger (Pyne 1982; Zack and Morgan 1994). The Coeur d'Alene Fire Study, (based on approximately 1500 tree records) shows that over the last 450 years, there was one-major stand replacing fire episode an average of once every 19 years somewhere in that 570,000 acre river basin.

During major fire events some watersheds were almost entirely burned over, while other large areas were unaffected. In any particular watershed, major stand-replacing disturbances came in pulses, with long intervals between the pulses.

While stand-replacing fires favor long-term dominance by early successional, shade-intolerant tree species, the mean time interval between stand replacing fires was long enough to allow development of mature and old growth forest structural stages, particularly in landscapes where fire intervals tended to be longest.

Re-burns of fires have occurred throughout history. Re-burns have been associated with, and have normally followed, severe fire years that have burned in high intensity conditions. Stand-replacing fires can create a high fuel loading in both standing and down wood. When these fuels season after several years, the load becomes a strong candidate for re-burn when high temperatures, low humidity, and winds combine.

LINKS

The TBA assessment estimates changes to the forest biome, many of which affect functional processes. Go to Appendix 80.

Click Here

Mixed-Severity Fires

Mixed-severity fires kill at least 10 percent of the overstory tree canopy, but do not replace the whole stand. Mean fire return intervals typically ranged from 55-85 years, depending upon landscape location. On very moist sites they may have been significantly less common, while on drier sites return intervals were 25 years or less (Smith and Fischer 1997; Zack and Morgan 1994). Mixed-severity fires create an irregular patchy mosaic of small to moderate-sized openings, thinned areas, underburned areas, and unburned areas. Mixed severity fires generally prolonged the period of dominance by early successional fire-adapted species and at a larger scale, allowed for the development of mature and old growth structural stages dominated by large trees. Fire also played many additional ecological roles as a carbon and nutrient recycling agent, dormancy breaking and stimulating agent for herb and shrub seeds and sprouts, and creator of tree cavities and snags (used by wildlife). Historically, mixed-severity fires were extremely variable in size (less than one acre to more than 1,000 acres) and introduced both variable sized patches and internal diversity within larger blocks created by the less frequent stand-replacing fires.

Low-Severity or Nonlethal Fires

Low-severity fires are typically underburns that kill less than 10 percent of the overstory tree canopy. They are most important on drier habitat types where conditions are dry enough to burn more frequently. Mean fire return intervals typically range from 10 to 30 years (Smith and Fischer 1997). Low-severity fires typically remove most small understory trees, particularly the more shade-tolerant, fire-intolerant species. On drier habitat types where these fires are common, the frequent burns maintain a large portion of the landscape in relatively open stands of large, shade-intolerant, fire-tolerant species (larch and ponderosa pine with lesser amounts of Douglas-fir).

Effects of Historic Stand-replacing Fires

These disturbances of large, infrequent stand-replacing wildfires created a dynamic shifting mosaic of forest successional stages on a very large scale. In between the stand-replacing fires, vegetation, aquatic systems, and wildlife habitat had long periods to develop. Intermediate disturbances (low and mixed severity fire; some insect, pathogen, and weather events) introduced finer scale variability within these larger patches. As a result, blocks of wildlife habitat tended to be large, and blocks of mature/late-successional forest also tended to be large, but internally diverse. Terrestrial/aquatic interactions meant that watershed conditions and fish habitat also tended to form a dynamic, large-scale, shifting mosaic. Over time any individual watershed could vary from predominantly mature/old forest (with wildlife and fish habitat that results) to almost all recently burned over. However, at any given time, at the larger scale (500,000 – 2,000,000 acres), the whole range of these conditions was represented in watershed-sized blocks of thousands to tens of thousands of acres.

Insects and Disease

Historically, insects and pathogens played a significant role in shaping forests. Mountain pine beetles (and occasionally spruce beetles) in white pine and lodgepole pine at times served as stand-replacing agents. They sometimes opened canopies enough to provide regeneration opportunities for climax species. Most often they served to release early seral species, creating fuels and increasing the probability of large stand-replacing fires. In some situations, Douglas-fir bark beetle can have the same effect on a smaller scale (USFS KIPNF 2003).

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 have 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).

Historically, root pathogens also acted as thinning agents. In natural mixed-species stands, root pathogens caused the greatest mortality in Douglas-fir, followed by true firs. White pine and larch were the most resistant tree species to these diseases (Hoff and McDonald 1994; Monnig and Byler 1992). Hence root pathogens favored the pines and larch, increasing the amount of those species over the first 150 years or so of stand life (USFS KIPNF 2003).

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, 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 adjacent forest lands in northwestern Montana, it is estimated that 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).

Landscape Patterns[25]

Landscape patterns affect wildlife habitat and dispersal, plant habitat and dispersal, disturbance (fire, insects, pathogens) spread and size, ecosystem response to disturbance, and human esthetic values.

Some important, interrelated concepts used to assess landscape patterns are patches, interior habitat, and fragmentation. A patch is defined as an area of

[25] *Condensed from USFS KIPNF (2003)*

continuous habitat or as an area capable of facilitating particular habitat functions for given species or species groups. Patches can be identified according to key habitat features of forest structure, composition, and process. Interior forest habitat is defined as the conditions typical of the central or interior part of a habitat patch, usually relatively stable and uninfluenced by the changing climatic conditions and other variables associated with edge conditions. In general, interior habitat is the opposite of fragmentation (the greater the fragmentation, the fewer acres of interior forest habitat). The size and shape of forested areas largely determines the size of interior habitat. Obviously, the larger the forested patch is the larger the interior habitat would be. The shape of the forested patch is also important. Interior habitat is maximized when the shape of the forested patch is circular and minimized when the forested patch is linear. Some forested patches may be so narrow that they only provide edge habitat and no interior habitat.

LINKS

For detailed descriptions of disturbance processes and functions of the habitat groups in the Kootenai Subbasin, go to Appendix 43.

Click Here

Compared to the historical condition, there are several important changes in landscape patterns. Generally, patch sizes are smaller today than they were historically. Analysis on the Idaho Panhandle National Forests shows that early and late-successional patches are smaller and more homogenous in size than historic. Compared to the historical situation, the late successional structural stages are much more fragmented. They are divided into smaller patches with generally more edge and less interior and they are more homogeneous in patch size (fewer large patches). In contrast, the medium size class is a larger percent of the landscape; however, the large patches of medium size class are internally fragmented by numerous small patches of early successional stages created by timber harvest, or patches of medium-sized trees linked together by long skinny leave strips.

The Upper Kootenai Subbasin Review, an analysis conducted on the KNF, shows that patch sizes have decreased across all patch types, including early successional patches (USFS 2002). Corresponding with smaller patch sizes are less interior habitat and greater fragmentation. On the KNF, the cool and the moist habitat types seem to have deviated most from historic conditions although all habitat types have declined in amount and size of interior habitat (USFS 2002).

2.4.2 Human Alterations to Critical Coniferous Forest Functional Processes

Through fire exclusion, logging, the introduction of non-natives, climate change and other perturbations, Kootenai Subbasin forests have, over the last fifty to one hundred years, undergone a series of significant changes. The most important coarse-scale changes in coniferous forests include[26]:

1. The shift away from early seral species (species that generally need high quantities of sunlight to persist, i.e. more sun loving) to those that can tolerate denser and more shaded forest conditions. This condition is considered to be a factor in reducing the resilience and sustainability of the forest.

   - Beginning in the 1930s, the loss of western white pine in the more moist forest environments (due to the combination of mountain pine beetle, and subsequent white pine blister rust that can continue to cause massive mortality of this species) is particularly significant in forested ecosystems throughout the US portion of the subbasin. This forest type has been replaced by fairly large expanses of Douglas-fir, western hemlock, and fir/spruce/mountain hemlock type. Due to the current composition of dense forest conditions and the subsequent susceptibility to bark beetles and root disease, these current types will likely experience future insect, disease and fire disturbance that will effect sustainability of a large portion of the forest ecosystem.

   - A similar situation exists in the higher elevation settings of subbasin forests with whitebark pine. A combination of mountain pine beetle, whitepine blister rust and fire exclusion has resulted in a replacement to Engelmann spruce/subalpine fir forests. These dense, multi-storied forests are now highly susceptible to very large scale fires and have greatly declined levels of whitebark pine compared to 20-30 years ago.

   - In both the moist and cool potions of subbasin forests, the shade-intolerant western larch was much more prevalent than today. Large overstory western larch trees were a preferred species for historic logging, and with fire suppression, this species is in decline as a predominant forest type in many areas. This type has been replaced by dense Douglas-fir, and fir/spruce/mountain hemlock forest types that are much less resistant to insects, diseases, and moderate intensity fire.

[26] *Adapted from USFS KIPNF (2003)*

- Within the drier portions of subbasin forests, less large ponderosa pine are present than occurred historically. These large, relatively open grown pines were easily accessible to historic lower elevation logging and with the combination of subsequent fire suppression, many areas have been replaced by dense Douglas-fir. These current conditions are much more susceptible to Douglas-fir beetle, root disease, and severe wildfire.

2. A shift in forest structure including the pattern or arrangement of the forest communities has occurred, and could affect resilience and the sustainability of historic ecological relationships.

    - In some areas, increases in density have created conditions that make the forest more susceptible to insects, diseases, and severe wildfire, especially when one considers the species-compositional changes that have occurred during the same timeframe.

    - The pattern and arrangement of forest structures have changed as well. Due to the small-scale pattern of timber harvest during the past several decades, large, spatial "patches" historically common, are now replaced by smaller patches less typical of historical conditions.

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 (Figure 2.15).

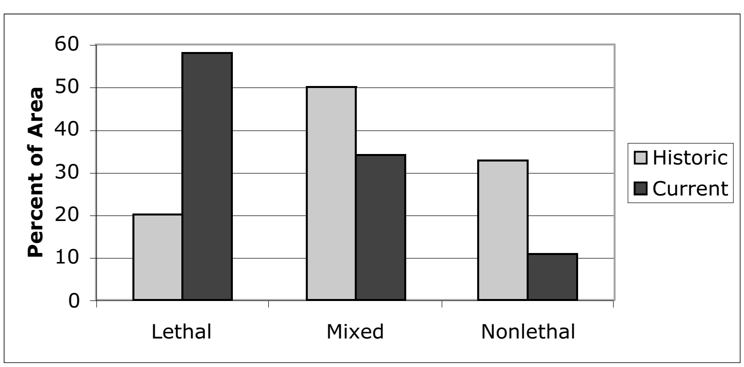

Figure 2.15. Fire severity for FS and BLM administered Forested Potential Vegetation Groups in western Montana and Idaho (after Quigley et al. 1996).

2.4.3 Presettlement Coniferous Forest Habitat Condition

Historically, approximately 20 percent of the overall, generalized landscape of the forests in the U.S. portion of the subbasin was in an "old growth", or late seral condition (Losensky 1993). The pattern (frequency and intensity) of disturbance events determined the distribution of this successional stage at any given point in time. In moist riparian areas and upper elevation cool, moist sites this old growth took the form of a multi-story, multi-age forest, while on warm, dry sites that experienced frequent, low-intensity fire events, stands were open and park-like and composed of mature trees with light understory. Twenty percent of the landscape was also in an early seral state (Losensky 1993), and in these stands, stand-replacing fires occurred at different rates and created different patch sizes. Intervals between stand-replacing events varied from 150 to 400 years in the cool, moist environment and 150 to 200 years in warm, moist habitats (Leavell 2000). The balance—sixty percent—of the U.S. portion of the subbasin is thought to have been in a varied, mixed-age, mixed-height, mixed-conifer, and mid-seral condition (Losensky 1993) (figures 2.13 and 2.14).

LINKS

For more information on historic forest conditions, see Appendix 46.

Click Here

For descriptions of the historic condition of Vegetation Response Unit Groups (analogous to PVGs), go to Appendix 44.

Click Here

The TBA assessment estimates presettlement coniferous (xeric and mesic) forest biome acres. Go to Appendix 80.

Click Here

Habitat Groups and VRUs

Table 2.15 summarizes the presettlement characteristics of Vegetation Response Unit (VRU) Groups in the U.S. portion of the Kootenai Subbasin (USFS KNF 1999).

Narrative and quantitative descriptions of the historic condition of Vegetation Response Unit Groups, which are analogous to Potential Vegetation Groups (PVGs), are provided in Appendix 44.

2.4.4 Present Coniferous Forest Habitat Condition

Basic information about current forest conditions for the Kootenai National Forest (forest types, habitat groups, number of trees, tree sizes, etc.) is summarized in Appendix 45 (an equivalent publication for the Idaho portion of the Kootenai is not available). Narrative and quantitative descriptions of the current condition of Vegetation Response Unit Groups, which are analogous to Potential Vegetation Groups (PVGs), are provided in Appendix 44. Maps showing the distribution of Vegetation Response Units for each geographical area in the U.S. portion of the subbasin can be found in Appendix 1.

Table 2.15. Summary of historic conditions of Vegetation Response Unit (VRU) Groups

VRU Group	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	<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 North aspect-nonuniform mixed severity 15-45 yr. FRI Nonuniform lethal stand replacement ave. 225 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 WL/LP with PP moist upland	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. Ave. basal area 60-100 sq.ft/ac
	3	Nonlethal, low severity 25-50 yr. FRI 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	5 to 50 ac	WL/DF/PP dry, lower elev WL/DF/LP moist, uplands	Variable gaps to large even-aged single storied patches to larger area multi-aged multistory and single story open grown stands. Ave. basal area 80-120 sq ft/ac, more in riparian areas. tpa ranged from 15-60
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,WRC,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

Table 2.15 (cont.). Summary of historic conditions of Vegetation Response Unit (VRU) Groups

VRU Group	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 vr. 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

Fire Disturbance Process

The Forest Service has been suppressing wildfires for many decades. Suppression efforts have been particularly effective for low and mixed-severity fires, virtually removing this agent as a significant disturbance process for the last 60 years. Rapid suppression of all fire starts has also removed most opportunity for fires to grow in size and intensity to become stand-replacing fires. For example, over the last 60 years on the northern portion of the IPNFs, there were only a few stand-replacing fires greater than 1,000 acres. Only two of those were greater than 10,000 acres, and they occurred in the same month during an extreme weather event.

The success of fire suppression efforts and the extent of resource management activities over the last 100 years has had a large influence on the structure and composition of forest and rangeland fuel conditions. The function and process of ecological systems has changed.

LINKS

For descriptions of the historic condition of Vegetation Response Unit Groups (analogous to PVGs), go to Appendix 44.

Click Here

For basic information about current forest conditions on the Kootenai National Forest, go to Appendix 45.

Click Here

Maps showing the distribution of Vegetation Response Units for each geographical area in the U.S. portion of the subbasin can be found in Appendix 1.

Click Here

Timber Harvesting

Timber harvests peaked on National Forest lands in the 1970s and then began to decline. Because of fire suppression, regeneration timber harvests are the current, predominant stand-replacing disturbance process. The majority of acres treated for timber harvest under the goals and objectives of the 1980s forest plans were even-age, regeneration prescriptions.

Regeneration harvest systems (clearcut, seed-tree, shelterwood) followed by prescribed fire can emulate to a certain degree some of the functions of stand-replacing fire, but not all of them. These silvicultural systems are generally successful in regenerating mixed species stands dominated by early successional shade-intolerant species. However, traditional regeneration harvest created unnaturally uniform conditions, and did not leave the scattered residual snags, residual live-tree patches and scattered fire-tolerant large live trees (larch and ponderosa pine) that were characteristic of historic fires. In addition, the size of regeneration harvest units (2 to 40 acres) has been much smaller than patches created by historic, natural-fire regimes. This is now beginning to change, with greater utilization of snag retention standards, new silvicultural systems such as irregular seed-tree and shelterwood systems with reserves, and increasing size of regeneration harvest units. Results of even-age, regeneration prescriptions primarily limited to 40 acres in size while deferring all acres in between from any disturbance have shaped the landscape and modified habitat and processes all across the KIPZ.

Salvage and partial cut harvesting (sanitation harvest, individual tree selection, commercial thin) somewhat emulate the effects of low and mixed-severity fire in terms of thinning stands. However, these harvest systems also differ from low and mixed-severity natural fire. The salvage and sanitation harvests remove larger dead and dying trees that historically remained to contribute to nutrient cycling, wildlife habitat, and aquatic functions. In most cases, partial cuts maintain a dense overstory canopy.

Road densities in the U.S. and Canadian portions of the subbasin are shown in figures 2.16 and 2.17. For a description of the effects of roads on focal and target species, see Trombulak and Frissell (2000).

Insects and Disease

With the impact of white-pine blister rust (an introduced disease) and the decrease in fire, the role of insects and pathogens as disturbance agents is growing and changing. White-pine blister rust accounts for major changes in forest successional patterns, having removed more than 90% of two conifer species (white pine and whitebark pine). With the absence of white pine and decreased amounts of ponderosa pine and larch, root pathogens have been transformed from thinning agents into major stand-change agents in Douglas-fir and true fir stands. Root pathogens now produce significant canopy openings on many sites. Depending upon the habitat type, root pathogens may either stall stands in a diseased shrub/ sapling/open pole successional stage, or strongly accelerate succession towards shade-tolerant species.

Bark beetles have also changed their role. Because there is more Douglas-fir relative to historical conditions, Douglas-fir bark beetles are now more important change agents than they were historically. In all but the driest habitat types, Douglas-fir bark beetles accelerate succession in the short-run, and in the long-run create fuel conditions and stand structures that may increase the risk of stand-replacing wildfires.

Native insects and pathogens are also now responsible for a relatively much larger proportion of forest disturbance than they were historically. The impact of all these insects and pathogens in the short-run is to strongly accelerate succession towards late seral, shade-tolerant tree species. A recent analysis of pathogen and insect impacts in ecoregion section M333d (Bitterroot Mountains Section) (Hagle et al. 2000) examined successional changes for the period 1935 to 1975. This analysis shows that in 40 years, pathogens and insects changed forest cover types to more late-successional, shade-tolerant tree species on over 80% of the area dominated by moist forest habitat types (Byler and Hagle 2000). The same analysis of insect and pathogen impacts also showed that almost 40% of the moist habitat type area analyzed was either stalled in small tree structures or was actually moving back towards the small tree structures as a result of the removal of the largest trees.

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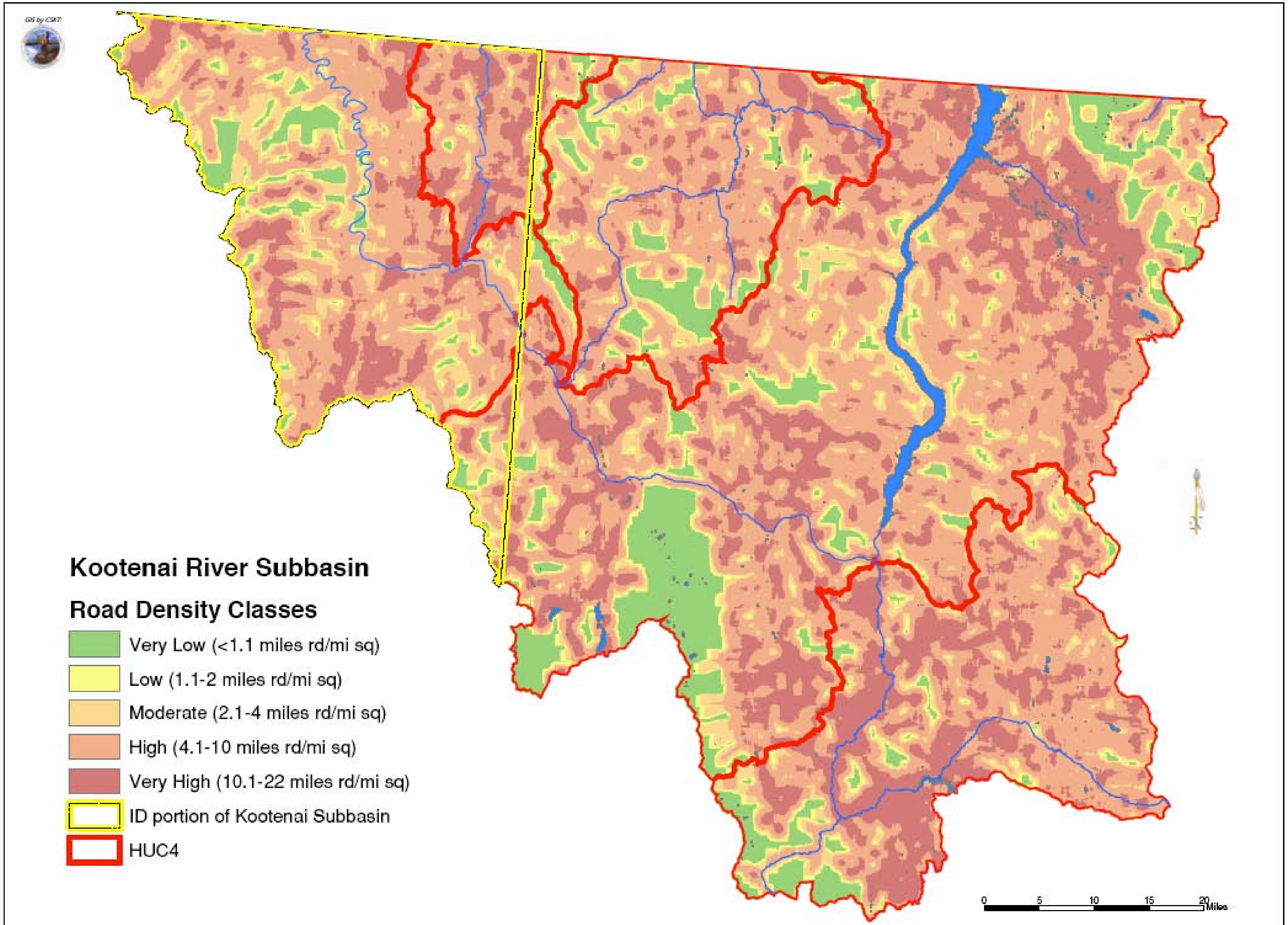

Figure 2.16. Road density in the U.S. portion of the Kootenai River Subbasin.

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Figure 2.17. Road density in the Canadian portion of the Kootenai River Subbasin.

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Vegetative Response Unit (VRU) Groups[27]

Warm/Dry VRU Group

A comparison of historic and existing forest cover types shows some changes and trends. In general, there is a decrease in seral species such as ponderosa pine and larch and an increase in Douglas-fir. This is most likely due to a combination of historic logging of seral ponderosa pine and larch and fire suppression, which allowed understory Douglas-fir to develop.

A comparison of historic and existing age-classes shows some changes and trends. In general, there is currently a higher proportion in the mid-successional stages and a lower proportion in the late-successional stages in comparison to historic conditions. This may be due to historic timber harvest of large overstory ponderosa pine and larch since many areas in this group were easily accessible for timber harvest in the early part of the 20th century. Many stands that were harvested then would now be in mid-successional stage.

Moist VRU Group

A comparison of historic and current cover types shows some changes and trends. Major changes are decreases in seral larch and white pine and increases in Douglas-fir and grand fir. The large decrease in white pine is most likely a result of white pine blister rust. The loss of larch may be due to historic logging of overstory larch. Douglas-fir and grand fir now dominate many stands in this group due to the removal of white pine and larch combined with effects of fire suppression.

A comparison of historic and existing age-classes shows some changes and trends. In general, there is an increase in mid-successional stages and a decrease in late-successional stages in comparison to historic conditions. As the most productive areas on the Forests, timber harvest activities have occurred throughout this group. In particular, older or decadent stands as well as disease-ridden white pine stands have been regenerated, which may be the reason for the decrease in the late-successional stage. In addition, portions of this group experienced stand-replacing fires in the late 1800s and early 1900s, which may contribute to the increase in the mid-successional stages.

Cool/Moist VRU Group

A comparison of historic and existing cover types shows some changes and general trends. Major changes are decreases in seral white pine, larch and to a lesser extent, lodgepole pine, and increases in Douglas-fir and spruce-subalpine fir.

[27] *Excerpted from USFS KIPNF (2003)*

The large decrease in white pine is most likely a result of white pine blister rust. Logging of overstory larch may contribute to the decrease in larch. The loss of lodgepole pine may be due to mountain pine beetle and subsequent salvage harvesting of dead and dying lodgepole pine stands. Spruce-subalpine fir and Douglas-fir now dominate many stands in this group with declines in seral white pine, larch, and lodgepole pine.

There are slight differences between the KNF and the IPNFs. On the IPNF, there are increases in the medium and large size classes and a decrease in the small size class. Areas in this group are highly productive and timber harvest activities have occurred here. In particular, older or decadent stands as well as insect and disease prone lodgepole pine and white pine stands have been regenerated, which may be the reason for the low proportion in the large/very large class. In addition, portions of this group experienced stand-replacing fires in the late 1800s and early 1900s, which may contribute to the high proportion in the medium successional stage.

LINKS

The TBA assessment estimates coniferous forest (xeric and mesic forest) biome acres and assesses various impacts by subunit. Go to Appendix 80.

Click Here

Cool/Cold VRU Group

Whitebark pine occurs in this group. Major changes here are decreases in whitebark pine and lodgepole pine and an increase in spruce-subalpine fir. Whitebark pine has declined dramatically due to white pine blister rust and fire suppression. The loss of lodgepole pine may be due to mountain pine beetle and fire suppression, as lodgepole pine tends to regenerate following stand-replacing fires. The proportions of spruce-subalpine fir and Douglas-fir may have increased due to fire suppression and natural succession from lodgepole pine stands.

There is an increase in medium size class and decreases in old growth and small size classes. These shifts may be due to the suppression of potentially stand-replacing fires.

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) will 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 such 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. Some tree crowns and large downed woody material will be left 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 have been reduced by mechanical treatments, and ponderosa pine forests will be managed for lower tree densities and fewer conifers in the understory than we see today.

As a result of these practices, biological diversity will have improved, as will have 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 have 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, structural, 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 Kootenai 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 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 that have grand fir, western hemlock/western redcedar, and subalpine fir understories increased well above historic levels.

- 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 Kootenai Subbasin is composed of Forest Cluster 4. No data was available for rating range clusters in the subbasin. The forest cluster ratings are summarized in table 2.16.

Table 2.16. Summary of ICEBMP ratings for Forest Cluster 4.

Forest Clusters	Primary Characteristics	Primary Risks to Ecological Integrity	Primary Opportunities to Address Risks to Integrity
Forest 4	1. Moist forest types	1. Hydrologic and aquatic systems from fire potentials	1. Restoration 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		

3. Fish and Wildlife Communities[1]

3.1 Presettlement and Historic Fish and Wildlife Communities

3.1.1 Historical Accounts of Populations and Habitats[2]

To understand the ecology of today's wildlife populations, it is important to consider past population dynamics, trends, and processes. Boas and Teit (1930) reported that the Native Americans in the Kootenai area hunted deer, elk, caribou, moose, mountain goat, mountain sheep, bear, and beaver. Tribal people prized marmot, ground squirrel, otter, muskrat, coyote, wolf and fox for their pelts and hunted birds for sustenance and plumage. They took grouse, ducks and geese for meat and eagles, hawks and woodpeckers for their plumage. This ethnographic study indicates that elk were abundant during presettlement times.

But even during presettlement times, humans caused changes in the structure, composition, and type of forested areas. Those changes in turn affected wildlife populations and habitat. Prehistoric humans influenced game and fish populations by hunting, and their use of fires probably increased open grazing and big game habitat (Barrett 1980; Barrett and Arno 1982).

Information from David Thompson's journals (1808-1812) suggests that historically, conifer vegetation (wildlife habitat) existed at lower stem densities and larger sizes than seen today. This condition would favor species like mule deer over white-tailed deer. Blocks of unfragmented forested habitat were much larger than today, which would have favored wide ranging species like wolverine, lynx, grizzly bear, cougar, and wolf.

David Thompson, of the Northwest Fur Company and the Hudson Bay Company recorded observations of mountain lion. He also hunted deer and geese. Native Americans traded pelts of beaver, bear, marten, elk, and deer. Vanek (1986) provides references to wildlife found on the Kootenai National Forest during the fur trade period. The list includes cougar, porcupine, weasel, mink, muskrat, bobcat, marten, marmot, beaver, coyote, gophers, mice, snowshoe rabbits, packrats, and bees. She also lists white-tailed and mule deer along with

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[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] *Adapted from USFS KNF (2002).*

black and grizzly bears as being present. Vanek points out that by the late 1880s mountain lions were trapped to near extinction.

With the arrival of the Northern Pacific Railroad in northwestern Montana (1883) came commercial meat and hide hunters, which took a toll on the large mammal populations (especially deer and elk). Reynolds (1905) makes reference to the scarcity of game found within the Kootenai National Forest area: " … at present large game of all kinds is pitiably scarce on the country where it once abounded. It is due, as usual, to the most unsportsmanlike slaughter carried on at anytime of year by practically everyone who carries a rifle into the hills." He further documents only one small band of caribou left; elk are very rare; moose are likely killed out; grizzly bear are very rare; and beaver, mountain lion, badger, and lynx are practically trapped out. Around the early 1800s elk numbers were approaching ten million throughout their range, and then market hunters essentially extirpated them from this part of the country. Today there are around 1 million elk in the United States (one tenth of the historic level).

Domestic sheep, cattle, and horses brought grazing pressure that modified plant succession (and thus wildlife habitat) in parts of the subbasin. Bear hunters were hired to reduce sheep losses, and they eradicated most of the black bears (Vanek 1975). Vanek also shows that mountain goats were all but eliminated by the early 1940s. In 1939, Abbot and Duvenack completed a study that showed that at the time, the Kootenai National Forest had a shortage of predatory animals.

An early Forest Service report (USFS 1925) indicates that on one part of the Forest " ... big game are confined to a few deer." According to the report there was ample range for game animals. Vanek (1975) documents that following the period of market hunters, elk were rare until after 1950, when transplanted elk (1951-52) began to disperse across the forest. Additional elk transplants (1952, 1960, and 1964) helped the elk population recover. Moose began to increase their numbers in the 1950s as well. The deer population, primarily mule deer, was also growing during this period (Couey 1972).

The historical record clearly indicates that large numbers of fur and game species were taken from the Forest between 1800 and the 1930s. Fur trappers, many of whom were aboriginals, worked most of the riparian areas of the West in the 19th century, heavily impacting populations of beaver and other furbearers. Although regulatory efforts to protect game species were initiated in the 1920s, predators were not protected by game laws and were extensively hunted. Populations of bear, mountain lion and wolf were dramatically reduced in the region (Baker et al. 1993).

Extirpation of some species (woodland caribou and Columbian sharptail grouse) has probably occurred on the Kootenai National Forest, but most species that were recorded historically are still present in some numbers. Reintroduction programs have occurred for elk, bighorn sheep, mountain goats, fisher, Columbian sharptail grouse, and fish. The existing grizzly bear population has also been augmented.

3.1.2 Circa 1850 Records of Species From IBIS

Appendix 47 lists terrestrial species thought to have occurred in the Kootenai 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 Flathead 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 19), plus those species known to have been extirpated (table 3.1), minus the species known to have been introduced (tables 3.2 and 3.3).

Table 3.1. Species extirpated within the Kootenai and Flathead Subbasins

Scientific Name	Common Name
Lepus townsendii [1]	White-tailed Jackrabbit
Phrynosoma douglassii [1]	Pygmy Short-horned Lizard
Columba fasciata [2]	Band-tailed Pigeon
Ectopistes migratorius [2]	Passenger Pigeon

[1] source IBIS Canada (http://habitat.cbt.org/)[3]
[2] source USFS KIPNF (2003)

LINKS

For the Idaho Conservation Data Center, which has species lists and information on species at risk in Idaho, go to http://fishandgame.idaho.gov/tech/CDC/

Click Here

For the Montana Natural Heritage Program website, which has species lists and information on species at risk in Montana, go to: http://nhp.nris.state.mt.us/

Click Here

3.1.3 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 according to two sources: the IBIS database[3] and the Kootenai and Idaho Panhandle National Forests. Table 3.2 lists those that were locally extirpated and subsequently reintroduced. Table 3.3 lists introduced terrestrial species. Table 3.4 lists introduced and hybridized fish species.

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[3] 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. The IBIS system for the Canadian portion of the Basin was developed through a cooperative effort with the IBIS group in the USA.

*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/)*

3.2 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

To compare total fish and wildlife community diversity across habitat types, we generated a list of the total number of terrestrial species using the Canadian IBIS database[3]. We then looked at the number of terrestrial species at risk in each of those habitat types and developed indices for each to indicate the proportion of species in each biome/habitat type that are at risk (table 3.5). This assessment targets several biomes (montane mixed conifer, ponderosa pine, riparian, wetland, and grasslands), and species-by-biome information for each is summarized in table 3.6 and figure 3.1.

Table 3.4. Non-native and hybridized fish species in the Kootenai subbasin. Source: MFWP 2003.

Name
Introduced Species
Bass
Black Bullhead
Brown Bullhead
Bluegill
Brook Trout
Brown Trout
Chinook Salmon
Coho Salmon
Golden Trout
Kokanee
Lake Trout
Largemouth Bass
Northern Pike
Pumpkinseed
Rainbow Trout
Sauger/Walleye
Smallmouth Bass
Sunfish
Yellow Perch
Hybrids
Brook X Bull Trout Hybrid
Rainbow X Cutthroat Trout
Redband X Rainbow Hybrid
Redband X Westslope Cutthroat
Yellowstone X Westslope Cutth.

LINKS

For a pre-1850 species list for the Kootenai Subbasin go to Appendix 47.

Click Here

Appendix 48 summarizes the changes that have occurred in wildlife habitats between presettlement times and the present.

Click Here

For a review of the literature on presettlement Kootenai hunting with information on relative abundance for a wide range of species, see: Smith, A.H. 1984. Kootenai Indian subsistence and Settlement Patterns. USACOE.

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, ponderosa pine (xeric forest), and mixed conifer (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).

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. Equivalent data are not available for the U.S. portion of the subbasin, although the Forest Service reports (USFS KIPNF 2003) that recent (since 1840) additions to the Kootenai and Idaho Panhandle National Forests include the European starling, English house

Table 3.5. The total species and the species at risk present within a given habitat type in the Kootenai and Flathead 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 Kootenai and Flathead subbasins.

IBIS Designa-tion	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 indecies were calculated.*

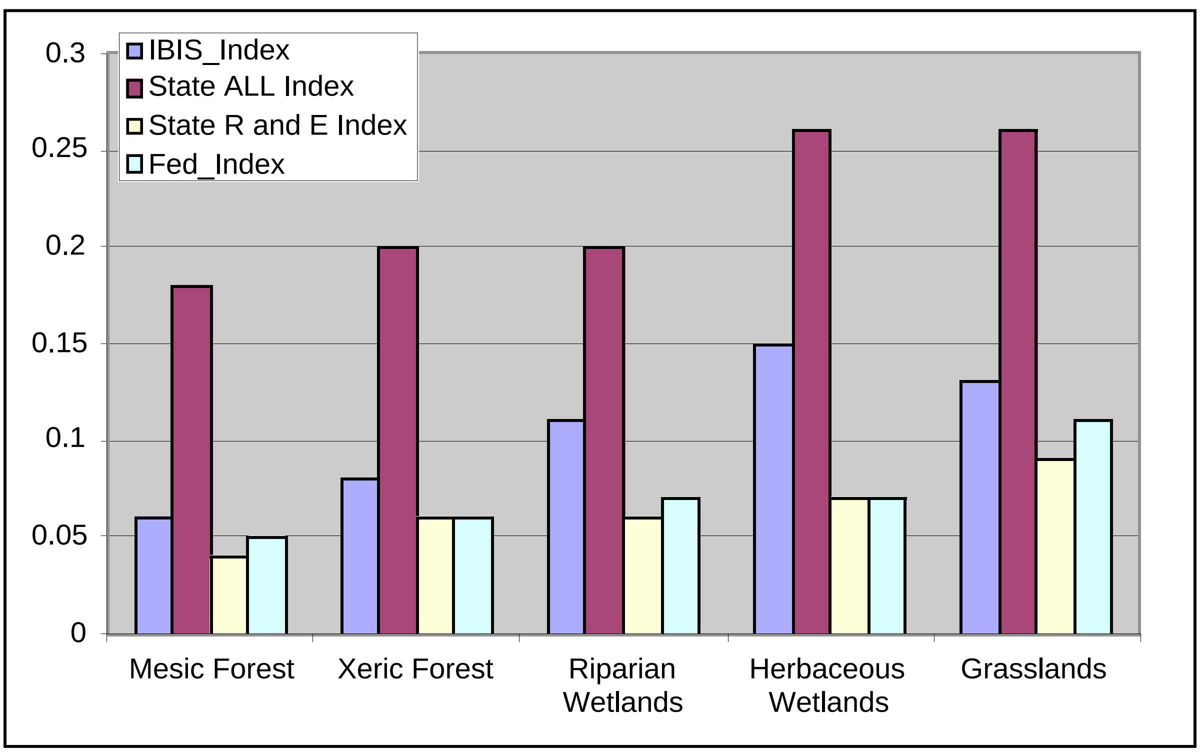

Figure 3.1. The percent of species at risk per total species in targeted biomes in the Kootenai and Flathead subbasins.

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

sparrow, rock dove, Merriam's turkey and ring-necked pheasant, and westward movement by the barred owl, blue jay, house mouse, and raccoon.

The types with the highest number of exotics in decreasing order are: agricultural and pasture areas, urban areas, grasslands, riparian wetlands, and shrub-steppe. Figure 3.2 shows the number of exotics by target biome.

3.3 Ecological Relationships

3.3.1 Number of Key Ecological Functions by Biome

The IBIS database identifies key ecological functions (KEFs) provided by each species listed in the database. Appendix 49 lists the number of KEFs found within each target biome. 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

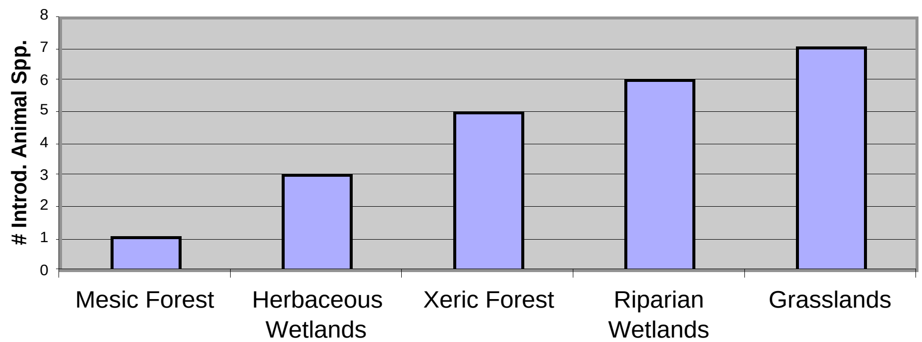

Figure 3.2. Non-native species by target biome (Source IBIS-Canada).

LINKS

Appendix 49 lists the number of key ecological functions (KEFs) by targeted biome.

Click Here

in the hierarchy (neither too general nor too specific) and for which definitions are well understood.

3.3.3 KEF Declines in Target Biomes

To identify possible declines in key ecological functions in the target biomes, we attempted to measure the impact on key ecological functions that have occurred as a result of human impacts on specific 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/habitat 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 a species providing a key ecological function, but the overall function of a habitat type could be maintained by other species performing a similar role in that biome or habitat type. With this caveat, determining the implications of species at risk effects on habitat function can serve to compare habitats in a general way and help identify restoration priorities.

The index of impact used here is the average of impacted KEF divided by the total KEFs for each General KEF category and normalized, such 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.

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.

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 3.5).

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, the Mesic Forest biome had the least impact of General KEF function followed by Xeric Forest, Riparian Wetlands, Grasslands, and Herbaceous Wetlands. The "Endangered Species" index and the "Any Impact" index ranked Mesic Forest as the least impacted followed by Riparian Wetlands, Xeric Forest, Herbaceous Wetlands, and Grasslands, with Grasslands being the most impacted.

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

Biome order	IBIS Status Index	Biome order	Endang-ered 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	conifer	5.96	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 Kootenai and Flathead 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 50 provides an explanation of the methodology for the specific KEF analysis used here.

Click Here

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

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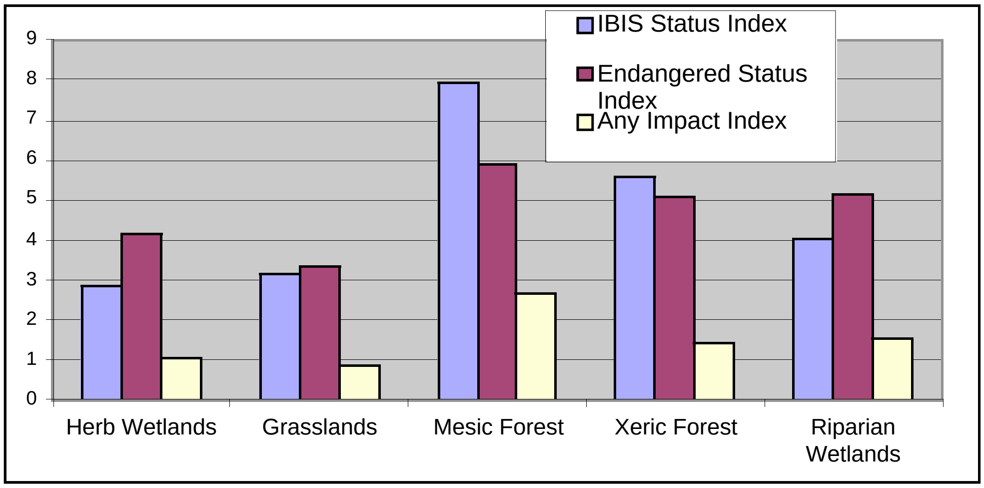

Figure 3.3. General KEF impact indices using three methods of impact assessment for targeted biomes in the Kootenai and Flathead Subbasins.

3.3.4 Functional Specialists

The IBIS-USA group performed an analysis of specific KEF functions (methodology is presented in Appendix 50). 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 subbasin planning process are listed in table 3.12.

[4] *Functional specialists are species that have only one or a very few number of key ecological functions. An example is the 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. Critical functional link species in the province (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*

LINKS

The results of our Key Ecological Correlate (KEC) analysis are presented in Appendix 51.

Click Here

3.3.5 Key Ecological Correlates (KECs)

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 IBIS-Canada 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 51. Table 1 of this appendix lists all of the KECs in the IBIS-Canada database. Table 2 of Appendix 51 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 51 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

[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.*

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 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

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	Average
1) Forest, Shrubland, & Grassland KECs	9%	11%	11%	7%	10%	**16%**	7%	8%	7%	**28%**	7%	8%	6%	8%	6%	**10%**
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%**

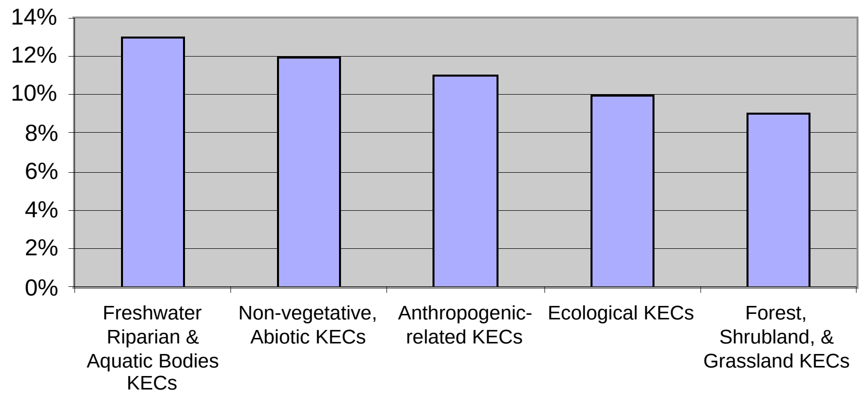

Figure 3.4. Percentage of the species in each main KEC category that are distressed (for those main KEC categories with distressed species).

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 51).

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 51 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. 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 to terrestrial vertebrates, 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 non-native 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

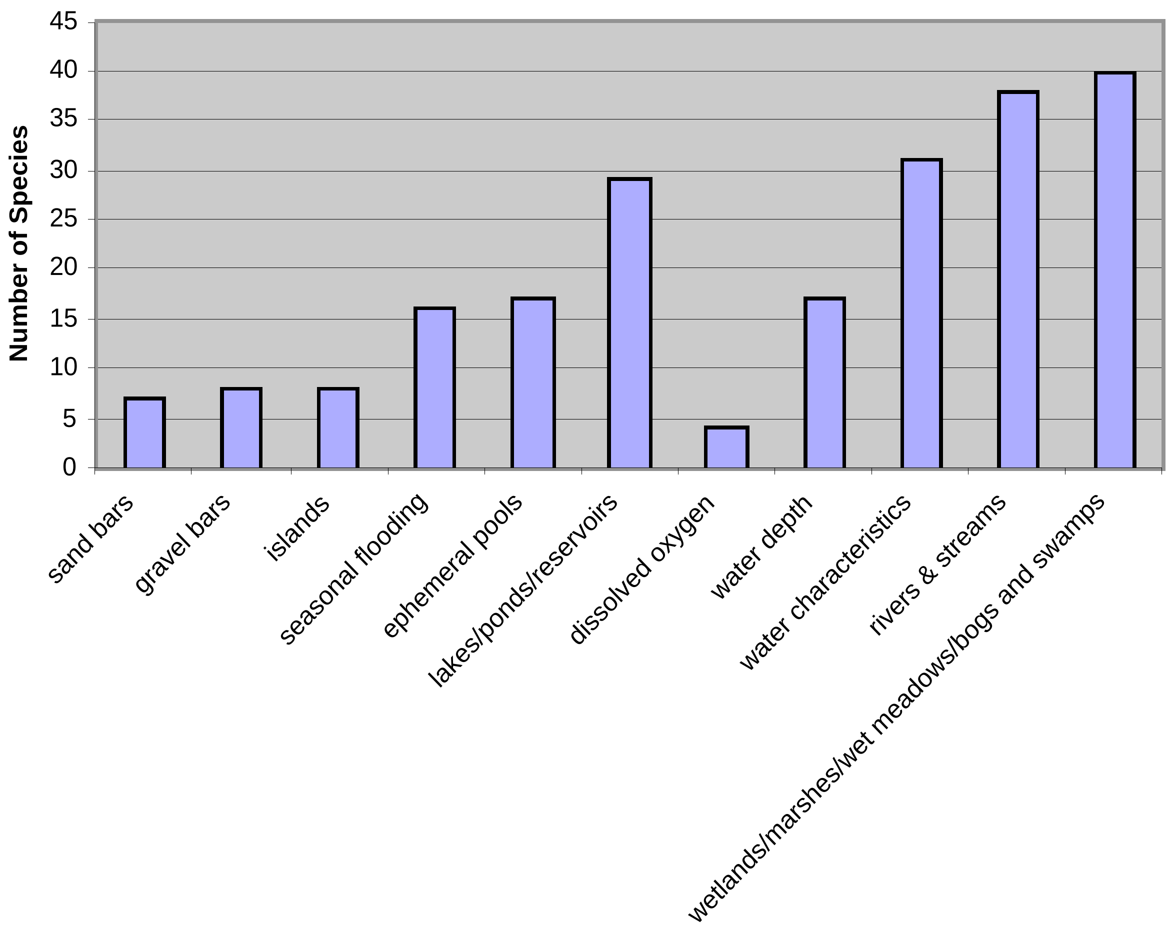

Figure 3.5. The number of Mountain Columbia Province terrestrial focal species with aquatic key environmental correlates.

fed on the millions of eggs buried in the gravel. Mink, otter, 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 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). On a smaller scale, a similar scenario has been playing itself out over the past couple decades in the upper Kootenai system with non-native kokanee populations in the Koocanusa Reservoir and in recent years in the lower Kootenai with the recent recovery of kokanee populations in the north arm of Kootenay Lake (B. Jamieson, pers. comm. 2004). Prior to their collapse, kokanee populations in the south arm of Kootenay Lake probably played a similar role in the lower Kootenai system as did adfluvial bull trout and westslope cutthroat trout. In all these cases, salmonids are conveying nutrients (lake-derived nitrogen and phosphorous) to tributaries upstream from one ecosystem (large lakes) to another (tributary streams) and from one biome to another.

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 Kootenai tied ecologically to salmonids.

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

KEFs Affected by the Loss of Salmonids

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

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

Common Name	Scientific Name
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*
Snowy Owl	*Nyctea scandiaca*
Belted Kingfisher	*Ceryle alcyon*
Birds (cont.)	
Willow Flycatcher	*Empidonax traillii*
Gray Jay	*Perisoreus canadensis*
Steller's Jay	*Cyanocitta stelleri*
Black-billed Magpie	*Pica pica*
American Crow	*Corvus brachyrhynchos*
Northwestern Crow	*Corvus caurinus*
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*
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*
White-tailed Deer (eastside)	*Odocoileus virginianus*
Reptiles	
Snapping Turtle	*Chelydra serpentina*
Western Terrestrial Garter Snake	*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 (*Salvelinus confluentus)*

4.1.1 Background

Reasons for Selection as Focal Species

Globally, the bull trout has 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 factor(s). 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 contiguous 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 threat(s); (3) the recovery potential is high; and (4) the degree of potential conflict during recovery is high (USFWS 2002).

The U.S. Forest Service lists bull trout as a sensitive species, primarily to emphasize habitat protection. The Idaho Panhandle National Forests have named bull trout as Management Indicator Species (MIS) in their Forest Plan 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 factor(s) making them very vulnerable to extinction throughout their range. Montana Department of Fish, Wildlife, and Parks (MFWP) has designated them 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.

LINKS

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

Click Here

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 distinct population segment (DPS) at the largest scale, to recovery units, to core areas, each of which are comprised of one to many local populations. 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 thorough definitions of these and other terms used in this section, go to Appendix 96.

Click Here

The Kootenai Tribe of Idaho and 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 of risk of extinction or extirpation at the national level, before being examined through the status assessment process. The B.C. Conservation Data Centre has blue-listed bull trout in British Columbia, which means 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 Resource Management 2003).

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 (BC Ministry of Forest 1997).

Bull trout are good indicators of aquatic ecosystem health. They have relatively strict habitat requirements. They require high quality, cold water; high levels of shade, undercut banks, and woody debris in streams; abundant gravel in riffles with low levels of fine sediments; stable, complex stream channels; and connectivity among and between drainages (USFWS 2002). 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, impacts in any single component can potentially affect bull trout. Because of this and their status, we have selected bull trout as a focal species in this assessment.

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 Montana portion of the Kootenai 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 various bull trout reports from the B.C. Ministry of Water, Land, and Air Protection, go to Appendix 113.

Click Here

Summary of population and current distribution data[1]

In the final ESA listing rule for bull trout, five subpopulations were recognized within the Kootenai River Subbasin (USFWS 1998). These included three portions of the mainstem system: (1) Upper—upstream from Libby Dam, (2) Middle—from Libby Dam downstream to Kootenai Falls, and (3) Lower— downstream

[1] *As mentioned previously, 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.*

from Kootenai Falls through Idaho to the United States/Canada border. The two disconnected subpopulations (referred to as disjunct by the Montana Bull Trout Scientific Group), in Bull Lake (MBTSG 1996b) and Sophie Lake (MBTSG 1996c), were considered separate subpopulations. At the time of listing, all Kootenai River bull trout subpopulations were considered to have unknown status and population trend, and the Sophie Lake subpopulation was considered to be at risk of stochastic extirpation due to its single spawning stream and small population size.

In its Bull Trout Draft Recovery Plan, the USFWS 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 Kootenai River Recovery Unit forms part of the range of the Columbia River population segment. The Kootenai River Recovery Unit includes 4 core areas (figure 4.1) and about 10 currently identified local populations.

In recent years, emphasis for the Kootenai River Subbasin has been placed on determining abundance through redd counts[2, 3]. Table 4.1 summarizes the status of redd count information from 1996 to 2000 for the four core areas in the Kootenai River recovery unit. Redd counts represent an unknown but substantial portion of the possible spawning population. Three of the four core areas have an established history of redd count trend information for migratory fish. Eight streams in the United States and three in Canada are now being monitored, with index redd counts conducted on an annual basis. Table 4.2 summarizes this information. In addition, six bull trout redds were counted in Goat Creek (a tributary of Callahan Creek, Montana) in 2003, the first year this stream was surveyed (A. Rief, USFS, unpublished data). Information for the Idaho portion of the subbasin is presented in tables 4.3 and 4.4. Redd counts have traditionally been conducted only for migratory fish. In some drainages, there are likely to be additional resident bull trout spawners whose redds are smaller than those of migratory fish, therefore difficult to identify in streams where brook trout exist. They have not been included in these totals. On the Wigwam River, five permanent monitoring sites were established in 2000 to evaluate juvenile abundance (Cope and Morris 2001). Juvenile abundance has also been monitored at three sites on Skookumchuck Creek for two years (Cope 2003 and Cope 2004 in prep), two sites on the White River, and at

LINKS

For a map showing current bull trout distribution and restoration and core habitat areas within the Montana portion of the Kootenai, go to Appendix 52.

Click Here

USFS bull trout distribution maps for the Kootenai Subbasin portion of the Idaho Panhandle and Kootenai National Forests are included in Appendix 1.

Click Here

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[2] *The Bull Trout Draft Recovery Plan states: Because of the large size of the migratory fish and the geology of the streams (which generally makes the redds easy to recognize), redd counts (Spalding 1997) have been shown to provide a repeatable method of indexing spawner escapement in many streams in this recovery unit (Rieman and McIntyre 1996). However, several authors have cautioned that redd counts should not be relied upon as the sole method of population monitoring (Rieman and Myers 1997, Maxell 1999) and may, in fact, lead to erroneous conclusions about population status and trend.*

[3] *Adapted from the Bull Trout Draft Recovery Plan (2003).*

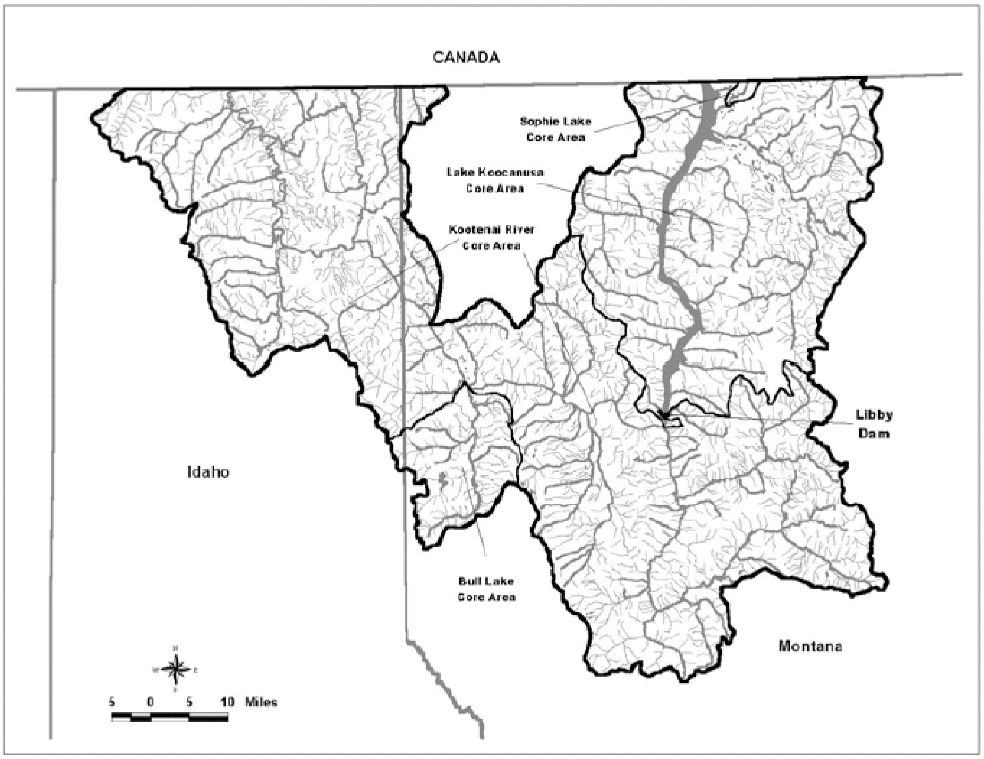

Figure 4.1. The Kootenai River Recovery Unit showing Core Areas Source: Bull Trout Draft Recovery Plan (USFWS 2002b).

LINKS

For bull trout information in the Kootenai Subbasin 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

Table 4.1. Summary of redd count information for migratory adults in the four bull trout core areas in the Kootenai River Recovery Unit.

Core Area Name	Drainage Basin (approx. square kilometers)	# of Local Populations Monitored	Mean Total # of Redds Counted (1996-2000)
Lake Koocanusa (Upper Kootenai)	270 (U.S. Only)	2 (1 in Canada)	848
Kootenay Lake and River (Lower Kootenai)	1230 (U.S. Only)	4	165
Sophie Lake	12	0	----
Bull Lake	130	1	83

Table 4.2. Summary of Montana and Idaho Kootenai River bull trout redd surveys for all index tributaries, 1993-2003. Source: MFWP and IDFG .

	93	94	95	96	97	98	99[b]	2000	2001	2002	2003
Stream	**Number of Redds**										
Grave Creek Includes (Clarence) and (Blue Sky) Creeks			15[g]	35 (5) (6)	49 (6) (1)	66 (13) (1)	134 (39) (10)	97 (9) (1)	173 (29) (13)	199 (38) (5)	245 (52) (20)
Quartz Creek Includes (West Fork)			67 (26)	47 (42)	69 (39)	105 (72)	102 (88)	91 (39)	154 (109)	62[e] (10)	55 (26)
O'Brien Creek			22	12	36	47	37	34	47	45	46
Pipe Creek			5	17	26	34	36	30	6[a]	11	10
Bear			6	10	13	22	36	23	4[e]	17	14
Keeler includes (North Frk) and (South Fork)				74	59 (18) (16)	92 (43) (10)	99 (52) (5)	90 (82) (5)	13[d] (4) (0)	102 (75) (0)	87 (26) (0)
Wigwam (U.S.) Includes Bighorn, Desolation, Lodepole Creeks			247	512 (12)	598 (17)	679 (6)	849 (21)	1195 (9)	1496 (19)	1892 (11)	2053 (10)
Other B.C. Includes (Skookumchuk) (White) (Blackfoot)					66 (66)	105 (105)	161 (161)	189 (189)	298 (132) (166)	404 (143) (153) (108)	373 (134) (143) (96)
West Fisher (USFS)	2	0	3	4	0	8	18	23	1	1	1
Callahan Creek (IDFG) (North) and (South Callahan) not mainstem										(13)f (14)	(32) (10)
Goat Creek (Callahan drainage in MT)											6

a Human-built dam below traditional spawning area.

b Included resident and migratory redds.

c Libby Creek dewatered at highway 2 bridge below spawning sites during spawning run.

d Beavers dammed lower portion during low flows, dam was removed but high water made accurate redd counts impossible.

e Log jam may have been a partial barrier.

f The 2002 survey on N. Callahan Creek was less extensive than in 2003.

g High flows.

• Note that during low-water years, beavers in some streams (Keeler, Pipe, Quartz) have an opportunity to build dams across the entire stream rather than just in side channels. Some bull trout migrate upstream before dam construction is complete, most either try to build redds below dams or appear to leave he streams entirely. This happened in Keeler Creek and Pipe Creek in 2001.

• Construction of dams by human for swimming is a chronic problem in Libby and Pipe Creeks. They usually are not complete barriers except during low water years. Also, in 2001, Libby Creek was dry for more than a mile during the spawning run. This probably accounts for the low numbers of redds counted relative to the previous years.

• In 2001, additional streams in B.C. Were surveyed either by plane or on foot. They include Skookumchuck (143), Middle Fork White River (197), Verdant Creek in Kootenay National Park (31), Blackfoot Creek, tributary to White River (50).

Table 4.3. Idaho Department of Fish and Game documented bull trout distribution in Kootenai River tributaries in Idaho through 2003. Streams where redd surveys were conducted are included even if no bull trout were observed. Source: IDFG.

Date	Stream	Method	# of Bull Trout	Total Length (mm)	Water Temp °C	Sourcea	Comments
10/13/99	Ball Cr.	Redd Survey	0			Walters and Downs 2001	
7/11/00	Boulder Cr.	Drift Net	1	120	11.5	Walters 2002	
8/23/00	Boulder Cr.	Snorkel	1	170	15	Walters 2002	Estimated size
10/4/00	Boulder Cr.	Redd Survey	0			Walters 2002	
10/18/00	Boulder Cr.	Redd Survey	0			Walters 2002	
8/16/01	Boulder Cr.	Snorkel	1	300	15	Walters 2003	Estimated Size
Sept-Oct 2001	Boulder Cr.	Redd Survey	0			Walters 2003	2 bull trout redds
8/14/02	Boulder Cr.	Snorkel	1	150	16.5	IDFG unpubl.	Estimated Size
8/16/02	Boulder Cr.	Snorkel	1	120	14.5	IDFG unpubl.	Estimated Size
8/16/02	Boulder Cr.	Snorkel	1	170	14.5	IDFG unpubl.	Estimated Size
Sept-Oct 2002	Boulder Cr.	Redd Survey	2		6.5	IDFG unpubl.	2 bull trout redds
10/18/99	Boundary Cr.	Redd Survey	0			Walters and Downs 2001	
9/27/00	Boundary Cr.	Redd Survey	0			Walters 2002	
10/2/00	Boundary Cr.	Redd Survey	0			Walters 2002	
10/6/00	Boundary Cr.	Redd Survey	0			Walters 2002	
Jul-Aug 98	Caboose Cr.	e-fish	1		13	Downs 2000	
Summer 1999	Caboose Cr.	e-fish	2		13	Walters and Downs 2001	
10/19/99	Caribou Cr.	Redd Survey	0			Walters and Downs 2001	
10/19/00	Caribou Cr.	Redd Survey	0			Walters 2002	
10/23/01	Caribou Cr.	Redd Survey	0			Walters 2003	
July-Aug 93	Caribou Cr.	e-fish	1			Paragamian 1994	
8/9/00	Curley Cr.	e-fish	1	124	19	Walters 2002	
10/2/02	Curley Cr.	Redd Survey	0			IDFG unpubl.	
1980-82	Curley Cr.	e-fish	1			Partridge 1983	Length not reported
July-Aug 98	Curley Cr.	e-fish	1		22	Downs 2000	
10/4/00	Curley Cr.	Redd Survey	0			Walters 2002	
Summer 1999	Debt Cr.	e-fish	1			Walters and Downs 2001	

Table 4.3 (cont.). Idaho Department of Fish and Game documented bull trout distribution in Kootenai River tributaries in Idaho through 2003. Streams where redd surveys were conducted are included even if no bull trout were observed. Source: IDFG.

Date	Stream	Method	# of Bull Trout	Total Length (mm)	Water Temp °C	Sourcea	Comments
1980-82	Deep Cr.	Observed	?			Partridge 1983	Number seen not reported
10/13/99	Fisher Cr.	Redd Survey	0			Walters and Downs 2001	
10/13/99	Long Canyon Cr.	Redd Survey	0			Walters and Downs 2001	
10/5/00	Long Canyon Cr.	Redd Survey	0			Walters 2002	
10/11/00	Long Canyon Cr.	Redd Survey	0			Walters 2002	
Jul-Aug 94	Long Canyon Cr.	e-fish	1			Paragamian 1995	
10/3/00	Moyie R.	Redd Survey	0			Walters 2002	
10/16/00	Moyie R.	Redd Survey	0			Walters 2002	
Sept-Oct 2001	Moyie R.	Redd Survey	0			Walters 2003	
10/13/99	Myrtle Cr.	Redd Survey	0			Walters and Downs 2001	
8/25/97	Myrtle Cr.	Snorkle	1	125		Downs 1999	
9/20/00	Myrtle Cr.	Redd Survey	0			Walters 2002	
10/7/02	N. Callahan Cr.	Redd Survey	4			IDFG unpubl.	
10/16/02	N. Callahan Cr.	Redd Survey	1		4	IDFG unpubl.	13 bull trout redds in 2002
9/16/03	N. Callahan Cr.	Redd Survey	2		8.5	IDFG unpubl.	
9/24/03	N. Callahan Cr.	Redd Survey	10		8	IDFG unpubl.	
9/30/03	N. Callahan Cr.	Redd Survey	2		7	IDFG unpubl.	32 bull trout redds in 2003
10/13/99	Parker Cr.	Redd Survey	0			Walters and Downs 2001	
10/5/00	Parker Cr.	Redd Survey	0			Walters 2002	
9/24/02	S. Callahan Cr.	Redd Survey	3		8	IDFG unpubl.	
9/25/02	S. Callahan Cr.	Redd Survey	16		7.5	IDFG unpubl.	
10/3/02	S. Callahan Cr.	Redd Survey	1		6.5	IDFG unpubl.	
10/17/02	S. Callahan Cr.	Redd Survey	0			IDFG unpubl.	4 bull trout redds in 2002
9/15/03	S. Callahan Cr.	Redd Survey	2		10	IDFG unpubl.	
9/25/03	S. Callahan Cr.	Redd Survey	3		8.5	IDFG unpubl.	10 bull trout redds in 2003
10/5/99	Snow Cr.		0			Walters and Downs 2001	
10/19/00	Snow Cr.		0			Walters 2002	
10/23/01	Snow Cr.		0			Walters 2003	
Jul-Aug 93	Snow Cr.	e-fish	1			Paragamian 1994	

Table 4.4. Estimated historic and current distribution of bull trout in the Idaho portion of the Kootenai.

Watershed	HUC Code	Bull Trout Distribution Historic (Prior to 1985)	Current (Since 1985)	Area of Sub-Watershed mi^2
Kootenai River		**P**	**SAR**	
Callahan Creek		P	SER	
Star Creek		U	U	
Boulder Cr	1701010407	SNF	SER	63.3
EF Boulder Cr	170101040707	U	SNP	15.5
Boulder Cr abv EF	170101040709	U	SNP	31.9
Curly Cr	1.70101E+13	P	SSR	11.4
Moyie River	17010105	U	SAR	204.8
American Cr	170101050208	U	U	12.8
Canuck Cr	170101050205	U	U	15.0
Spruce Cr	17010105020030	U	SNF	7.6
Round Prarie Cr	170101050201	U	SNF	37.5
Meadow Cr	170101050104	U	SNF	24.3
Placer Cr	17010105010209	U	SNF	3.9
Deer Cr	170101050106	P	SSR	30.8
Skin Cr	17010105010209	U	U	10.2
Cow Cr	1.70101E+13	U	U	11.4
Fry Cr	1701010404	U	U	50.8
Deep Cr	1701010408	P	SSR	184.0
Dodge Cr	1701010408070720	U	SNF	11.5
Trail Cr	17010104080705	U	SNF	16.2
Fall Cr	17010104080709	U	SNF	22.2
Ruby Cr	170101040809	U	SNF	14.9
Twentymile Cr	17010104080507	U	SNF	10.0
Brown Cr	170101040805	U	U	25.6
Caribou Cr	170101040810	P	SSR	13.1
Snow Cr	170101040812	P	SSR	17.9
Myrtle Cr	1701010409	P	SSR	42.9
Ball Cr	1701010410	U	SNF	26.8
Fleming Cr	170101040310	U	U	18.6
Rock Cr	170101040301	P	SSR	16.4
Trout Cr	170101040214	P	SSR	19.5
Mission Cr	170101040203	U	SNF	30.9
Parker Cr	170101040110	P	SSR	16.4
Long Canyon Cr	1701010411	P	SSR	30.3
Smith Cr	1701010412	U	SNF	71.6
Smith Cr abv Cow Cr	17010104120111	U	SNP	30.7
Cow Cr	17010104120113	U	SNP	21.9
Boundary Cr	1701010414	SSR	SNF	94.6
Boundary Cr abv Blue Joe	170101041415	SSR	SNF	10.5
Blue Joe Cr	170101041412	SSR	SNF	10.7
Grass Cr	170101041409	SSR	SNF	27.4
Saddle Cr	170101041405	SSR	SNF	10.3
Kootenai Drainage, ID	17010104, 17010105			1081

SER = Spawning/Early Rearing.
SSR = Suspected Spawning/Rearing,
SAR = Sub Adult and Adult Rearing.
SNF = Surveyed, Not Found.
SNP = Suspected Not Present.
P = Historically Present.
U = Unknown.

one site on Blackfoot Creek for one year (Cope 2004 in prep). On the Wigwam River, five permanent monitoring sites were established in 2000 to evaluate juvenile abundance (Cope and Morris 2001). In North and South Callahan Creeks, estimated minimum densities were 5.3 fish/100m^2 and 4.2 fish/100m^2, respectively during August 2003 (Idaho Department of Fish and Game unpublished data). Much of the following narrative summary of population and current distribution data for Kootenai River Core Areas is excerpted from USFWS (2002b).

Koocanusa Reservoir Core Area

The population in the Canadian headwaters of Koocanusa Reservoir is believed to be one of the strongest metapopulation in existence (Marotz, B. MFWP, pers. comm. 2000). Adult bull trout reach large sizes in Koocanusa Reservoir. Researchers noted higher growth in bull trout through age four in Koocanusa Reservoir than for bull trout from Flathead Lake and Hungry Horse Reservoir (MBTSG 1996c). Radio telemetry studies involving 36 adult bull trout surgically implanted with tags at the Wigwam River weir in 1996 to 1998 showed that post-spawning adult fish generally wintered in Koocanusa Reservoir in Montana (Baxter and Westover 2000). Before making the spawning run in the Kootenay River, the fish gathered off the mouth of the Elk River during late May and early June. Between mid-June and mid-July, most were in the lower reaches of the Elk River, and by the end of July they entered the Wigwam River. Spawning peaked the last week of September, and adults were back in the Kootenay River or Koocanusa Reservoir by the end of October (Baxter and Westover 2000).

Bull trout redd counts have 9 and 10 years of consecutive data in Wigwam and Grave Creek, respectively, and both indicate an significantly increasing population trend. Surveys in British Columbia's Wigwam River drainage began in 1978, but were sporadic until recently. Gill netting trend data from Koocanusa Reservoir has been collected since reservoir construction and are significantly correlated to redd counts and indicate that the Koocanusa bull trout population is increasing.

Upstream from Libby Dam, bull trout from Koocanusa Reservoir also utilize the Grave Creek drainage in the United States for spawning and rearing. The Tobacco River provides the migration corridor between the reservoir and Grave Creek. The redd count information presently available for Grave Creek suggests this local population is increasing in concert with other waters supporting adfluvial runs from Lake Koocanusa.

Redd searches have been conducted on other Koocanusa Reservoir tributaries in the United States, including Five Mile, Cripple Horse, Bristol, Warland, Williams, Lewis, Stahl, and Barron creeks. Field crews have not found redds, and bull trout presence in these and other United States tributaries is described as "incidental" (MBTSG 1996c).

LINKS

QHA 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 Kootenai. These data are a compilation put together by our Technical Team. Go to Appendix 32 and 33.

Click Here

Appendix 54 also provides narrative information on bull trout status and distribution for much of the Montana portion of the Kootenai.

Click Here

Bull Trout distribution and abundance information for the Upper Kootenai in Montana is summarized in Appendix 55.

Click Here

Appendix 91 presents the results of the Upper Kootenay River Bull Trout Radio Telemetry Project (2000-2003).

Click Here

In 1978, British Columbia Ministry of Water, Land, and Air Protection first monitored spawning bull trout in the upper Wigwam River and Bighorn (Ram) Creek, using migrant traps (Oliver 1979). Between July and October 1978, 515 adult bull trout passed upstream through the traps. During the next survey, in 1995, 247 bull trout redds were identified on the Wigwam River system in British Columbia. Since 1995, a trapping study has indicated that the numbers of bull trout that spawn in the Wigwam River are increasing. Baxter *et al.* (2000) reported the capture of between 616 and 978 adult bull trout annually during 1996 to 1999 at a weir on the Wigwam River. The weir was operated to catch migrating and post-spawning adults in the fall. Due to the location of the weir, these counts represent only a portion of the total numbers of fish using that drainage. Ground surveys conducted from 1994 to 2003 found increasing numbers of bull trout redds in the Wigwam River drainage (figure 4.2). Baxter and Westover (2000) state that the Wigwam River is arguably "the most prolific bull trout population in the species distributional range."

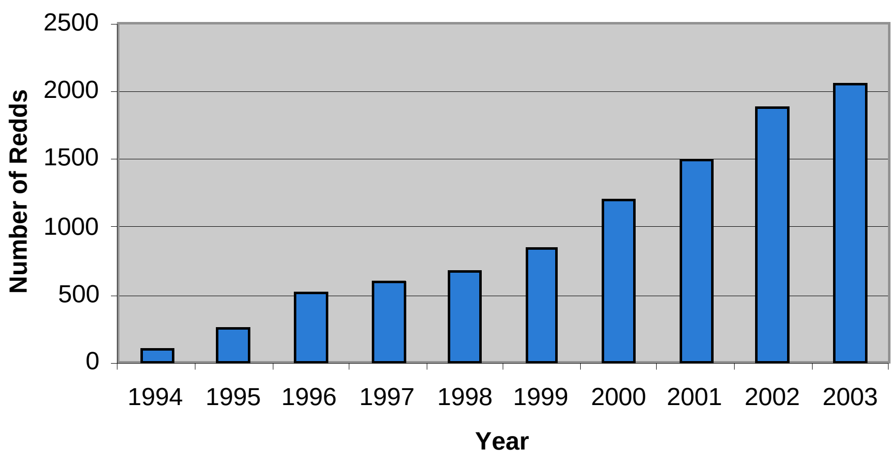

Figure 4.2. Bull trout redd counts, 1994-2003 (Bill Westover, BCWLAP pers. comm. 2003)

Spawning by migratory bull trout is also known to occur in British Columbia in several upper Kootenay River tributaries, including Gold Creek, Bull River, St. Mary River, Skookumchuck Creek, Lussier River, White River, Kikomun Creek, and Findlay Creek (B. Westover, British Columbia Ministry of Water, Land, and Air Protection, pers. comm., 2001). Numbers of fish and location of spawning activity in these drainages are currently being examined. A study using radio telemetry to find other spawning concentrations and track movements of bull trout in the upper Kootenay has recently been completed (Westover 2004 in prep). Redd counts have been established on index reaches of several streams (Westover, pers. Comm. 2003) In Skookumchuck Creek, bull trout redds have steadily increased, from 66 in 1997 to 143 in 2002 and 134 in 2003. In the index reach of the Middle Fork White River, 67 redds were located in 2000, increasing to 166 in 2001, 153 in 2002, and 143 in 2003. In the index reach of Blackfoot Creek 108 redds were located in 2002 and 96 in 2003. Both fluvial and adfluvial (from Koocanusa Reservoir) bull trout were tracked into the same spawning streams (B. Westover pers. Comm. 2004).

Five juvenile bull trout monitoring sites were established in the Wigwam River basin in 2000. Bull trout represented 92.4 percent of the catch, and the mean density of juvenile bull trout was estimated to be 17.2 fish per 100 square meters, indicating a very high population density for this species (Cope and Morris 2001). Mean density of juvenile bull trout on Skookumchuck Creek ranged from 0.8 – 9.7 fish/100m ≤ in 2002 (Cope 2003)and from 1.5 – 36.3 fish/100m ≤ on the White River and Blackfoot Creek in 2003 (Cope 2004 in prep).

Kootenai River / Kootenay Lake Core Area

Bull trout are widely distributed through the lower Kootenai River, from Libby Dam downstream to Kootenay Lake in British Columbia. Spawning and rearing by migratory adults occur in tributaries draining portions of British Columbia, Idaho, and Montana (Figure 4). These migratory fish spend their adult lives in Kootenay Lake or the Kootenai River. Libby Dam is an impassable barrier to upstream migration.

Spawning and rearing of migratory bull trout have been documented in four tributaries of the Kootenai River between Libby Dam and Kootenai Falls (Quartz, Pipe, and Libby creeks and the Fisher River). These migratory fish spend their adult lives in the Kootenai River or Kootenay Lake. Tagging studies had previously confirmed that fish from above the falls sometimes moved downstream over Kootenai Falls (Marotz et al. 1988). Kootenai Falls is not a complete barrier, but rather a substantial barrier to upstream bull trout movement. The most recent and extensive telemetry study (Dunnigan et al. 2003) found that out of 58 radio tagged bull trout captured and subsequently tagged (and released) above Kootenai Falls, 22 (38 percent) migrated over the falls after tagging. Of these 22 fish, only one bull trout ascended the falls.

The most heavily used spawning and rearing stream for bull trout between Kootenai Falls and Libby Dam is in the Quartz Creek drainage (MBTSG 1996a). Between 1994 and 2003, this drainage supported from 47 to 154 redds annually. Most of the redds were observed in the West Fork of Quartz Creek. The remaining redds were observed in Quartz Creek downstream from the confluence with the

West Fork. Personnel from MFWP and the Kootenai National Forest have conducted inventories of bull trout spawning sites on several other tributaries to the Kootenai River between Libby Dam and Kootenai Falls. These include Pipe, Granite, Libby, Midas, and Dunn creeks and the Fisher River drainage. Pipe Creek (5 to 36 redds in 1991 to 2003) and Bear Creek, a tributary to Libby Creek (4 to 36 redds in 1995 to 2003) support annual bull trout spawning. Resident bull trout are also suspected to be present in tributaries to Libby Creek, such as Big Cherry Creek. They also exist in Libby Creek above Libby Falls. During the late 1980s, several tributaries of Libby Creek were sampled, and bull trout were found in Poorman Creek and Ramsey Creek, but not in Little Cherry Creek (MBTSG 1996a).

In the Fisher River, low numbers of adult migratory bull trout have been documented (MBTSG 1996a). In 1993, redd counts were completed on 13 streams in the Fisher River drainage. A total of 13 suspected bull trout redds were observed (4 in the East Fisher River, 8 in Silver Butte Fisher River, and 1 in the Fisher River). In 1999, 18 redds were found in West Fisher Creek, and 23 were counted there in 2000. Between 2001 and 2003, only a single redd was located in West Fisher Creek each year, reflecting a fair amount of instability in the numbers of adult bull trout spawning in this drainage. The majority of streams surveyed contained potential obstacles to fish passage (including beaver dams, log jams, and falls), and few suitable spawning sites exist due to the high gradient, the large streambed substrate, low pool/riffle ratio, and subterranean water flow.

The most important spawning and rearing stream in the Montana portion of the Kootenai River downstream from Kootenai Falls is O'Brien Creek (MBTSG 1996b). From June to September 1992, the Montana Fish, Wildlife and Parks operated an upstream trap in O'Brien Creek. During this period, 20 adult bull trout were captured in the trap. Because of the relatively large size of adults captured (up to 76 centimeters [30 inches]), these fish were probably migrants from the Kootenai River or Kootenay Lake (MBTSG 1996b). Since 1992, spawning site inventories have been completed annually in O'Brien Creek, and 12 to 47 redds have been counted (table 4.2). Resident bull trout are also suspected to occur in O'Brien Creek, but have not been confirmed. Brook trout are present in O'Brien Creek, and 87 probable brook trout redds (species determination was based on size, timing, and observation of fish on redds) were recorded in 1994 (MBTSG 1996b). Brook trout hybridization with bull trout is suspected in O'Brien Creek.

During 1992, Montana Fish, Wildlife and Parks conducted redd searches in several other Montana tributaries to the Kootenai River below Kootenai Falls, including Callahan, Ruby, and Star creeks and the Yaak River. Field crews found no redds in the Yaak River, from its junction with the Kootenai River to Yaak Falls, a barrier falls located approximately 11 kilometers (7 miles) upstream

(MBTSG 1996b). The channel through this area is high gradient and composed of large substrate. The Yaak River is a large system with average discharges around 4.25 to 5.66 cubic meters per second (150 to 200 cubic feet per second) during August through October. Because of the substrate composition and the size of the stream, redds may be hard to detect. Low numbers of small bull trout were present during electrofishing surveys downstream from Yaak Falls. Additional survey work is needed to determine potential bull trout utilization of the Yaak River below the falls. Extensive sampling upstream from Yaak Falls has failed to document the presence of bull trout in the United States section of the Yaak River (MBTSG 1996b).

Redd counts conducted in the headwaters portion of Callahan in 2002 and 2003 by IDFG found 17 and 42 bull trout redds in the Idaho portion of the North and South Forks of Callahan, respectively (Jody Walters, IDFG, pers. comm. 2004). Ruby and Star creeks do not appear to be suitable for spawning, and no redds have been found, but juvenile bull trout occur in low numbers. Bull trout spawning in the mainstem Kootenai River has not been documented at this time and probably does not occur due to lack of suitable habitat and thermal conditions.

Limited information is available regarding abundance and life history attributes of bull trout in the lower Kootenai River in Idaho. The Idaho Department of Fish and Game is currently conducting research on bull trout distribution and movements. Bull trout have been documented in the Idaho portion of the basin in the Kootenai and Moyie Rivers and Callahan, Curley, Deer, Deep, Fall, Caribou, Snow, Myrtle, Rock, Trout, Parker, Long Canyon, and Boundary Creeks (PBTTAT 1998). Additional observations of bull trout were reported in Boulder, Caboose, and Debt creeks in Idaho, just downstream from the Montana border (Table 4.3). Typically, sightings of bull trout in Idaho waters have been limited to individual fish. Adult bull trout appear to be well distributed throughout the Kootenai River in Idaho, but at very low densities, based on electrofishing data. Radio telemetry data indicates that some of those fish overwinter in the deep holes of the lower river (Walters 2002). Five of eight adult bull trout radio-tagged in O'Brien Creek in Montana migrated downstream into Idaho following spawning.

There is evidence that some bull trout sampled in Idaho are migrants from Kootenay Lake, British Columbia. At least two fish tagged by biologists in British Columbia have been located in Idaho as far upstream as the Moyie River (L. Fleck, B. C. Ministry of Water, Land, and Air Protection, pers. comm.; D. O'Brien, U. of B.C., pers. comm.).

While there were previous anectdotal reports of large bull trout spawning in the Callahan drainage, spawning by fluvial or adfluvial bull trout has recently been documented for the first time in Boulder Creek and North and South Callahan Creeks in Idaho (Walters 2003; IDFG unpublished data). Juvenile bull trout less than 200 millimeters (7.9 inches) long have been occasionally documented in the Kootenai River and tributaries in Idaho, but may have originated from upstream sources in Montana (Table 4.3; Walters and Downs 2001).

Bull Lake and Sophie Lake Core Areas

Bull Lake, a natural lake in the headwaters of the Lake Creek drainage near Troy, Montana, is considered in the Draft Bull Trout Recovery Plan to be a bull trout secondary core area (figure 4.1). In 1917, Troy Dam (also called Northern Lights Electric Company Dam) was constructed on Lake Creek, about 24 kilometers (15 miles) downstream from Bull Lake (MBTSG 1996b). It is believed that migration of bull trout over a natural barrier at the dam site was difficult or impossible prior to this dam. The dam is currently an upstream passage barrier. The local population(s) of bull trout in Bull Lake is unusual in that the adult spawners run downstream from Bull Lake, using Lake Creek as a corridor to access spawning areas in Keeler Creek. This pattern of downstream spawning migration has also been observed in the Flathead River drainage (Upper Kintla Lake and Cyclone Lake) and the Pend Oreille drainage (IDFG unpublished data) but is considered rare across the range of bull trout. Trapping of Keeler Creek in 1977 resulted in the collection of migrating adult bull trout during June to October (Marotz *et al.* 1988).

Sophie Lake contains a small and disjunct bull trout secondary core area in a closed basin (Figure 4.1). There is no historical record of bull trout stocking or transplant to this water, but because of the closed nature of this basin, these fish could have been artificially introduced early in the 20th century.

Bull trout reach maturity in Sophie Lake, with a single spawning and rearing area in Phillips Creek (MBTSG 1996c). Phillips Creek headwaters are in British Columbia, and Phillips Creek flows through private timberland that has substantial logging history and road development in its upper reaches. About 3 kilometers (2 miles) north of the United States/Canada border, Phillips Creek drops over a large (120 meters) series of falls and cascades (a complete natural barrier) and then proceeds south across the border. In the United States, Phillips Creek continues south for another 5 kilometers (3.5 miles) across private land before terminating at Sophie Lake. This lake has intermittent drainage to Koocanusa Reservoir, which lies just 1.5 kilometers (1 mile) to the west, but the two lakes are probably not sufficiently connected for fish passage to occur. Water is withdrawn from Phillips Creek upstream from the barrier falls (in British Columbia) for power production, and Phillips Creek is heavily dewatered for irrigation purposes in the United States and Canada. Bull trout juveniles (70 to 182 millimeters) were sampled just north of the border by survey crews of the British Columbia Ministry of Water, Land, and Air Protection (Westover, in litt. 1999). Bull trout are not known to exist in the stream system upstream from the falls. The U.S. Fish and Wildlife Service Partners For Fish and Wildlife program is working to improve habitat in the degraded lower reaches of the stream.

Bull trout are also present in Glen Lake, but they are probably not reproducing in this system. The fish access Glen Lake as juveniles outmigrating from Grave Creek via the Glen Lake ditch (MBTSG 1996c). Bull trout that mature in Glen Lake cannot return to Grave Creek because of a migration barrier in the ditch. These fish are essentially lost from the Koocanusa Reservoir core area. In 2001, a project was completed to screen this ditch and improve fish passage over the dam on Grave Creek.

Historic Distribution[4]

Historically, bull trout were one of six native salmonid species distributed throughout the Kootenai River drainage. The historical importance of Kootenai Falls as a barrier to fish movement is unknown, although recent radio telemetry information indicates that this series of falls is traversed by adult bull trout at certain flows. If this was the case, this bull trout population likely included migratory fish from Kootenay Lake in British Columbia as well as Kootenai River fish, which may have moved freely throughout the drainage. Resident bull trout may have been present. If upstream passage did not occur over Kootenai Falls, the bull trout population in the Kootenai Drainage upstream was isolated at this point, likely resulting in one-way gene flow downstream. Libby Dam is currently a barrier blocking upstream migration as there are no fish ladders at the dam. Therefore, any bull trout that are entrained at Libby dam cannot return upstream to their natal streams to spawn. Little quantitative information exists regarding historic bull trout abundance downstream from Kootenai Falls in Montana or Idaho. The valleys of the lower Kootenai were developed for agriculture during the late 19th and early 20th century, and the habitat for bull trout was negatively impacted prior to the collection of substantive fishery data. We recognize the lack of information as a major gap in our knowledge of the drainage. Suckley (1861) reported collecting a bull trout from the Kootenay River, but the exact location of this collection is unknown.

The ethnographic literature provides some information about historical distribution of bull trout. Schaeffer (1940) said of the Kutenai Indians that char (bull trout), trout, and whitefish were the important fish varieties, taken principally

LINKS

QHA spreadsheets contain historic bull trout distribution by lifestage for HUC-6 watersheds in the U.S. and B.C. portions of the Kootenai. These data are a compilation put together by our Technical Team. Go to Appendices 32 and 33.

Click Here

For bull trout information in the Kootenai Subbasin 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

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[4] *Adapted from MBTSG 1996a, b, and c.*

during the period of spring freshette. He mentions the Upper Kutenai using basket traps for fishing in the tributaries of the Kootenai and Elk rivers, where trout and char were taken when they were moving into the main river in the autumn. Harpoons were used to catch char during their downstream movement in September. Char were caught in this way at the junctions of the Wigwam and Lodgepole Creek, with the Elk River (Schaeffer 1940). Smith (1984) reviewed the ethnographic literature for the Kutenai Indians. He records four sources of information that state that the Kutenais used bull trout as a food source (Boas 1918; Schaeffer 1940; Turney-High 1941; Ray 1942). Appendices 32 and 33, which are our lake and stream Qualitative Habitat Assessment (QHA) spreadsheets contain historic bull trout distribution by lifestage for HUC-6 watersheds and selected lakes in the U.S. and B.C. portions of the Kootenai as estimated by the Technical Team.

Bull trout age and growth data were analyzed in O'Brien Creek in 1950, Grave Creek in 1952 and Flower Creek in 1959 (Peters 1964). Opheim (1960) collected bull trout in Pipe Creek and Flower Creek in 1959. They were collected in Flower Creek in 1960, 1961, and 1962 and were estimated to comprise 5.5 percent of the fish population (by number) (Huston 1961, 1963).

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

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.

LINKS

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

Click Here

The USFWS (2002) states that the small, disjunct, bull trout population in Sophie Lake may have been artificially introduced early in the 20th century. Though there is no historical record of bull trout stocking or transplants into Sophie Lake, artificial introduction is a possibility because Sophie Lake is a closed-basin lake.

Historic and current harvest

The harvest of bull trout has not been legal in the Kootenai River drainage in the United States since 1995. In 2003, Montana Fish, Wildlife & Parks (MFWP) proposed, and the USFWS agreed, to allow limited, experimental angler harvest of bull trout in Koocanusa Reservoir beginning in the spring of 2004. The proposal was prompted by a significant increase in redd counts in Koocanusa Reservoir tributaries, reflecting recovered status for bull trout in this core area.

Currently below Libby Dam there is some risk to bull trout from incidental hooking and handling mortality. A fishery for large rainbow trout is becoming more popular in the Kootenai River, and many of the techniques used by those anglers are also effective on bull trout.

Table 4.5 shows angler days each year from 1997 to 2001 in the Montana portion of the Kootenai Subbasin.

LINKS

Appendix 57 is the Environmental Assessment for the MFWP proposal to allow for a limited recreational bull trout fishery in Koocanusa Reservoir.

Click Here

Table 4.5. Annual angler days in the Montana portion of the Kootenai Subbasin. Source: Montana Fisheries Information System Database Query 2003.

Watershed	1997	1999	2001
17010101 Upper Kootenai	66,191	61,074	61,687
17010102 Fisher	8534	8399	5589
17010103 Yaak	6513	4557	5,650
Totals	81,238	74,030	72,926

The program by MFWP to allow limited angling for bull trout went into affect in the spring of 2004. The agency has modified fishing regulations to reestablish a recreational bull trout fishery in Koocanusa Reservoir with the following limits and restrictions:

- Creel card that allows for the yearly capture of two (2) bull trout, only one daily and in possession, at Koocanusa Reservoir.
- Anglers that acquire cards will be required to provide name, address, and telephone number for a creel survey to identify the success and monitor success of the program.
- There will be a seasonal reservoir-wide bull trout harvest closure (catch and release) from March 1 through May 31 to protect bull trout as they migrate along the shorelines of the reservoir.

In British Columbia, anglers are currently allowed to harvest one bull trout per day from Kootenay Lake and Koocanusa Reservoir (table 4.6), but they may not take bull trout from most of the tributaries to those waters. British Columbia also allows anglers to keep one trophy bull trout over 75 cm (~30 inches) per day in the lower Elk River and one bull trout per day from the Kootenay River between April 1 and October 31. Between June 1 and September 21, 1996, a creel survey estimated only 23 bull trout were taken from the Canadian portion of Koocanusa Reservoir in nearly 27,000 angler days, a harvest rate not believed to present a problem for bull trout recovery (USFWS 2002b).

Table 4.6. Bull trout regulations summary for British Columbia. Source: British Columbia Ministry of Water, Land, and Air Protection.

Area Governed	Regulation
General	
	Regional daily catch quota = 1 bull trout
Lake Koocanusa	
	Daily catch quota = 1 bull trout (any size)
Kootenay River upstream of Lake Koocanusa to the confluence with the White River	
	Daily catch quota = 1 bull trout (none under 30 cm) from April 1 to October 31
	Bull trout release from November 1 to March 31
	Single barbless hook all year
	Bait ban from June 15 to October 31
Kootenay River upstream of the confluence with the White River	
	Same regulations as above except it is closed to all fishing from April 1 to June 14.
Lower Elk River	
	Daily catch quota = 1 bull trout (none under 75 cm) from June 15 to October 31.
	Bull trout release from November 1 to March 31
	No fishing from April 1 to June 15.
	Single barbless hook all year
	Bait ban from June 15 to October 31
Wigwam River and tributaries	
	Bull trout release
	No fishing April 1 to June 15
	Fly fishing only and bait ban all year
	There is also no fishing in Lodgepole Creek, Bighorn Creek and the Wigwam River upstream of km 42 from September 1 to October 31.

Since 1959, increasingly protective regulations have been established to maintain healthy bull trout populations in western Montana (table 4.7). Complete closure of all waters to bull trout fishing, except Swan Lake in 1995, eliminated all legal harvest of bull trout in Montana, including Koocanusa Reservoir.

Table 4.7 Bull trout regulations summary for Montana.

Year	Bull Trout Regulation
Pre-1959	15 fish, not >10 lb. & 1 fish 18 minimum
1959	10 fish, not >10 lb. & 1 fish 18 minimum
1982	Lakes and streams — 1 bull trout 18 minimum
1985	Streams & lakes — 1 bull trout per day, no minimum size
1990	Streams & lakes — 1 bull trout per day, immediate kill or release
1992	Close all waters to taking of bull trout except HHR and Swan Lake
1995	Close all waters except Swan Lake

MFWP estimates that if every angler fished for bull trout, the incidental daily catch rates for bull trout would be between 0.04 and 0.09 fish per day or between 1,900 and 4,200 bull trout from Koocanusa Reservoir, and they assume that the new angling regulations will produce similar catch rates, except that the actual take will be substantially lower than the catch. This is based on Rumsey and Weaver (1997) who report that anglers at Swan Lake released 86 percent of bull trout. The agency expects similar results at Koocanusa Reservoir. Additionally, more than 50 percent of harvested fish in Swan Lake were subadult or nonspawning adult bull trout, and MFWP predicts that the take from Koocanusa Reservoir will be similar. The agency also notes that anglers would be limited to one bull trout daily and in possession and only two bull trout per year, and that would further reduce impacts to the population. Furthermore, the proposed closure from March 1 through May 31 will reduce take of bull trout during a popular Kamloops fishing period and when bull trout are actively moving along the shorelines.

In the Idaho section of the Kootenai River, 24 bull trout were estimated harvested from January to August 14, 1982 (Partridge 1983). Bull trout made up 1 percent of the total salmonid harvest that year. Partridge (1983) documented angling effort of 102 h/km in 1982, with 82 percent (74 h/km) of the effort for salmonids. In comparison, Graham (1979) estimated fishing pressure of 1,662 h/km of river for a 5.6 km section above Kootenai Falls, Montana in 1979. In a 1993 creel survey, Paragamian (1995a) reported that no bull trout were seen during survey days, but there were reports of bull trout being caught that year. Paragamian (1995a) documented angling effort of 144 h/km. In 2001, bull trout made up 1 percent of the total catch (includes all species caught, but not necessarily harvested) for the Kootenai River, Idaho (Walters 2003). Angling effort in 2001 was 384 h/km, but this estimate only included the section of river from Deep Creek to the Idaho-Montana border. Angling effort downstream of Deep Creek is minimal, but this section of river was included in Partridge (1983) and Paragamian's (1995a) effort estimates.

With increasing fishing pressure throughout the entire Kootenai Subbasin, some hooking mortality is inevitable, as are 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. Bull trout spawners are particularly vulnerable to poaching because they often enter small tributary streams several months prior to spawning and congregate in pools. In some watersheds, extensive road systems provide easy access to prime spawning areas. Poaching activity usually peaks during July, August, and September when large fish are in tributaries and are easily taken (Long 1997).

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 and Parks increased enforcement efforts, and penalties for illegal harvest of bull trout were raised. Enforcement has not seen this kind of poaching in recent years.

4.1.2 Population Delineation and Characterization

Population Units

LINKS

Appendix 58 is Chapter 4 of the Bull Trout Draft Recovery Plan, which addresses the Kootenai River Recovery Unit.

Click Here

The Bull Trout Draft Recovery Plan recognizes 10 identified local populations. (In that document, 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.) Table 4.8 lists local populations by core area. Each of these are described in the section titled: *"Summary of population and current distribution data."*

Table 4.8. List of local populations (in bold) by core area, in the Kootenai River Recovery Unit. Streams designated by (mc) are migratory corridors only, and are not considered to host their own local population. Source: USFWS (2002b).

CORE AREA	LOCAL POPULATION
Lake Koocanusa	Kootenai River (mc) **Wigwam River** (BC and MT) Tobacco River (mc) **Grave Creek** BC tributaries - Unspecified1
Sophie Lake	**Phillips Creek** upstream of Sophie Lake
Kootenai River (MT/ID/BC) and Kootenay Lake (BC)	Kootenai River (mc) **Fisher River** **Libby Creek** **Pipe Creek** **Quartz Creek** **O Brien Creek** **Callahan Creek** ID tributaries - Unspecified BC tributaries - Unspecified
Bull Lake	Lake Creek (mc downstream) **Keeler Creek**

Life History[5]

Bull trout populations in the Kootenai may exhibit one of three life history forms: resident, fluvial, or adfluvial. Resident bull trout generally spend their entire life cycle in small headwater streams. Fluvial and adfluvial bull trout spawn in tributary streams where the juveniles rear from one to four years before migrating to either a river system (fluvial) or a lake/reservoir system (adfluvial) where they grow to maturity (Fraley and Shepard 1989). All three life history forms are present in the Kootenai subbasin.

Adfluvial bull trout mature at four to seven years of age (Mallet 1969; Pratt 1985; Shepard et al. 1984; Goetz 1989) and may spawn every year or in alternate years (Block 1955; Pratt 1985; Fraley and Shepard 1989; and Ratliff 1992). Adfluvial fish grow larger in size and have higher average fecundities than fluvial or resident stocks.

LINKS

Appendix 59 contains additional information on life histories of Montana bull trout. See also Shepard et al. 1984.

Click Here

Bull trout are fall spawners, typically migrating to spawning areas during August and early September, primarily in third and fourth-order streams. In some systems, bull trout have been observed moving into spawning tributaries during high spring runoff, giving them access to habitat that becomes inaccessible later in the year when flows are lower (Pratt 1985; Pratt and Huston 1993). In the Idaho section of the Kootenai River, bull trout generally began moving upstream toward O'Brien Creek, Montana (a spawning tributary) by June or July and entered O'Brien Creek in June, July, and September (Walters and Downs 2001; Walters 2002, 2003). In North and South Callahan Creeks, bull trout spawning commenced when water temperatures dropped below 9° C. Peak spawning in these two streams occurred from the third week of September to the first week of October (IDFG unpublished data).

Eggs hatch after 100 to 145 days of incubation (Heimer 1965; Allan 1980; Weaver and White 1984). Fry remain in the gravel for another 65 to 90 days until yolk sac absorption is complete; parr marks develop and actual feeding begins while fry are still in the gravel. Fry emerge from gravels in early spring, usually April (Shepard et al. 1984). Bull trout generally reach lengths of about one inch (25 to 28 mm) before filling their air bladders and emerging from the stream bed (Shepard et al. 1984).

Juvenile bull trout live near the stream bottom for the first two years of life using pockets of slow water within swift stream reaches (Pratt 1984b; Shepard et al. 1984). Unembedded cobble and boulders, and dispersed woody debris are commonly used forms of cover. Juvenile bull trout typically rear close to spawning areas, usually in middle to upper stream reaches. Young fish feed primarily on aquatic insects including mayflies (*ephemeroptera*), true flies (*diptera*), stoneflies

[5] *Adapted and condensed from PBTTAT (1998)*

(*plecoptera*), caddisflies (*trichoptera*), and beetles (*coleoptera*) until they reach about 4 inches (100 to 110 mm) and become piscivorous, sometime during their second growing season (Graham et al. 1980; Shepard et al. 1984; Boag 1987).

Juvenile bull trout may migrate from natal streams during the summer or fall of their second or third growing season (Ringstad 1976; Oliver 1979; Shepard et al. 1984; Pratt 1996). In tributaries to the Clearwater system in north-central Idaho, juvenile bull trout are routinely captured by smolt traps during spring runoff. In Callahan Creek, approximately 2 km from the mouth, 19 juvenile bull trout were caught in a screw trap fished from early April through early July, 2003. These fish were believed to be out-migrants, as some were recaptured the day after being released upstream of the trap (Idaho Department of Fish and Game, unpublished data). Time spent migrating from natal streams to the Kootenai River has not been studied, but Goetz (1991) reported that juvenile out migrants move downstream quickly in other stream systems.

Migratory corridors tie spawning, wintering, summering, and foraging habitat areas together. Movement is also important in the long term for persistence and interaction of local populations within the metapopulation. Gene flow, refounding of locally extinct populations, and support of locally weak populations require open corridors among populations. Disruption of migratory corridors increases stress, reduces growth and survival, and may lead to the loss of migratory life history types. Resident stocks in isolated marginal habitats are at a greater risk for extinction (Rieman and McIntyre 1993).

Bull trout grow rapidly in lake environments. In Lake Pend Oreille, fish six inches to ten inches (150 to 250 mm) in size can grow to adult size (over 20 inches (500 mm)) within three years (Jeppson 1960; 1961). Growth rate and size at maturity are greater for fluvial fish than resident fish, and greater for adfluvial fish than fluvial fish. Compared to current knowledge of tributary habitats, less is known about daily and seasonal habitat needs of bull trout in Kootenay Lake.

LINKS

Appendix 60 shows bull trout genetic distribution and status in the Montana portion of the Kootenai Subbasin.

Click Here

Appendix 52 shows bull trout distribution and restoration and core habitat areas in the Montana portion of the Kootenai.

Click Here

Appendix 61 lists the streams in the Montana portion of the Kootenai Subbasin that contain brook trout as of February 2003.

Click Here

Bull Trout genetic purity information for the Upper Kootenai in Montana is summarized in Appendix 55.

Click Here

Genetic Integrity

Brook trout, numerous in many bull trout spawning and rearing streams in the U.S. portion of the Kootenai, can and do hybridize with bull trout, though the offspring are generally sterile. Brook trout are found throughout the upper Kootenai River drainage in British Columbia. Their numbers, however, are generally low and they do not occur in the Wigwam River system. Most brook trout are found in warmer, more heavily impacted streams (USFWS 2002b). The rate of hybridization of bull trout with brook trout was 25 percent for a sample of 24 fish collected in the river between Kootenai Falls and Libby Dam (USFS KNF 2002). Downstream from Kootenai Falls, brook trout are present in O'Brien Creek, and 87 probable brook trout redds were recorded in 1994 (MBTSG 1996b). Brook trout hybridization with bull trout is suspected in O'Brien Creek. Brook trout are also present in Pipe Creek, Keeler Creek, Lower Grave Creek (although not in spawning areas), and West Fisher Creek. Bull trout sampled from Kootenay Lake were not hybridized and had significant genetic differences from fish sampled upstream from Kootenai Falls (USFS KNF 2002). In the past, there were only a few private fish ponds in the upper Kootenai. Several unlicensed ponds are known to be present in the Grave Creek drainage (MBTSG 1996c). In recent years, the Lincoln County Conservation District has received numerous requests for private pond construction permits, many which requested permission to stock brook trout (USFWS 2002b). The trend is expected to continue. The USFWS (2002b) believes the proliferation of private ponds presents a risk to bull trout recovery efforts. In the upper Kootenai River drainage in British Columbia, private fish farms are permitted to raise only rainbow trout and they must be in self-contained artificial ponds on their own property (USFWS 2002b).

4.1.3 Population Status

Current Status

The status and population trend of all Kootenai River bull trout subpopulations was unknown at the time the species was listed (USFWS 1998) (table 4.9), however the Sophie Lake subpopulation was considered to be at risk of stochastic extirpation due to its single spawning stream and small population size. The section entitled *"Summary of Population Data"* in the Bull Trout Focal species section of this report provides information on the current status of local populations, including data on populations of index streams up to 2003.

Table 4.10 summarizes the Kootenai National Forest's characterization of subpopulations in the Montana portion of the Kootenai as part of their Section

LINKS

Appendix 55 includes Idaho Panhandle and Kootenai National Forest assessments of the status of bull trout (and other salmonid species) in the Idaho and Montana portions of the Kootenai.

Click Here

Table 4.9. Summary of bull trout subpopulation characteristics. Source: Klamath River and Columbia River Bull Trout Population Segments: Status Summary (1998).

Drainage	Subpopulation	Single Spawning Area	Re-founding Unlikely	Life History Forms[1]	Number	Status[2]
Kootenai	Upper Kootenai River	N	Y	M	500	U
	Sophie Lake	Y	Y	M	U	U
	Middle Kootenai River	Y	N	M, R	<75	U
	Lower Kootenai River	N	N	M	<40	U
	Bull Lake	N	Y	M	<75	U

[1] *M= Migratory; R = Resident*
[2] *D= Depressed; S= Strong, U = Unknown*

Table 4.10. Kootenai National Forest characterization of bull trout subpopulations in the Montana portion of the Kootenai Subbasin as part of their Section 7 consultation with the USFWS. FA=Functioning Appropriately; FAR=Functioning at Risk.

Stream	Subpopulation Size	Growth and Survival	Life History Diverstiy & Connectivity	Persistence and Genetic Integrity
UPPER KOOTENAI				
Wigwam	FA	FA	FA	FA
Grave Creek	FAR	FAR	FAR	FAR
Sophie/Phillips Creek	FAR	FAR	FAR	FAR
MIDDLE KOOTENAI				
Fisher River	FAR	FAR	FAR	FAR
Libby Creek	FAR	FAR	FAR	FAR
Quartz Creek	FA	FAR	FA	FAR
Pipe Creek	FAR	FAR	FAR	FAR
LOWER KOOTENAI				
O'Brien Creek	FAR	FAR	FAR	FAR
Lake and Keeler Creeks	FAR	FAR	FA	FAR
Callahan Creek	FAR	FAR	FAR	FAR
Lower Yaak River	FAR	FAR	FAR	FAR

7 consultation with the USFWS. Appendix 55 includes the Idaho Panhandle and Kootenai National Forests' assessments of the status of bull trout local populations (and other salmonid species) in the Montana and Idaho portions of the Kootenai (see the links column).

In the final listing rule, the magnitude of threats to bull trout was rated high for the Middle Kootenai subpopulation (between Libby Dam and Kootenai Falls) and moderate for the other four subpopulations. In all five subpopulations, the threats were considered imminent. In its Draft Bull Trout Recovery Plan, the US Fish and Wildlife Service (2002b) states that the historic distribution of bull trout in the Kootenai Recovery Unit is relatively intact, but abundance of bull trout in portions of the watershed has been reduced, and remaining populations are fragmented.

Historic Status

Quantitative data on historic bull trout abundance and productivity in the Kootenai Subbasin are not available. Evermann (1892) reported bull trout were common in most of the larger tributaries of the Columbia River in Montana. It is known that bull trout were an important food species for the Kutenai Indians (Smith 1984).

Theoretical Reference Condition[6]

The goal of the Draft Bull Trout Recovery Plan is to ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed across the species native range, so that the species can be delisted. Specifically, the Kootenai River Recovery Unit Team adopted the goal of a net increase in bull trout abundance in the Kootenai River Recovery Unit, with restored distribution of any extirpated populations that the recovery unit team identifies as necessary to recovery.

In order to assess progress toward the Kootenai River Recovery Unit objective, the recovery unit team adopted the following recovery criteria. The assumption was made that no core area is viable with a population of less than 100 adults because of the inherent stochastic and genetic risks associated with populations smaller than that. The recovery criteria are applied on a core area-by-core-area basis. In this recovery unit, a distinction was made between two types of core areas—primary and secondary—based mostly on the size, connectedness, complexity of the watershed, and the degree of natural population isolation. Koocanusa Reservoir and the Kootenai River/Kootenay Lake complex downstream from Libby Dam are the two primary core areas. Bull Lake and Sophie Lake are the two secondary core areas.

1. Distribution criteria will be met when the total number of identified local populations (currently numbering 10 in United States waters) has been maintained or increased, and local populations remain broadly distributed in all 4 existing core areas.

2. Abundance criteria will be met when the primary Koocanusa Reservoir and Kootenai River/Kootenay Lake core areas are each documented to host at least 5 local populations (including British Columbia tributaries) with 100 adults in each, and each of these primary core areas contains at least 1,000 adult bull trout. The abundance criteria for the Bull Lake and Sophie Lake secondary core areas will be met when each core area supports at least 1 local population of bull trout containing 100 or more adult fish.

3. Trend criteria will be met when the overall bull trout population in the Kootenai River Recovery Unit is accepted, under contemporary

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[6] *Northwest Power and Conservation 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 excerpted from the Bull Trout Draft Recovery Plan (2002b).*

standards of the time, as 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 Libby Dam (as identified through U.S. Fish and Wildlife Service Biological Opinions) and when over half of the existing passage barriers identified as inhibiting bull trout migration on smaller streams within the Kootenai River Recovery Unit have been remedied.

Table 4.11 presents the numeric standards necessary to recover abundance of bull trout in primary and secondary core areas of the Kootenai River Recovery Unit.

Table 4.11. Numeric standards necessary to recover abundance of bull trout in primary and secondary core areas of the Kootenai River Recovery Unit of the Columbia River drainage. Source: USFWS (2002b). The numbers in the second and third columns refer to numbers of adult bull trout spawning annually.

CORE AREAS	Existing Number (Estimated) Local Populations (United States)	Existing Number (Estimated) Local Populations with > 100 (United States)	Recovered Minimum Number Local Populations with > 100 (United States)	Recovered Minimum Number Core Area Total Adult Abundance
Lake Koocanusa	2	2	2	1,000
Kootenai River/Kootenay Lake	6	1 to 4	5	1,000
Bull Lake	1	1	1	100
Sophie Lake	1	0	1	100

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 from Libby 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 ebbs and flows with river management. Mainstem Columbia River operations affect bull 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. A sliding refill date allows filling later in high water years.

LINKS

For a more complete discussion of how Mainstem Columbia River operations affect subbasin fisheries, and how those effects might be minimized see Appendix 18.

Click Here

4.1.5 Environment-Population Relationships

Environmental Factors Particularly Important to Bull Trout Survival or Key Ecological Correlates (KECs)[7]

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

[7] *This section is adapted from USFWS (2002).*

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 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 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).

LINKS

For the website containing descriptions of surface waters included in the Montana water quality assessment database go to: http://nris.state.mt.us/wis/environet/2002_305bhome.html.

Click Here

For the website listing 303(d) water-quality impaired streams and lakes for the Idaho portion of the subbasin, go to: http://inside3.uidaho.edu/WebMapping/IDEQ/

Click Here

For more detailed results of the QHA lake and stream assessment, including attribute scores, see Appendices 32 and 33.

Click Here

Appendix 31 summarizes the baseline condition for bull trout in bull trout drainages in the Montana portion of the Kootenai.

Click Here

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) indicated that increases in fine sediment reduce egg survival and emergence.

LINKS

Appendix 62 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 63 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

Environment s Ability to Provide Key Ecological Correlates

As part of our assessment, the Kootenai Subbasin (MT, ID, and B.C.) Technical Teams[8] evaluated all the sixth-code HUCs and selected lakes in Montana, Idaho, and Canada[9] on the basis of eleven stream habitat attributes (Parkin and McConnaha 2003) and thirteen lake habitat attributes considered key to resident salmonids. This watershed analysis 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 4.12). Those used in LQHA are the ones considered by our Technical Team to be the main habitat drivers in lakes in the subbasin (table 4.13). For each 6th Code HUC, the technical team used quantitative data (when it existed) and professional knowledge and judgement to score each of the attributes for each HUC. We did the same for selected lakes (table 4.14).

Table 4.15 ranks stream habitat-attributes for bull trout averaged across the regulated mainstem HUCs in the U.S. portion of the subbasin. Tables 4.16

[8] The Kootenai Subbasin Technical Team members participating in the HUC-by-HUC assessment included fisheries biologists and hydrologists from the Kootenai Tribe of Idaho, Montana Fish, Wildlife and Parks, Idaho Fish and Game, Idaho Department of Environmental Quality, US Army Corps of Engineers, US Fish and Wildlife Service, the Idaho Panhandle and Kootenai National Forests, two provincial Canadian ministries, and a private consulting firm.

[9] In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portions 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 4.12. Eleven habitat attributes used in the Kootenai Subbasin QHA analysis of 6th code 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 4.13. Habitat attributes used in the Kootenai Subbasin Lacustrine 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 4.14. Lakes assessed in the Kootenai Subbasin using the Lacustrine QHA spreadsheet tool.

Lake	Location
Kootenay Lake	Canada
Moyie Lakes	Canada
Duncan Lake	Canada
Trout Lake	Canada
Koocanusa Reservoir	U.S./Canada
Kilbrennan	U.S.
Loon Lake	U.S.
Bull Lake	U.S.
Sophie Lake	U.S.
Boulder Lake	U.S.
Granite Lake	U.S.
Leigh Lake	U.S.
Therriault Lake	U.S.
McArthur Lake	U.S.

and 4.17 rank stream habitat-attributes for bull trout averaged across all tributary 6th-code HUCs in the U.S. and B.C. portions of the subbasin, respectively. Tables 4.18 and 4.19 show the ranking by 4th-code HUC for the U.S. and B.C. portions of the subbasin. Table 4.20 ranks habitat attributes for selected subbasin reservoirs and lakes in both Canada and the U.S. The rankings provide a good indication of the subbasin's ability to provide key ecological correlates required for bull trout viability and persistence and the habitat attributes that may be the most limiting for bull trout in the subbasin.

Based on this analysis, of the eleven stream habitat attributes considered key to resident salmonids, the most degraded for bull trout in the tributary streams of the U.S. portion of the subbasin (when averaged across all the HUCs) are high temperature, riparian condition, channel stability, and fine sediment, in that order. In the regulated mainstem, they are altered flows, riparian condition, fine sediment, and channel stability. In the B.C. portion they are channel stability, fine sediment, riparian condition, and habitat diversity. The rankings vary at the HUC-4 scale.

Of the thirteen lake/reservoir-habitat attributes considered key to resident salmonids, the four most limiting to bull trout in reservoirs are: migratory obstructions, volumetric turnover rates, hydraulic regime, and trophic status. The habitat in lakes is in significantly better condition, and none of the lake habitat attributes scored low enough to be considered limiting.

Table 4.15. Ranking of key habitat attributes for the regulated mainstem in the U.S. portion of the Kootenai Subbasin for bull trout based on a QHA analysis. Those with the highest rank (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
Oxygen	0.00	1
Low Temperature	0.03	2
Obstructions	0.16	3
Pollutants	0.17	4
Habitat Diversity	0.23	5
High Temperature	0.33	6
Channel stability	0.34	7
Fine sediment	0.37	8
High Flow	0.44	9
Riparian Condition	0.50	10
Low Flow	0.86	11

Table 4.16. Ranking of key habitat attributes for 6th-code HUC tributary watersheds in the U.S. portion of the Kootenai Subbasin for bull trout based on a QHA analysis.

Habitat Attribute	Score	Rank
Low Temperature	0.00	1
Oxygen	0.03	2
Obstructions	0.06	3
Pollutants	0.07	4
High Flow	0.15	5
Low Flow	0.17	6
Habitat Diversity	0.20	7
Fine sediment	0.26	8
Channel stability	0.26	8
Riparian Condition	0.27	9
High Temperature	0.28	10

Table 4.17. Ranking of key habitat attributes for 6th-code HUC iwatersheds in the B.C. portion of the Kootenai Subbasin for bull trout based on a QHA analysis.

Habitat Attributes	Score	Rank
Low Temperature	0.00	1
Oxygen	0.03	2
Obstructions	0.07	3
Pollutants	0.09	4
High Flow	0.17	5
Habitat Diversity	0.21	6
Low Flow	0.22	7
Fine sediment	0.27	8
Channel stability	0.27	8
High Temperature	0.28	9
Riparian Condition	0.29	10

Table 4.18. Ranking of key stream-habitat attributes for the regulated mainstem and tributaries at the HUC-4 watersheds for bull trout in the U.S. portion of the subbasin based on a QHA analysis of 6th-field HUCs. Those attributes 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). The most limiting attributes are highlighted in yellow. Note that the QHA scores for some HUC-4s (e.g., Lower Kootenai) and the regulated mainstem are significantly higher than for others. Note also that the attribute rankings in the regulated mainstem differ from those of the tributaries.

	Regulated Mainstem		Fisher		Lower Kootenai		Moyie		Upper Kootenai	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
Channel stability	0.34	7	0.28	6	0.41	8	0.30	8	0.21	8
Fine sediment	0.37	8	0.32	8	0.41	8	0.27	7	0.20	7
Habitat Diversity	0.23	5	0.25	5	0.28	6	0.23	5	0.17	5
High Flow	0.44	9	0.13	3	0.22	4	0.10	2	0.14	3
High Temperature	0.33	6	0.31	7	0.50	9	0.33	10	0.19	6
Low Flow	0.86	11	0.24	4	0.22	4	0.17	4	0.15	4
Low Temperature	0.03	2	0.00	1	0.01	1	0.00	1	0.00	1
Obstructions	0.16	3	0.04	2	0.11	2	0.16	3	0.04	2
Oxygen	0.00	1	0.00	1	0.15	3	0.00	1	0.00	1
Pollutants	0.17	4	0.00	1	0.24	5	0.25	6	0.00	1
Riparian Condition	0.50	10	0.38	9	0.29	7	0.31	9	0.25	9

Table 4.19. Ranking of key stream-habitat attributes at the HUC-4 scale for bull trout in the B.C. portion of the subbasin based on a QHA analysis of all 6th-field HUCs.

	Bull River		Duncan Lake		Elk		Kootenay Lake		Slocan		St. Mary	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
Channel stability	0.45	6	0.18	3	0.25	6	0.16	7	0.22	6	0.38	8
Fine sediment	0.51	7	0.13	3	0.27	7	0.14	5	0.27	8	0.31	7
Habitat Diversity	0.38	4	0.11	2	0.20	5	0.13	4	0.17	5	0.23	5
High Flow	0.34	3	0.00	1	0.10	2	0.03	3	0.05	4	0.13	3
High Temperature	0.05	2	0.00	1	0.00	1	0.00	1	0.02	3	0.00	1
Low Flow	0.51	7	0.00	1	0.18	4	0.02	2	0.01	2	0.21	4
Low Temperature	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1
Obstructions	0.00	1	0.00	1	0.00	1	0.00	1	0.01	2	0.02	2
Oxygen	0.00	1	0.00	1	0.00	1	0.00	1	0.01	2	0.00	1
Pollutants	0.00	1	0.00	1	0.14	3	0.00	1	0.01	2	0.00	1
Riparian Condition	0.41	5	0.11	2	0.20	5	0.15	6	0.24	7	0.29	6

Table 4.20. Ranking of key habitat attributes for reservoirs and selected lakes in the Kootenai 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. It is important to note that the lake scores were much lower than reservoir scores. All of the habitat attributes in lakes are relatively intact when compared to that of reservoirs.

Reservoirs	Score	Rank
Oxygen	0.00	1
Gas saturation	0.00	1
Macrophytes	0.00	1
Habitat diversity	0.03	2
Temperature	0.06	3
Substrate condition	0.07	4
Pollutants	0.08	5
Shoreline condition	0.11	6
Entrainment	0.16	7
Trophic status	0.19	8
Hydraulic regime	0.22	9
Volumetric turnover rates	0.28	10
Migratory obstruction	0.41	11
Lakes		
Oxygen	0.00	1
Gas saturation	0.00	1
Entrainment	0.00	1
Macrophytes	0.00	1
Volumetric turnover rates	0.01	2
Habitat diversity	0.01	2
Substrate condition	0.01	2
Shoreline condition	0.02	3
Pollutants	0.03	4
Temperature	0.03	4
Hydraulic regime	0.03	4
Trophic status	0.04	5
Migratory obstruction	0.06	6

4.1.6 Bull 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 those conditions that currently inhibit populations and ecological processes and functions relative to their potential.

In the HUC-by-HUC assessment of all Kootenai Subbasin 6th-field HUCs, the technical team concluded that of the habitat attributes considered most important to resident salmonids (when averaged across all the HUCs) are high temperature, riparian condition, channel stability, and fine sediment, in that order. In the regulated mainstem, they are altered flows, riparian condition, fine sediment, and channel stability. In streams in the B.C. portion they are channel stability, fine sediment, riparian condition, and habitat diversity. In reservoirs they are migratory obstructions, volumetric turnover rates, hydraulic regime, and trophic status. The rankings vary at the HUC-4 scale. This phase of the HUC assessment considered only habitat factors (factors such as the presence of non-native 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).

According to a series of 1996 reports by the Montana Bull Trout Scientific Group (MBTSG 1996a, 1996b, and 1996c) forestry practices rank as the highest risk to bull trout in the subbasin, largely because it was the dominant land use in all core areas. This risk to the bull trout population is elevated due to the number of core areas (Quartz, Pipe and Libby Creek drainages) available due to fragmentation caused by Libby Dam. The threat from dam operations is considered high because of the biological effects associated with unnatural flow fluctuations and gas supersaturation problems that may arise from spilling water. The dam is a fish migration barrier, restricting this migratory population to 29 miles of river, which increases the likelihood of localized effects becoming a higher risk. Dam operations are considered a very high risk to the continued existence of the Kootenai drainage population of bull trout (Montana Bull Trout Scientific Group 1996).

LINKS

Appendix 87 reports on a spill test conducted in June of 2002.

Click Here

The following paragraphs are adapted from the Draft Bull Trout Recovery Plan. They summarize the factors or conditions identified by the USFWS (2002) that have led to the decline of bull trout and/or that currently inhibit bull trout populations in the Kootenai Subbasin.

Dams

In Koocanusa Reservoir, drawdown limits to protect fishery resources have been advocated since at least 1987 (MBTSG 1996c). In the late 1980s and early 1990s, proposed drawdown limits were exceeded during more than 50 percent of these years. Extreme drawdowns have been shown to have negative consequences on benthic insect production, zooplankton production, and terrestrial insect deposition (MFWP 1997). There is concern about the long-term maintenance of fisheries in Koocanusa Reservoir, given the continuing operational fluctuations (MFWP 1997).

Entrainment studies at Libby Dam have documented low numbers of bull trout passing through the dam, primarily in the spring. Skaar et al. (1996) found a total of 6 bull trout in a sample of 13,186 entrained fish captured below the dam. They estimated that the total number of fish entrained was 1.15 to 4.47

million and that the total number of bull trout could be as high as several thousand. However, since the time of that study, operations and discharge schedules have changed, and the total number of bull trout present in the reservoir has also likely increased substantially. Adult bull trout marked with floy tags in the Wigwam River system (upstream from Koocanusa Reservoir) have also been documented to pass through Libby Dam. One fish was subsequently recaptured alive in O'Brien Creek, at least 55 kilometers (34 miles) downstream from Libby Dam (Baxter and Westover 2000). Two others were found dead in the Kootenai River downstream from the dam.

In 1978, a selective withdrawal system was installed at Libby Dam (MBTSG 1996c). Selective withdrawal results in little or no thermocline formation in Koocanusa Reservoir. The absence of a thermocline may contribute to entrainment of fish. Currently, the fisheries sampling program is not designed to identify affects of operations on use of the reservoir by bull trout. The impact of existing dam operations on bull trout represents a major research need.

Impoundment of the Kootenai River by Libby Dam in 1972 also altered the aquatic environment in the river downstream from the dam. The operation of Libby Dam by the U.S. Army Corps of Engineers departs drastically from natural downriver discharge patterns on a seasonal and sometimes daily basis. After the dam was built, temperature patterns, sediment loads, and water quality were altered downstream from Libby Dam. These alterations resulted in changes in periphyton, aquatic insects, and fish populations (Dayley et al. 1981; MFWP 1983). Snyder and Minshall (1996) proposed bottom-up food limitation as the mechanism behind declining fish populations in the Kootenai River. As an example, by the 1990s, the mountain whitefish population in the Idaho reach had decreased by up to 75 percent compared to the early 1980s (Partridge 1983; Paragamian 1995a,b; Downs 2000; Walters and Downs 2001). Mountain whitefish are likely a prey species of bull trout in the Kootenai River and therefore may affect bull trout survival or fitness. Maximum discharge through the existing turbines is about 792.4 cubic meters per second (28,000 cubic feet per second). Daily peaking of flows has been identified as another issue of concern in the river downstream. Gas supersaturation, which can cause gas bubble disease in fish, is a problem when spilling occurs. Except for a spill test in June of 2002 (Appendix 87), spill has not routinely occurred in over a decade. An additional affect of Koocanusa Reservoir was that it became a nutrient sink, reducing available phosphorous and nitrogen to the Kootenai River below and reduced productivity in the river (Woods 1982; Snyder and Minshall 1996). Paragamian (2002) suggested the change in productivity led to a fish community shift, with a greater representation of omnivores and fewer insectivores. Collectively, these changes in river ecology as a result of dam operations have had variable and largely unquantified impacts on downstream habitat for juvenile bull trout and their food supply.

Since dam construction, lack of seasonal peak flows has been allowing delta formation at the mouths of some tributaries in Montana and Idaho. These depositional areas may eventually impede upstream movement of bull trout spawners during low flows. Migrant bull trout may be especially sensitive because their fall spawning run coincides with low tributary flows and reduced water depths. A delta at the mouth of Quartz Creek is of particular concern because of that stream's importance to migratory bull trout reproduction. Studies completed in 1988 concluded that this delta did not represent a barrier, but the delta should be monitored periodically to determine whether the surface elevation is increasing (Marotz et al. 1988).

Troy Dam, constructed in 1917 at the mouth of Lake Creek, is an upstream fish passage barrier. The dam is located at the site of a natural waterfall suspected to have been at least a seasonal barrier to fish passage. The Bull Lake bull trout secondary core area population is isolated upstream from this barrier and is supported by spawning and rearing habitat within the Lake Creek drainage, especially in Keeler Creek.

LINKS

Appendix 98 shows barriers in the Montana portion of the Kootenai Subbasin.

Click Here

Forest Management Practices

Forestry practices rank as a high risk in the Kootenai River Subbasin, largely because forestry is the dominant land use in the basin. The risk to bull trout is elevated due to the fragmentation in the drainage caused by Libby Dam. Virtually all drainages supporting bull trout in the Kootenai River Subbasin are managed timberlands. In the upper Kootenai River Subbasin, upstream from Libby Dam, both the Grave Creek and Wigwam River drainages are largely second-growth forest, and timber harvest continues. Extensive road construction has resulted in increased water and sediment yields (MBTSG 1996c). At the present time, within the United States portion of the basin, only the headwaters of the Grave Creek drainage are protected from future timber management activities.

In the Elk River watershed in British Columbia (a tributary to the upper end of Koocanusa Reservoir), sediment from roads and logging sites was once so severe that water quality investigators felt that settling basins may be needed to protect the stream's water quality. New logging practices in British Columbia, conducted under the current Forest Practices Code, are much more stringent than they were 25 years ago (Westover, in litt. 1999). However, high-water events continue to cause sedimentation. New timber harvest and road building underway in the Wigwam River watershed are of major concern because this watershed currently provides high-quality bull trout habitat. The new activities are being monitored closely, with data to be collected on flows, suspended sediment, temperature, and ground water, both before activities begin and into the future (Westover, in litt. 1999).

There are extensive private timberlands in the upper Kootenai River watershed in the United States, mostly owned by Plum Creek Timber Company (formerly Champion International). Much of this land has been heavily roaded and logged, particularly in the Fisher River drainage and the Lake and O'Brien Creek watersheds (MBTSG 1996c). These lands are now covered under the Native Fish Habitat Conservation Plan, which the U.S. Fish and Wildlife Service agreed to with Plum Creek Timber Company in 2000; condition of native-fish habitat in these watersheds is expected to improve under that agreement.

According to the Environmental Impact Statement for the Kootenai National Forest Plan, almost two-thirds of the Kootenai National Forest in Montana, particularly the west half, has problems with watershed instability. Frequent flooding and concentrated high water yields, sedimentation, and small slumps occur below clear-cuts and roads (MBTSG 1996a). The Montana Department of Environmental Quality (MDEQ 2003) lists 129 stream miles in the Kootenai River drainage as having impaired water quality as a result of silvicultural activities. The channel of Keeler Creek, in Montana, is in a destabilized condition because of extensive timber harvest activities and poorly constructed roads, built primarily between 1941 and 1970 (MBTSG 1996c). During that period, over 100 million board feet were clear cut from 23 square kilometers (5,780 acres). Serious flooding occurred in 1974 and 1980.

A point source of sediment pollution exists on Therriault Creek Road, in the Tobacco River drainage, due to improper road drainage and fill slope construction along the stream channel. Edna Creek, tributary to Fortine Creek, has heavy accumulations of sediment in the stream channel (Marotz et al. 1988).

A review of the National Forest database for portions of the Kootenai River Subbasin in Idaho (PBTTAT 1998) revealed that in watersheds important to bull trout, road density averaged 1.5 kilometers per square kilometer (2.4 miles per square mile), with roads covering 1.7 kilometers per square kilometer (2.8 miles per square mile) of riparian area and with 1.1 road crossings per kilometer of stream. A total of 16 percent of the watersheds had been logged. Zaroban et al. (1997) found that Idaho Forest Practice Act rules were implemented 97 percent of the time, and when applied, they were 99 percent effective at preventing pollutants from reaching a stream (PBTTAT 1998). However, in half the timber sales reviewed, sediment was still being delivered to streams.

Current forestry practices are less damaging than past practices were, but the risk is still high because of the existing road system, mixed land ownership, lingering results of past activities, and inconsistent application of best management practices (MBTSG 1996c).

Livestock Grazing

While there may be site-specific impacts, aquatic habitat degradation due to improper livestock grazing is not considered a widespread problem in the Kootenai River Subbasin, in either the United States or British Columbia. Where localized impacts occur, these should be addressed.

Agricultural Practices

The Montana Department of Environmental Quality lists 73 miles of streams in the upper Kootenai River watershed in Montana as having impaired water quality as a result of agriculture (MDEQ 2003).

There are at least two irrigation diversions in Grave Creek. The North Fork of Grave Creek is actually an irrigation ditch and requires occasional work within the stream channel to maintain suitable flow conditions. The Glen Lake Ditch has lacked any functional fish screening, and bull trout moving downstream were historically lost into this irrigation ditch, some ending up in Glen Lake (MBTSG 1996c). In 2001, a project to stabilize the structure, screen the ditch, and improve fish passage over the dam was completed. The diversion still results in some dewatering of the mainstem of Grave Creek in certain years. Dewatered streams in the upper Kootenai River drainage include Grave, Phillips, Sinclair, and Therriault creeks—a total of 22.5 kilometers (14 miles) of streams (MFWP 1991).

In the Idaho portions of the Kootenai River valley, channel straightening, diking, and creation of drainage ditches have grossly modified and/or eliminated some of the lower tributary and mainstem river habitat (PBTTAT 1998; USFWS 1999). Practices that contribute to decreased water quality and/or temperature increases in the lower river corridor could hinder fish use of this river as a migratory corridor and rearing habitats. A problematic diversion on Boundary Creek in Idaho is being screened to eliminate the entrainment of juvenile and adult bull trout. Additional diversion issues may exist on Long Canyon Creek (USFWS 2002).

Agricultural practices have not had major impacts in the upper Kootenay River watershed in British Columbia, as most of the lands are forested.

Transportation Networks

Railroads are located along the middle portion of the Kootenai River and along the Fisher River. The rerouting of the Great Northern Railroad in the late 1960s shortened the stream channels of the Fisher River, Wolf Creek, and Fortine Creek by over 3 kilometers (0.6 miles) (MBTSG 1996a). Major portions of the lower 16 kilometers (10 miles) of the Fisher River and most of Wolf Creek were channelized.

On portions of Pleasant Valley Fisher River, the main Fisher River, and Swamp Creek east of Libby, there are straightened and riprapped channels along U.S. Highway 2. This highway also parallels the Kootenai River further west. The potential for negative impacts to bull trout to occur as a result of migration barriers, spills, weed suppression, fire suppression, and road maintenance is high (MBTSG 1996a).

Transportation corridors also occur along portions of the drainage in British Columbia, but their overall impact to habitat on the Kootenai River system has not been extensive.

Mining

Annual discharges from the Cominco, Ltd. phosphate plant in Kimberly, British Columbia, exceeded 7,257,472 kilograms (8,000 tons) of phosphorous in the middle to late 1960s (MBTSG 1996c). Pollution abatement measures were installed in 1975, and the plant eventually closed in 1987. Phosphorus levels in Koocanusa Reservoir are now much lower. High fluoride levels also existed in the Kootenai River prior to the early 1970s.

The Sullivan Mine, at Kimberly, British Columbia, has been in operation since 1900. Until 1979, acid mine drainage and heavy metals from the mine and concentrator were discharged untreated into Mark, Kimberly, and James creeks, tributaries of the St. Mary River (MBTSG 1996c). This discharge negatively affected fish and aquatic life in these tributaries, as well as in the Kootenay River itself. Wastewater treatment facilities were installed in 1979, significantly decreasing the quantity of heavy metals reaching the Kootenay River (Kootenai River Network 2000). The Sullivan Mine closed in December 2001 (B. Westover, pers. comm., 2004).

Five open pit coal mines occur in the Elk River drainage in British Columbia. The major water quality problems associated with these coal fields are nitrogen residuals from bulk explosives and increased delivery of suspended sediment to the Elk River and its tributaries. In recent years, better runoff collection systems have been installed, along with settling ponds, and chemical flocculents are selectively used at the mines. Under permit stipulations, suspended sediment concentrations in effluents are not to exceed 50 milligrams per liter (50 parts per million) (MBTSG 1996c). Impacts are likely to continue on a localized scale. In 1995, it was discovered that selenium was being released from the weathering of large accumulations of waste rock at the mines (McDonald and Strosher 1998). To date, studies on trout embryos from sites near the mines have found none of the toxic effects often associated with bioaccumulated selenium (Kennedy et al. 2000). Additional concerns have been expressed over presence of heavy metals. The mines are located over 96.6 kilometers (60 miles) from the Kootenay River, in the Elk River drainage upstream from a passage barrier at Elko. Overall, current mine impacts to bull trout in the upper Kootenai River may not be significant, but the potential for future problems remains. Recently the B.C. government attempted to auction off coalbed methane leases in the Canadian headwaters of North Lodgepole Creek, a tributary of the Wigwam River but no bids were received. The potential remains, however, for development at some future date.

Historically, mining was much more active in the Kootenai River drainage than it is today. Underground mining began in the Kootenai River Subbasin in the late 1800s, and large-scale surface mining flourished beginning in the late 1960s. The Montana Department of Environmental Quality (MDEQ 2003) lists 35 stream miles in the Kootenai River drainage as having impaired water quality as a result of mine tailings. Twenty-nine stream miles are listed as impaired from abandoned mines, and 12 miles from placer mining. Some small private mining operations continue in the Lake Creek drainage and in Canada. Water quality impairment in Lake Creek is the result of a copper and silver mine, mill, and tailings impoundment owned by ASARCO, Inc. (MBTSG 1996b). This facility is not presently in operation.

Acid mine drainage from the Snowshoe Mine in the Libby Creek drainage has affected trout populations in 5 kilometers (3 miles) of Snowshoe Creek and 24 kilometers (15 miles) of Big Cherry Creek for over 70 years (MBTSG 1996a). Efforts are currently underway to reclaim this site, but other abandoned mines need similar attention (MBTSG 1996a). Historic mining operations in the Fisher River drainage have contributed to channel degradation. Big Cherry, Libby, and Snowshoe creeks suffer from impaired water quality as a result of mining activities. Several other drainages in the basin have historical impacts from small mining operations.

In Idaho, Boulder Creek and Blue Joe Creek have a legacy of water quality and habitat degradation problems from mining activity (PBTTAT 1998). Blue Joe and Boundary Creeks experience episodes of toxic runoff from the Continental Mine.

A large copper and silver mine complex has been proposed in the Libby Creek watershed, with potential impacts on Little Cherry Creek, which may contain a local population of genetically pure, native Columbia River redband trout (MBTSG 1996a). This Noranda proposal is not currently active; it will require consultation for potential impacts to bull trout under section 7 of the Endangered Species Act if it is revived. Because of risks from historic mines and proposed future mines, the historic/current and restoration risks of mining are rated as high in the Kootenai River drainage.

Residential Development

Many of the streams in this area, particularly in the lower Kootenai River Subbasin, flow through private land. The human population in areas around Eureka, Libby, and Troy, Montana; around Bonners Ferry, Idaho; and in portions of southern British Columbia is increasing, resulting in increased housing development along streams. Development exacerbates temperature problems, increases nutrient loads, decreases bank stability, alters instream and riparian habitat, and changes hydrologic response of affected watersheds. Because of the proximity of this development to bull trout spawning and rearing habitat, rural residential development is considered to be a risk. The location of the development and not the magnitude is of primary concern at this time for bull trout recovery.

Fisheries Management

Illegal harvest has been well documented in this subbasin and is considered a high risk to bull trout recovery because of the well-known and limited spawning areas (MBTSG 1996a, 1996b, 1996c). Poaching activity peaks during summer months when fish are in the tributaries and can be easily taken (Long 1997). Using interviews with convicted poachers in northwest Montana (and northern Idaho), researchers estimated that an average of 22 bull trout per week were harvested from a portion of the Kootenai River in recent years, with additional fish mortally injured but not retrieved (Long 1997). An angler survey on the Elk and Wigwam Rivers in British Columbia estimated that 28 bull trout were illegally taken from these waters during the summer of 1998 (Westover 1999).

In the late 1960s and early 1970s, just prior to completion of Libby Dam, several tributaries to Koocanusa Reservoir were treated with toxicants to remove rainbow trout and restore westslope cutthroat trout. These tributaries included Young, Big, Five Mile, Sullivan, and Clarence creeks (MBTSG 1996c). At the time of treatment only Clarence Creek was known to support bull trout.

Brook trout are present in many bull trout spawning and rearing streams in the Kootenai River Subbasin. Brook trout are present throughout the upper Kootenay River drainage in British Columbia, although their numbers are generally low and they do not occur in the Wigwam River system. Most brook trout are found in warmer, more heavily impacted streams (Westover, in litt. 1999).

Other non-native fish species found in the Kootenai River drainage include coastal rainbow trout (the Kamloops/redband trout are native in the lower Kootenai), Yellowstone cutthroat, kokanee salmon (in Koocanusa Reservoir), lake trout (in a closed basin lake), northern pike, yellow perch, smallmouth bass, largemouth bass, black bullhead, and pumpkinseed sunfish. *Mysis relicta* (opossum shrimp) have also been introduced into lakes in the drainage. Brown trout were collected in Lake Creek in 1994 and in the Kootenai River downstream from Kootenai Falls in 1998 and 2000. These are the first recorded occurrences of brown trout in the Kootenai River drainage in Montana. Brown trout, collected sporadically in the Idaho portion of the Kootenai since 1998 (Downs 2000; Idaho Dept. of Fish and Game, unpublished data), were also collected in the Idaho portion of the Kootenai River in 2001, 2002, and 2003 in very low numbers during an annual late-summer electrofishing effort by KTOI and IDFG. Most were collected near Crossport, ID.

Predation or competition by largemouth bass, northern pike, or other cool or warm-water species could have negative impacts in localized situations. The presence of kokanee salmon in Koocanusa Reservoir and in the Kootenai River downstream may benefit bull trout by providing a food source for subadult and adult fish (MBTSG 1996c).

Historically, few private fish ponds existed in the upper Kootenai River drainage. Several unlicensed ponds are known to be present in the Grave Creek drainage (MBTSG 1996c). The Lincoln County Conservation District has received numerous requests for private pond construction permits during the past few years. Many applicants for private pond permits request authorization to stock brook trout. Requests for private fish pond permits are likely to continue to increase along with local human population growth (MBTSG 1996c). Proliferation of private ponds presents a risk to bull trout recovery efforts. In the upper Kootenai River drainage in British Columbia, private fish farms are permitted to raise only rainbow trout and they must be in self-contained artificial ponds on their own property.

Extensive gravel mining occurred when Highway 93 was reconstructed near Eureka. The pits created by this mining have now filled with water, potentially creating habitat for non-native fish species such as perch and northern pike (MBTSG 1996c). There is a concern that this newly created habitat may exacerbate the spread of some non-native species.

Most non-native species currently present were intentionally introduced through agency stocking in the last century. Such stocking of brook trout, coastal rainbow trout, and Kamloops rainbow has occurred in the upper Kootenai River drainage (extending the range of the latter, which are native in Kootenay Lake). The kokanee salmon population in Koocanusa Reservoir resulted from an accidental release of fish from a hatchery in British Columbia in the 1970s (MBTSG 1996c). Presently, coastal rainbow trout are planted only in isolated lakes. All other fish plants in the United States, with the exception of Koocanusa Reservoir, are with westslope cutthroat trout, which are native to the Kootenai River.

There have been continuing problems across northwest Montana with illegal fish introductions. Illegal introductions have occurred in at least 28 waters in the Kootenai River drainage (Vashro, in litt. 2000), most of which involved warm- or cool-water species (pike, perch, bass, bluegill, bullhead) and most of which occurred or were only detected in the past 10 years. Two northern pike have been gill netted in Koocanusa Reservoir (Westover, in litt. 1999). Illegal fish stocking is reportedly a problem on both sides of the border (Westover, in litt. 1999). A lake trout was documented for the first time in an angler catch from Kootenay Lake in fall 1999 (Westover, pers. comm., 2001). As with other large lakes, the potential for establishment of a reproducing lake trout population in Kootenay Lake is cause for concern (Donald and Alger 1993; Fredenberg 2000).

Stocking programs on either side of the international border have the potential to negatively impact Kootenai River bull trout if the non-native species emigrate and become established. The Province of British Columbia stocks brook trout only in landlocked lakes in the upper Kootenai River drainage (Westover, in litt. 1999). High-elevation lakes are stocked with westslope cutthroat trout. Some low-elevation lakes in the lower Kootenay River drainage are stocked with rainbow trout. Fisheries management programs in Canada are outside our jurisdiction, but close communication and collaboration has occurred in the past and must be continued.

In recent years, the fisheries management emphasis in the United States portion of Koocanusa Reservoir has switched from westslope cutthroat trout (a failed program because of reservoir constituency and possibly the cutthroat stock) to Kamloops rainbow trout (MBTSG 1996c). Koocanusa Reservoir is being stocked with sterile Kamloops rainbow trout in United States waters in hopes of providing a trophy fishery sustained by the kokanee salmon forage base, circumstances similar to those occurring naturally downstream in Kootenay Lake. The full extent of interactions between Kamloops and bull trout, two large, piscivorous species, are unknown, however, they have been stocked since 1985 (in B.C.) and 1988 (in MT) and bull trout have increased every year since. In addition, anecdotal evidence from Kootenay Lake, British Columbia, and Lake Pend Oreille, Idaho, indicates they are compatible in the presence of an abundant kokanee forage base. Anglers in British Columbia have reported catching hatchery-reared rainbow trout (Westover, in litt. 1999), and the potential impacts of these plants on remaining westslope cutthroat trout need to be further evaluated.

Currently, in British Columbia, anglers are allowed to harvest one bull trout per day from Kootenay Lake and Koocanusa Reservoir (Westover 1999). Bull trout caught in most tributaries to these waters must be released. Between June 15 and October 31, anglers are allowed to keep one trophy bull trout (over 75 centimeters [30 inches]) per day in the lower Elk River and one bull trout per day from the Kootenay River from April 1 to October 31. There is also a summer bait ban and a year-round single barbless hook restriction in these rivers. Parnell (1997) estimated only 23 bull trout were harvested from the Canadian portion of Koocanusa Reservoir in nearly 27,000 angler days between June 1 and September 21, 1996. This low rate of harvest is not believed to present a problem for bull trout recovery.

The North Arm of Kootenay Lake, British Columbia, has been supplemented with commercial fertilizer since 1992, following an intensive investigation that concluded such a program would partially compensate for declining productivity in the fishery due to the loss of nutrients. Declining nutrient loads were correlated with lower in-lake nutrient concentrations, chlorophyll *a* concentrations, and macrozooplankton densities and with a dramatic decline in kokanee salmon stocks (Thompson 1999). Nutrients were applied at the north end of the lake, and the response of the food web was monitored. Models predicted that increased zooplankton production resulting from fertilization might be shunted into increased abundance of *Mysis relicta*. In fact, *Mysis relicta* abundance decreased during the experiment. Kokanee abundance increased fourfold to sevenfold, and populations of Gerrard rainbow trout also increased (Ashley and Thompson 1993; Ashley et al. 1994, 1997, 1999). Thompson (1999) was unable to obtain an estimate of bull trout abundance in Kootenay Lake, but stated that tributary surveys found as many as 200 bull trout (presumably adult spawners) in some tributaries and suggests that the bull trout population may be increasing in a trajectory similar to Gerrard rainbow as a result of improved forage (especially kokanee). Olmsted *et al.* (2001) estimated that over 500 adult bull trout from Kootenay Lake congregated annually in 1995 to 1997 below Duncan Dam, a structure blocking upstream access to spawning areas in the upper Duncan River. British Columbia Hydro successfully passed most of those fish over the dam.

Except for Koocanusa Reservoir, the harvest of bull trout is no longer legal in the Kootenai River drainage in the United States. However, there is still some risk to bull trout in these closed areas from incidental hooking and handling mortality. The Kootenai River in Montana received an estimated 37,491 angler days of fishing pressure in 1999, up from 25,213 angler days in 1991 (MFWP 1992, 2000).

For Bull and Sophie lakes, anglers have expressed strong support for attempts to improve the fishery with non-native fish. Largemouth bass are well established in Bull Lake and northern pike have also been seen there. The interaction of largemouth bass with bull trout is unknown (MBTSG 1996b). Northern pike and bluegill were illegally introduced in Sophie Lake during the past decade and have become well established (Vashro, in litt. 2000). The northern pike population appears to have grown dramatically in recent years.

Lake trout are present in Spar Lake, which is a closed basin lake (MBTSG 1996b) located adjacent to Bull Lake and in the same drainage. Northern pike are present in some other valley lakes and in backwater areas of the Kootenai River. Both lake trout and northern pike are potential predators on, and competitors with, juvenile bull trout. Although their distribution in the drainage is presently limited, lake trout, if they become established in the Kootenai River/ Kootenay Lake system, could pose a major threat to bull trout. Interactions of bull trout with many other non-native species are presently unknown. Future sport fishery management directed at improved recreational fishing for non-native species has the potential to conflict with the goal of restoring bull trout in portions of this drainage (MBTSG 1996c).

Isolation and Habitat Fragmentation

There are two components to the risk from environmental instability. First is the likelihood that a catastrophic event could occur. Second is the risk to bull trout when such events occur. The Kootenai River drainage is at a relatively high risk from environmental instability due to climate, geology, and aspect (MBTSG 1996a, 1996b, 1996c; PBTTAT 1998). This area receives high annual precipitation and frequent rain-on-snow events. Rain-on-snow is a common term used to describe cloudy weather periods when warm winds and rain combine to produce rapid snowmelt. These events generally occur during early to midwinter periods. Much of the bull trout spawning and rearing habitat in the Kootenai River drainage is in watersheds with unstable soils and steep slopes. Extensive bedload aggradation combined with low flow conditions can result in dewatering. Seasonal loss of surface flow is evident within aggraded reaches of the Libby, Callahan, and Keeler Creek watersheds (MBTSG 1996a, 1996b). Several landslides have occurred in the Wigwam River drainage (Westover, in litt. 1999), sometimes extending entirely across the river downstream from Lodgepole Creek in British Columbia. A poorly timed or extremely large slide could potentially block spawning access to this and other critical tributaries.

Rieman and McIntyre (1993) concluded that temperature is a critical habitat variable for bull trout. Temperatures in excess of 15 degrees Celsius (59 degrees Fahrenheit) are thought to limit bull trout distribution in many systems (Fraley and Shepard 1989; Brown 1992). In Libby Creek, summer water temperatures as high as 22 degrees Celsius (72 degrees Fahrenheit) and 27 degrees Celsius (81 degrees Fahrenheit) were recorded during 1992 and 1994, respectively (MBTSG 1996a). The Fisher River is also known to have elevated water temperatures (MBTSG 1996a).

Natural thermal limits to bull trout distribution are suspected at several locations. For example, Fortine Creek joins Grave Creek, forming the Tobacco River. Fortine Creek drains mostly low-elevation lands. Summer maximum water temperatures in Fortine Creek greatly exceed those recorded in Grave Creek, which drains high-elevation lands along the Whitefish Divide. Grave Creek is the only bull trout spawning and rearing habitat for this core area that is situated entirely in the United States, and the Tobacco River provides the migratory corridor linking it to Koocanusa Reservoir. Concerns exist that the migratory corridor of the Tobacco River may be compromised by the thermal input of Fortine Creek (MBTSG 1996c).

Water temperatures are probably limiting to bull trout in many Idaho tributaries (PBTTAT 1998), particularly those in watersheds that have natural barriers that block access to the upper drainage (e.g., Moyie River). All are low-elevation streams, and many may not have been hospitable for bull trout, even historically.

If a local population is small enough, variations in survival can cause a declining population for a period long enough that it can be extirpated (Rieman and McIntyre 1993). The local bull trout population in Bull Lake is estimated at several hundred fish or fewer (MBTSG 1996b). Sophie Lake covers only about 81 hectares (200 acres), and bull trout spawn and rear only in Phillips Creek (MBTSG 1996c). The number of adult bull trout is probably fewer than 100 fish. Both of these secondary core areas are at high risk due to their small size, isolation, and restricted habitat.

LINKS

Appendix 64 lists the waters in Montana Fish, Wildlife & Park's Region One that have tested positive or have questionable results for fish pathogens in the National Fish Health Database. Further queries may be conducted at: http://www.esg.montana.edu/nfhdb/fh1.html

Click Here

Pathogens

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 64 lists the waters in Montana Fish, Wildlife & Park's Region One that have tested positive or have questionable results for fish pathogens.

Table 4.22 rates the potential effects of these various land management activities on important bull trout habitat components in Montana, and table 4.23 rates the degree of risk the various activities pose to the restoration of bull trout populations within identified bull trout restoration/conservation areas in the Kootenai Subbasin.

*Table 4.21. Potential effects of land management activities on important bull trout habitat components (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	Recera-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 4.22. Activities posing risk to the restoration of bull trout populations within identified bull trout restoration/conservation areeas in the Kootenai Subbasin (source: MBTSG 1998).

Activity	Lower Kootenai	Middle Kootenai	Upper Kooteani
Rural and Industrial Development			High Risk
Mining	High Risk	High Risk	
Grazing			
Agriculture	Very High Risk		High Risk
Irrigation Diversion			High Risk
Dams	High Risk	Very High Risk	High Risk
Forestry (timber harvest and secondary roads)	Very High Risk		Very High Risk
Recereation			
Transportation System	High Risk	High Risk	
Fire		High Risk	

4.2 Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi*)

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. A recent status report estimated that the subspecies currently occupies about 59 percent of its historic range, but only about 10 percent of its currently occupied range is populated by westslope cutthroat trout with no evidence of genetic introgression (Shepard et al. 2003).

The USFWS, charged with administering the federal Endangered Species Act (ESA) for resident salmonids, 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 state rank for both Montana and Idaho 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.

In British Columbia, westslope cutthroat trout are blue-listed, meaning 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. Both species require high quality, cold water and clean gravel for spawning, and both species do best in complex habitats, much of which is created by large woody debris.

It appears that many of the areas in western Montana where westslope cutthroat trout have been displaced are also areas with a considerable amount of riparian disturbance and instream effects from upland management (USFS 1998). Because they use the entire aquatic system in the subbasin, impacts in any single

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 Montana portion of the Kootenai 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 Kootenai 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

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 for B.C., go to http://srmwww.gov.bc.ca/cdc/

Click Here

component is potentially reflected by westslope cutthroat trout populations. We selected westslope cutthroat trout as a focal species in this assessment because of this susceptibility and their conservation rankings.

Summary of Population Data[1]

Westslope cutthroat occur in about 1,440 linear miles of stream habitat in the U.S. portion of the Kootenai River Subbasin. Abundance data are available for 1,051 of those stream miles. Approximately 70 percent of those have stocks that are considered abundant (table 4.23). However, those stocks have various degrees of genetic purity or have not yet been tested genetically. Only 170 miles of the 1,051 stream miles for which abundance data are available have westslope cutthroat trout stocks that have genetic purity of greater than 90 percent. And in only 125 of those 170 miles of stream are the fish considered abundant. Hence, westslope cutthroat trout with a genetic purity of greater than 90 percent are consideered abundant in only about 12 percent of the total stream miles surveyed.

Data for the Montana portion of the Kootenai from the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (table 4.27) indicate westslope cutthroat trout stocks are strong or predicted strong in 15 HUCs, depressed or predicted depressed in 159 HUCs, and absent or predicted absent in the remaining 11 HUCs. Correlation analysis performed among watersheds in this part of the drainage revealed a significant, positive relation between the number of stream miles occupied by westslope cutthroat trout (MFWP, in litt. 1998) and the number of HUCs that ICBEMP indicated

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 as of 1998. Source: USFWS (1999a).

Watershed	4th-field HUC No.	No. of 6th Field HUCs	No. of Occupied Miles			Occupied Tribs or Reaches
			Abundant	Rare	Total	
Upper Kootenai River	17010101	89	512	162	674	122
Fisher River	17010102	33	97	76	173	48
Yaak River	17010103	22	125	79	204	53
Lower Kootenai River	17010104	35	no data	no data	324	30
Moyie River	17010105	8	no data	no data	65	7
COMBINED KOOTENAI		187	734	317	1440	260

[1]For the Lower Kootenai River, IDFG included the entire stream length if westslopes were present, however, the species has been shown to be absent in numerous stream reaches below barriers within this drainage.

[1] Condensed and adapted from Status Review for Westslope Cutthroat Trout in the United States, USFWS 1999a.

were known or predicted to have westslope cutthroat trout. Using data generated by ICBEMP, 43 HUCs compose the Kootenai drainage within Idaho (table 4.27). Westslope cutthroat trout were determined present in a HUC if the HUC was known or predicted to have spawning and rearing occurring, or if it was a migratory corridor. A strong or depressed status was only conferred to a HUC if spawning and rearing occurs. Hence, in HUCs that are determined to be utilized by westslope cutthroat trout only as migratory corridors, the status is absent. Therefore, in the Idaho portion of the Kootenai River drainage, westslope cutthroat trout presence is known or predicted in 41 HUCs and absent in two. Westslope cutthroat trout status is known or predicted strong in four HUCs and known or predicted depressed in 37 HUCs.

Upper Kootenai River (including all of the Kootenai in Montana except the Yaak and Fisher)

Among the total 674 stream miles occupied by westslope cutthroat trout stocks in the Upper Kootenai in Montana, 512 have stocks that are considered abundant; stocks in the remaining 162 miles of stream are considered rare. Data from ICBEMP (table 4.27) indicate westslope cutthroat trout stocks are strong or predicted strong in 15 HUCs; depressed or predicted depressed in 159 HUCs; and absent or predicted absent in the remaining 18 HUCs.

Fisher River

Among the total 173 stream miles occupied by westslope cutthroat trout stocks in the Fisher River drainage, 97 have stocks that are considered abundant; stocks in the remaining 76 miles of stream are considered rare. Data from ICBEMP (table 4.27) indicate westslope cutthroat trout stocks are strong or predicted strong in none of the HUCs; depressed or predicted depressed in 29 HUCs; and absent or predicted absent in the remaining four HUCs.

Yaak River

Among the total 204 stream miles occupied by westslope cutthroat trout stocks in the Yaak drainage in Montana, 125 contain abundant stocks; stocks in the remaining 79 miles of stream are considered rare. Data from ICBEMP (table 4.27) indicate westslope cutthroat trout stocks are strong or predicted strong in five HUCs; depressed or predicted depressed in 15 HUCs; and absent or predicted absent in the remaining two HUCs.

Lower Kootenai (including all of the Kootenai in Idaho except the Moyie)

In the Idaho portion of the Lower Kootenai watershed, stocks of westslope cutthroat trout are known to occur in 33 stream reaches. Data from ICBEMP (table 4.27) indicate westslope cutthroat trout stocks are strong or predicted strong in two HUCs and depressed or predicted depressed in the remaining 31 HUCs.

LINKS

A map in Appendix 65 shows westslope cutthroat trout distribution and conservation classes in the Montana portion of the Kootenai Subbasin.

Click Here

Westslope cutthroat trout abundance and distribution data compiled by the USFS for the U.S. portion of the Kootenai are summarized in Appendix 55.

Click Here

For various westslope cutthroat trout reports from the B.C. Ministry of Water, Land, and Air Protection, go to Appendix 113.

Click Here

Moyie River

Data from ICBEMP (table 4.27) indicate westslope cutthroat trout stocks are strong or predicted strong in two HUCs and depressed or predicted depressed in the remaining six HUCs that collectively constitute the Moyie River watershed in Idaho.

In summary, westslope cutthroat trout in the Kootenai River drainage in Montana occur in about 223 tributaries or stream reaches that collectively encompass 1,051 linear miles of stream habitat, distributed among 3 watersheds (table 4.23). Westslope cutthroat trout in the Kootenai River drainage in Idaho occur in about 37 tributaries or stream reaches that collectively encompass 389 linear miles of stream habitat, distributed between 2 watersheds (table 4.23). Appendix 92 gives a brief history and current status of the westslope cutthroat trout fishery in the upper Kootenai, B.C.

LINKS

For a MFWP map showing westslope cutthroat trout genetic distribution and status in the Montana portion of the Kootenai, see Appendix 66.

Click Here

QHA spreadsheets contain current and historic westslope cutthroat trout distribution by lifestage for HUC-6 watersheds and selected lakes in the U.S. and B.C. portions of the Kootenai. These data are a compilation put together by our Technical Team. Go to Appendices 32 and 33.

Click Here

Appendix 92 is a brief history of the westslope cutthroat trout fishery in the Upper Kootenay, B.C

Click Here

Historic Distribution

Behnke (1996) states that the original distribution of westslope cutthroat trout is uncertain. It is believed they inhabited all major drainages west of the Continental Divide (Leary et al. 1990). In the Montana portion, 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 2,640 miles of stream (table 4.24).

Table 4.24. Miles of habitat historically (circa 1800) occupied by westslope cutthroat trout in the U.S. (Shepard et al. 2003).

4th Code HUC Name	Occupied	Unoccupied	Total
Upper Kootenai	1213	218	1430
Fisher	416	38	454
Yaak	356	14	369
Lower Kootenai	526	6	531
Moyie	130	9	138
Totals	**2640**	**283**	**2923**

Current Distribution

Westslope cutthroat trout in the U.S. portion of the Kootenai River drainage occur in about 260 tributaries or stream reaches. In Montana, however, only 1,615 miles (39.2 percent) of the estimated 4,119 miles of stream habitat have been surveyed for westslope cutthroat trout. Thus, the subspecies could occupy additional unsurveyed stream miles. Among those 1,615 surveyed miles, westslope cutthroat trout of varying degrees of genetic purity were documented in 1,051

(65.1 percent) (USFWS 1999). Only 170 of those miles had stocks with a genetic purity of greater than 90 percent. In the Idaho portion, westslope cutthroat trout of varying degrees of genetic purity are known to occupy another 389 miles. The Idaho Department of Fish and Game has collected westslope cutthroat trout from Ball, Burton, Caboose, Caribou, Cascade, Fall, Grass, Snow, and Trout Creeks (Paragamian 1994, 1995a and b). Most of those collections were made in the lower stream reaches where access to and from the Kootenai River mainstem is possible.

Status of Westslope Cutthroat Trout Introductions, Artificial Production and Captive Breeding Programs

In Montana, westslope cutthroat captive brood stock (M012) are 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 currently appear to have no effect on wild riverine stocks, with the possible exception of planted fish escaping downstream and mixing with wild fish. As partial mitigation for Libby Dam, the Army Corps of Engineers constructed a westslope cutthroat trout hatchery, the Murray Springs Hatchery near Eureka, Montana, which was completed in 1980. Cutthroat trout raised there were first released into Koocanusa Reservoir in 1981. The hatchery is owned by the U.S. Army Corps of Engineers and is operated by the Montana Department of Fish, Wildlife & Parks. The Corps pays for the operation and maintenance of the hatchery, and the fish it raises are planted into many Lincoln County lakes and streams. Cutthroat trout have not been stocked directly in Koocanusa for several years and will likely never be again, although remote site incubators (RSIs) are being used on Young Creek, a tributary.

In 1996, MFWP began testing the use of RSIs at Young Creek as a recovery technique to imprint westslope cutthroat to specific Koocanusa Reservoir tributaries. The objectives of the study were to: (1) to determine if recruitment of 0-to-2 year-old westslope cutthroat from reservoir tributaries is limiting the reservoir population; and (2) to determine if artificial imprinting of eyed westslope cutthroat trout eggs can be an effective technique to reestablish spawning runs in tributaries where habitat degradation or local extirpation due to random events has caused an under utilization of adequate quality spawning habitat. Westslope cutthroat trout eggs for the Young Creek RSI studies came from Washoe Park State Fish Hatchery in Anaconda, Montana. The results of this study are expected to quantify the proportion of both juvenile and adult production attributable to wild and hatchery origin. Researchers are optimistic that the program will demonstrate that RSIs can increase the number of juvenile and adult westslope

LINKS

Appendix 54 provides information in narrative form on westslope cutthroat trout distribution for much of the Montana portion of the Kootenai.

Click Here

USFS westslope cutthroat trout distribution maps for Montana and Idaho are included in Appendix 1.

Click Here

LINKS

For current and historic fish stocking records in Montana, go to: http://www.fwp.state.mt.us/fishing/stock02.asp

Click Here

For stocking information for Idaho, go to: http://www2.state.id.us/fishgame/fish/fishstocking/stocking/year.cfm?region=1

Click Here

For westslope cutthroat trout hatchery brood stock histories in Montana, see Appendix 67

Click Here

For more information on the use of Remote Site Incubators in the Kootenai to Appendix 68.

Click Here

cutthroat trout in Young Creek. Efforts to determine if these fish return to their natal areas to spawn as adults are ongoing. Success would offer promise for future tributary restoration. Some of the most productive, low-gradient spawning habitats available in the upper Kootenai drainage were lost due to inundation by Koocanusa Reservoir. Additional information on the use of RSIs in the Kootenai River Subbasin is presented in Appendix 68.

In Idaho, Yellowstone cutthroat trout have been stocked into some of the lakes in the Kootenai River subbasin. However, only westslope cutthroat trout are currently stocked in the Idaho portion of the subbasin (http://www2.state.id.us/fishgame/fish/fishstocking/stocking/year.cfm?region=1). These fish are from Conner Lake, British Columbia broodstock. No streams in the Idaho portion of the subbasin are stocked with trout of any species.

Historic and current harvest[2]

Since the 1950s, fisheries managers in the Montana portion of the Kootenai River Subbasin have attempted to protect bull trout and westslope cutthroat trout (MBTSG 1995c) from overharvest by recreational angling. Even with these efforts, native populations of these species have declined, and MFWP has increased restrictions on anglers in response. However, even under catch-and-release regulations, hooking mortality can be a major souce of mortality in heavily fished waters. Table 4.25 shows angler days in each of the major subbasin watersheds in Montana.

Table 4.25. Angling pressure on waters in the Kootenai Subbasin (source: MFWP 2003)

Watershed	1997	1999	2001
17010101 Upper Kootenai	66,191	61,074	61,687
17010102 Fisher	8534	8399	5589
17010103 Yaak	6513	4557	5,650
Totals	81,238	74,030	72,926

Although angler harvest of westslope cutthroat trout may have caused appreciable declines in some Montana Kootenai westslope stocks during the 1900s, angler harvest is now closely regulated in the state and is not considered a threat to the subspecies (MFWP, in litt. 1999). In many Kootenai River Subbasin waters, fishing for westslope cutthroat trout is restricted to catch and release. Elsewhere in the drainage, harvest is greatly restricted.

[2] *The Montana part of this section is excerpted from USFWS (1999)*

In the Idaho reach of the Kootenai River, westslope cutthroat trout comprise 2 to 7 percent of the salmonid harvest (Partridge 1983; Paragamian 1994; Walters 2003). A total of 45, 156, and 235 westslope cutthroat trout were harvested in 1982, 1993, and 2001, respectively (Partridge 1983; Paragamian 1995a; Walters 2003). On the mainstem Moyie River, Horner and Rieman (1984) reported that rainbow trout and brook trout were caught by 18 anglers checked in the summer of 1984, but no westslope cutthroat trout were reported.

In the Idaho portion of the subbasin, the harvest of westslope cutthroat trout is allowed year around in the Kootenai River, while tributaries have a Memorial Day weekend opener (last weekend in May) and November 30, season closure. The Kootenai River has a 2-trout bag limit and 16 inch (406 mm) minimum size limit. A 6-trout bag limit and no size limit is allowed in tributary streams with the exception of a 2-trout bag limit in the Moyie River. Fishing pressure for westslope cutthroat trout in Moyie and Kootenai River tributaries is believed to be minimal as Boundary County, Idaho has relatively few anglers, especially in comparison to the rest of the Idaho Panhandle (N. Horner, IDFG, pers. comm.). In addition, fishing pressure on the Kootenai River ranges from only 10 to 39 h/ha (Partridge 1983; Paragamian 1995a; Walters 2003).

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[3]

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

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[3] *Adapted from USFWS Status Review (1999). For additional information, see also Shepard et al. (1984).*

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 69.

Click Here

For additional genetic information, see also Appendix 70, 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 71.

Click Here

For a MFWP map showing westslope cutthroat trout genetic distribution and status in the Montana portion of the Kootenai, see Appendix 66.

Click Here

For a map showing westslope cutthroat trout distribution and conservation classes throughout the Montana portion of the subbasin, see Appendix 65.

Click Here

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 (resident, fluvial, and adfluvial) 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 occur within the Kootenai River Subbasin (Marotz et al. 1998).

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

The headwaters of Koocanusa Reservoir contain important, genetically pure stocks of fluvial and adfluvial westslope cutthroat trout. However, recent research in the

Kootenai River drainage in British Columbia (Rubidge et al. 2001) reports the rapid spread of rainbow trout introgression into westslope cutthroat trout populations previously reported as free from detectable levels of introgressive hybridization. Shepard and others (2003) reported that among the streams surveyed in the U.S. portion of the Kootenai Subbasin, stocks of unintrogressed cutthroat trout occupied 142.5 miles; stocks that are less than 10 percent introgressed occupied 29.5 miles; stocks between 25 percent and 10 percent introgressed occupied 86.3 miles; and stocks greater than 25 percent introgressed occupied 576.5 miles. Westslope cutthroat trout stocks inhabiting 197.1 miles of stream are suspected to be unintrogressed (with no record of stocking or contaminating species present), and stocks inhabiting 1,498 miles are potentially altered (potentially hybridized with records of contaminating species being stocked or occurring in stream). Table 4.26 presents the break down by watershed. The most likely reason for the apparent increase in hybridization and introgression within the tributaries of the upper Kootenai River is the continued and expanded introductions of rainbow trout into the Koocanusa Reservoir and adjacent tributaries (Rubidge et al. 2002).

LINKS

Westslope cutthroat trout status in Montana and Idaho and data on genetic purity for the Upper Kootenai in Montana are summarized in Appendix 55.

Click Here

Table 4.26. Genetic Status of Westslope Cutthroat Trout in U.S. portion of the Kootenai. Source: Shepard et al. 2003.

Basin	Genetically Tested				Suspected	Potentially	
	Unaltered	< 10%	>10% & <25%	>25%	Unaltered	Unaltered	Total
Kootenai	67.9	21.3	54.7	321.3	65.6	699.8	1230.5
Fisher River	20.2		5.7	156.8	6	227.6	416.4
Yaak	54.4	8.2	25.9	98.4	15.8	155.9	358.6
Kootenai					91.1	313.8	404.9
Moyie River					18.6	92.1	110.6
Totals	**142.5**	**29.5**	**86.3**	**576.5**	**197.1**	**1489.2**	**2521**

In the Idaho portion of the Kootenai River Subbasin there is evidence of introgression from nonnative species such as coastal rainbow trout and Yellowstone cutthroat trout (Sage 1993, 1995; Leary 1997). Columbia River redband trout are also native to the Kootenai River and add to the complexity of determining the distribution and status of westslope cutthroat trout in the drainage. Redband trout X westslope cutthroat trout hybrids are reported from the Boundary and Boulder Creek drainages (Sage 1993, 1995; Leary 1997). Similar visual (i.e., phenotypic) and meristic characteristics of westslope cutthroat trout and Columbia River redband trout make correct identification difficult, which is furthermore complicated when hybridization between the two species occurs (USFWS 1998). Behnke (1992) indicated that the redband trout of the Columbia River drainages share cutthroat trout-like characteristics.

4.2.3 Population Status

Current Status

LINKS

Appendix 72 shows the "risk scores" for Kootenai and Flathead Subbasin conservation populations.

Click Here

Twenty-five years of population estimates reveal a population decline for westslope cutthroat trout in the Kootenai River Subbasin (Hoffman et al. 2002). Severe declines in westslope cutthroat trout abundance in Koocanusa Reservoir tributaries have been measured since the early eighties in population index streams (Marotz et al. 1998).

During the late 1940s, anglers caught primarily westslope cutthroat trout (*Oncorhynchus clarki lewisi)* and burbot (*Lota lota)* in the section of the Kootenai River between Kootenai Falls and the site of the present Libby Dam. Rainbow trout (*Onchorhynchus mykiss)*, bull trout (*Salvelinus confluentus)*, and mountain whitefish (*Prosopium williamsoni)* were seldom captured at that time. Catch of burbot and westslope cutthroat trout declined during the 1950s, while rainbow trout and mountain whitefish catches increased (Bonde and Bush 1982). This trend continued following the completion of Libby Dam in 1972 (May and Huston 1979). Bull trout, rainbow trout, and westslope cutthroat trout were not common in the section of the river from Kootenai Falls to one mile upstream of Bonners Ferry, Idaho prior to impoundment by Libby Dam, and remained uncommon following impoundment. This is likely due to a lack of spawning habitat (May and Huston 1979).

In 1973, 44 percent of trout captured in the Kootenai River were westslope cutthroat trout, with angler catch rates recorded at 0.5 fish/hour, ranking the river among other Montana blue ribbon trout streams. Estimates in a 1994 report documented significant population reductions in the river, less than five percent of the trout captured were westslope cutthroat trout. In the Idaho reach of the Kootenai River, westslope cutthroat trout comprise 2 to 7 percent of the salmonid

Table 4.27. 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-field HUCs in the Columbia River basin. Data are given as the number of 6th-field HUCs in which WCT stocks are strong (S), depressed (D), absent (A), predicted strong (PS), predicted depressed (PD), or predicted absent (PA).

Watershed	4th-field HUC No.	No. of 6th Field HUCs	No. of Occupied Miles			Trend	ICBEMP Data						
			Abundant	Rare	Total		S	D	A	PS	PD	PA	TOTAL
Upper Kootenai River	17010101	89	512	162	674	U	6	69	5	0	9	0	89
Fisher River	17010102	33	97	76	173	U	0	25	4	0	4	0	33
Yaak River	17010103	22	125	79	204	U	5	12	2	0	3	0	22
Lower Kootenai River	17010104	35	no data	no data	324	U	2	19	0	0	12	0	33
Moyie River	17010105	8	no data	no data	65	U	2	6	0	0	0	0	8
COMBINED KOOTENAI		187	734	317	1440	U	15	131	11	0	28	0	185

harvest (Partridge 1983; Paragamian 1995a; Walters 2003). There is no data to indicate that the westslope cutthroat trout population has decreased in the Idaho reach of the Kootenai River as it has in Montana, but there is no data prior to the work of Partridge (1983). Also, Columbia River redband trout were likely always the dominant trout in the Idaho reach.

Table 4.27 shows the trend and status for cutthroat trout across the U.S. portion of the Kootenai Subbasin as determined in the USFWS 1999 Status Review. Appendix 65 shows westslope cutthroat trout distribution and conservation classes for the Montana portion of the subbasin.

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. However, more isolet populations were at less risk than metapopulations due to genetic introgression, disease, and population demographics. Composite population risk scores ranged from a low of 4 to a high of 16. "Isolets" were at relatively high risk from population-type risks, but at much lower risk from genetic and disease risks than "metapopulations." Appendix 72 presents the risk scores for Kootenai Subbasin conservation populations assessed as part of the Westslope cutthroat trout status review update done in 2002. Figure 4.3 shows a frequency distribution of composite population risk scores for the westslope cutthroat trout populations in the Kootenai Subbasin.

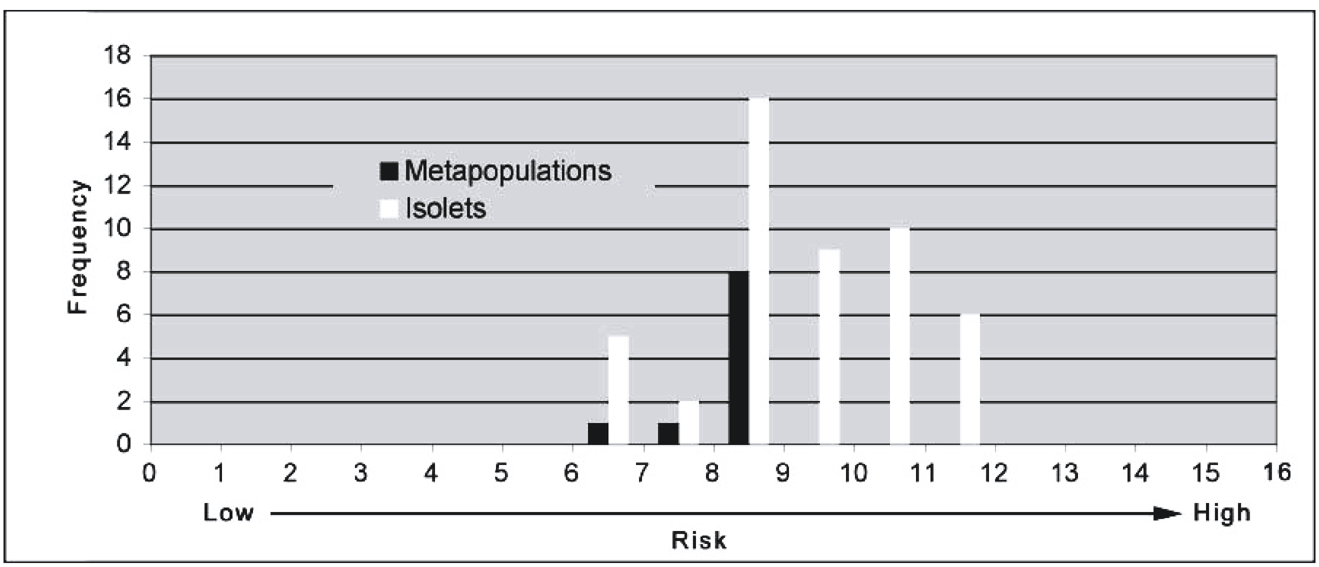

Figure 4.3. Distribution of the number of designated westslope cutthroat trout populations by composite population risk scores and population type for the Kootenai Subbasin (excludes genetic and disease risks).

Historic Status

Quantitative data on historic westslope cutthroat trout abundance and productivity in the Kootenai Subbasin is not available. Shepard et al. (2003) estimated that the subspecies historically occupied 2,640 miles of stream. It is assumed that prior to European settlement most of these streams were generally characterized by optimum habitat conditions and therefore supported abundant and productive native fisheries.

Theoretical Reference Condition[4]

In 1999, MFWP finalized a "Memorandum of Understanding and Conservation Agreement for Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in Montana" (MFWP 1999), which was 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 identified the following objectives:

LINKS

Appendix 73 is the Memorandum of Understanding and Conservation Agreement for westslope cutthroat trout in Montana

Click Here

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 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

[4] *Guidance from the NWPCC 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 in Montana."*

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 Kootenai River drainage will have at least one interconnected population. To ensure that this population persists, it 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

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 from Libby 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 ebbs and flows 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.

LINKS

For a more complete discussion of how Mainstem Columbia River operations affect subbasin fisheries, and how those effects might be minimized see Appendix 18.

Click Here

- Summer flow augmentation causes reservoirs to be drafted during the biologically productive summer months. This negatively affects 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)[5]

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) 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 likely inversely related to the amount of fine sediment in the substrate in which the fertilized eggs were deposited (Alabaster and Lloyd 1982; 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

[5] *This section is condensed from the USFWS (1999).*

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 thermal tolerance. Eaton et al. (1995) reported thermal tolerance limits for 4 species of salmonids at the 95th percentile of observed maximum water temperatures inhabited by each species. Maximum thermal tolerance limits for brook, cutthroat, rainbow, and brown trout were reported at 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 is likely an important habitat parameter for predicting westslope cutthroat trout productivity in the subbasin. Belt Supergroup rocks are generally deficient in nitrogen and phosphorous (Stanford and Hauer 1992). Hence the subbasin's bedrock geology contributes relatively little in the way of dissolved ions, nutrients, and suspended particulates to streams (Makepeace 2003). Fraley and Graham (1981b), however, found that of five geologic types in the North and Middle Forks of the Flathead (which has a bedrock geology very similar to that of much of the Kootenai), 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. The western margin of the Idaho and southern B.C. portions of the subbasin encompass a portion of the Priest River Complex, which exposes Cretaceous granitic rocks of the Kaniksu batholith (Link 2002), and which intrudes Belt Supergroup rocks. Smaller granitic intrusions also occur in other parts of the subbasin. These

LINKS

For the website containing descriptions of surface waters included in the Montana water quality assessment database go to: http://nris.state.mt.us/wis/environet/2002_305bhome.html.

Click Here

For the website listing 303(d) water-quality impaired streams and lakes for the Idaho portion of the subbasin, go to: http://inside3.uidaho.edu/WebMapping/IDEQ/

Click Here

Brook trout are believed to have displaced many westslope cutthroat trout populations. Appendix 61 lists streams in the Montana portion of the Kootenai that contain brook trout as of May 2003.

Click Here

granitic rocks generally contribute higher levels of dissolved ions, nutrients, and suspended particulates to subbasin streams than Belt rocks.

LINKS

For more detailed results of the QHA assessment, including attribute scores and HUC rankings, see Appendices 32 and 33.

Click Here

Appendix 31 summarizes the baseline condition for bull trout in bull trout drainages in the Montana portion of the Kootenai. (These determinations can also be used for assessing conditions for westslope cutthroat trout.

Click Here

Environment's Ability to Provide Key Ecological Correlates

As part of our assessment, the Kootenai Subbasin (MT, ID, and B.C.) Technical Teams[8] evaluated all the sixth code HUCs and selected lakes in the Montana, Idaho, and Canadian[9] portions of the 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 4.28). Those used in LQHA are the ones considered by our Technical Team to be the main habitat drivers in lakes in the subbasin (table 4.29). For each 6th Code HUC, the technical team used quantitative data (when it existed) and professional knowledge and judgement to score each of the attributes for each HUC. We did the same for selected lakes (table 4.30).

Table 4.31 ranks stream habitat-attributes for westslope cutthroat trout averaged across the regulated mainstem HUCs in the U.S. portion of the subbasin. Tables 4.32 and 4.33 rank stream habitat-attributes for westslope cutthroat trout averaged across all tributary 6th-code HUCs in the U.S. and B.C. portions of the subbasin, respectively. Tables 4.34 and 4.35 show the ranking by 4th-code HUC for the U.S. and B.C. portions of the subbasin. Table 4.36 ranks habitat attributes for selected subbasin reservoirs and lakes in both Canada and the U.S. The rankings provide a good indication of the subbasin's ability to provide key ecological correlates required for westslope cutthroat trout viability and persistence and the habitat attributes that may be the most limiting for westslope cutthroat trout in the subbasin.

[8] The Kootenai Subbasin Technical Team members particiapating in the HUC-by-HUC assessment included fisheries biologists and hydrologists from the Kootenai Tribe of Idaho, Montana Fish, Wildlife and Parks, Idaho Fish and Game, Idaho Department of Environmental Quality, US Army Corps of Engineers, US Fish and Wildlife Service, the Idaho Panhandle and Kootenai National Forests, two provincial Canadian ministries, and a private consulting firm.

[9] In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portions 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 4.28. 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 4.29. Habitat attributes used in the Kootenai Subbasin Lacustrine 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

LINKS

Appendix 62 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 63 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

Table 4.30. Lakes assessed in the Kootenai Subbasin using LQHA.

Lake	Location
Kootenay Lake	Canada
Moyie Lakes	Canada
Duncan Lake	Canada
Trout Lake	Canada
Koocanusa Reservoir	U.S./Canada
Kilbrennan	U.S.
Loon Lake	U.S.
Bull Lake	U.S.
Sophie Lake	U.S.
Boulder Lake	U.S.
Granite Lake	U.S.
Leigh Lake	U.S.
Therriault Lake	U.S.
McArthur Lake	U.S.

Table 4.31. Ranking of key habitat attributes for the regulated mainstem in the U.S. portion of the Kootenai Subbasin for westslope cutthroat trout based on a QHA analysis.

Habitat Attribute	Score	Rank
Oxygen	0.00	1
Pollutants	0.17	2
Obstructions	0.17	2
High Temperature	0.26	3
Low Temperature	0.33	4
Habitat Diversity	0.34	5
Channel stability	0.38	6
Fine sediment	0.38	6
Low Flow	0.40	7
High Flow	0.54	8
Riparian Condition	0.63	9

Table 4.32. Ranking of key habitat attributes for 6th-code HUC tributary watersheds in the U.S. portion of the Kootenai Subbasin for westslope cutthroat trout based on a QHA analysis.

Habitat Attribute	Score	Rank
Low Temperature	0.01	1
Oxygen	0.02	2
Pollutants	0.05	3
Obstructions	0.07	4
Low Flow	0.08	5
High Flow	0.21	6
High Temperature	0.25	7
Habitat Diversity	0.31	8
Channel stability	0.32	9
Fine sediment	0.44	10
Riparian Condition	0.47	11

Table 4.33. Ranking of key habitat attributes for 6th-code HUC watersheds in the B.C. portion of the Kootenai Subbasin for westslope cutthroat trout.

Habitat Attribute	Score	Rank
Oxygen	0.00	1
Low Temperature	0.00	1
Obstructions	0.00	1
High Temperature	0.00	1
Pollutants	0.02	2
High Flow	0.14	3
Low Flow	0.15	4
Fine sediment	0.36	5
Channel stability	0.38	6
Habitat Diversity	0.38	6
Riparian Condition	0.40	7

Table 4.34. Ranking of key stream-habitat attributes for the regulated mainstem and tributaries at the HUC-4 scale for westslope cutthroat trout in the U.S. portion of the subbasin based on a QHA analysis of all 6th-field HUCs. The most limiting attributes are highlighted in yellow.

	Regulated Mainstem		Fisher		Yaak		Lower Kootenai		Moyie		Upper Kootenai	
Habitat Attribute	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Channel stability	0.38	6	0.36	6	0.23	7	0.42	10	0.22	6	0.29	7
Fine sediment	0.38	6	0.79	8	0.36	8	0.40	9	0.21	5	0.37	9
Habitat Diversity	0.34	5	0.36	6	0.17	4	0.39	8	0.23	7	0.30	8
High Flow	0.54	8	0.23	4	0.18	5	0.21	6	0.06	3	0.23	6
High Temperature	0.26	3	0.34	5	0.19	6	0.32	7	0.21	5	0.21	5
Low Flow	0.40	7	0.11	3	0.06	3	0.06	2	0.03	2	0.09	4
Low Temperature	0.33	4	0.00	1	0.00	1	0.05	1	0.00	1	0.00	1
Obstructions	0.17	2	0.05	2	0.05	2	0.12	4	0.14	4	0.06	3
Oxygen	0.00	1	0.00	1	0.00	1	0.11	3	0.00	1	0.00	1
Pollutants	0.17	2	0.00	1	0.00	1	0.19	5	0.21	5	0.01	2
Riparian Condition	0.63	9	0.52	7	0.60	9	0.40	9	0.33	8	0.47	10

Table 4.35. Ranking of key stream-habitat attributes at the HUC-4 scale for westslope cutthroat trout in the B.C. portion of the subbasin based on a QHA analysis of all 6th-field HUCs.

	Bull River		Elk		Kootenay Lake		Kootenay River		St. Mary	
Habitat Attribute	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Channel stability	0.47	4	0.35	5	0.35	5	0.29	6	0.46	7
Fine sediment	0.53	6	0.36	6	0.33	4	0.23	4	0.35	5
Habitat Diversity	0.53	6	0.37	7	0.37	7	0.27	5	0.38	6
High Flow	0.28	3	0.13	3	0.11	2	0.06	3	0.14	3
High Temperature	0.01	2	0.00	1	0.00	1	0.00	1	0.00	1
Low Flow	0.28	3	0.15	4	0.13	3	0.05	2	0.16	4
Low Temperature	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1
Obstructions	0.00	1	0.00	1	0.00	1	-0.01	1	0.02	2
Oxygen	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1
Pollutants	0.00	1	0.11	2	0.00	1	0.00	1	0.00	1
Riparian Condition	0.52	5	0.35	5	0.36	6	0.31	7	0.47	8

Table 4.36. Ranking of key habitat attributes for reservoirs and selected lakes in the Kootenai Subbasin for westslope cutthroat trout based on a LQHA analysis.Note the lake scores are much lower than reservoir scores. Habitat attributes in lakes are relatively intact when compared to that of reservoirs.

Reservoirs	Score	Rank
Temperature	0.00	1
Oxygen	0.00	1
Gas saturation	0.00	1
Substrate condition	0.12	2
Pollutants	0.14	3
Habitat diversity	0.18	4
Volumetric turnover rates	0.33	5
Trophic status	0.34	6
Entrainment	0.40	7
Migratory obstruction	0.44	8
Macrophytes	0.46	9
Hydraulic regime	0.46	9
Shoreline condition	0.80	10
Lakes		
Oxygen	0.00	1
Gas saturation	0.00	1
Entrainment	0.00	1
Volumetric turnover rates	0.01	2
Macrophytes	0.02	3
Habitat diversity	0.03	4
Pollutants	0.03	4
Substrate condition	0.03	4
Temperature	0.04	5
Migratory obstruction	0.06	6
Hydraulic regime	0.06	6
Trophic status	0.07	7
Shoreline condition	0.09	8

Based on this analysis, of the eleven stream habitat attributes considered key to resident salmonids, the most degraded for westslope cutthroat trout in tributaries in the U.S. portion of the subbasin (when averaged across all the tributary HUCs) are riparian condition, fine sediment, channel stability, and habitat diversity, in that order. In the regulated mainstem they are riparian condition, altered hydrograph, fine sediment, and channel stability. In the B.C. portion of the subbasin they are riparian condition, habitat diversity, channel stability, and fine sediment. The rankings vary at the HUC-4 scale. Of the thirteen lake/reservoir-habitat attributes considered key to resident salmonids, the four most limiting to westslope cutthroat trout in reservoirs are: shoreline condition, hydraulic regime, macrophytes, and migratory obstructions. The habitat in lakes is in significantly better condition, and none of the lake habitat attributes scored low enough to be considered limiting.

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 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 currently occupy only 27 percent of their historic range in Montana, and genetically pure populations occupy only 3 percent of their historic range. In the U.S. portion of the Kootenai Subbasin, Shepard et al. (2003) found that non-introgressed westslope cutthroat trout occupy 5 to 72 percent of their historical habitats (the second percentage 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.

LINKS

Appendix 64 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

Based on the conclusion of these analyses, the MOA, and the conservation priority agencies have placed on westslope cutthroat trout, we believe that proper conservation, restoration, and mitigation actions will secure the long-term viability of westslope cutthroat trout in the Kootenai Subbasin.

4.2.6 Westslope Cutthroat Trout Limiting Factors and Conditions

The NPCC 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 Kootenai Subbasin Summary (Marotz et al. 2000) describes these four limiting factors (and others) as they relate to native fish in the subbasin.

In our own HUC-by-HUC assessment of all Kootenai Subbasin 6th field HUCs in the U.S., our technical team concluded that of the habitat attributes considered most important to resident salmonids, the most limiting for westslope cutthroat trout when averaged across all the HUCs in the U.S. portion of the subbasin are riparian condition, fine sediment channel stability, and habitat diversity, in that order. In the B.C. portion of the subbasin they are riparian condition, habitat diversity, channel stability, and fine sediment. 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 4.37 provides results of this survey and lists the known impacts to conservation populations and the miles of stream presently impacted within the Kootenai 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 known and suspected potential limiting factors for westslope cutthroat trout in the Kootenai River Subbasin.

Table 4.37 Known impacts to conservation populations and miles of stream presently impacted within the Kootenai Subbasin.

4th Code HUC	Management Impact	Miles Presently Impacted
Upper Kootenai	Angling	14.4
Upper Kootenai	Dewatering	14.2
Upper Kootenai	Hydroelectric, water storage, and/or flood control	8.9
Upper Kootenai	Mining	17.3
Upper Kootenai	Range (livestock grazing)	28.2
Upper Kootenai	Roads	80.2
Upper Kootenai	Stocking	26.0
Upper Kootenai	Timber Harvest	69.3
Yaak	Range (livestock grazing)	29.9
Yaak	Roads	75.8
Yaak	Stocking	29.9
Yaak	Timber Harvest	75.8

Montana Portion of the Kootenai

Timber management is the dominant land use in the Kootenai River drainage, and an extensive road system to support forestry practices and other forest uses exists throughout the Montana portion of the drainage. Forestry practices have had adverse effects on the habitats of westslope cutthroat trout in some areas of the drainage. The Montana Department of Environmental Quality (MTDEQ) lists 182 miles water in the Kootenai River drainage as being water-quality impaired as the result of silviculture and 125.5 impaired by agricultural practices; additional impairments result from other land-use practices (MTDEQ 303(d) website 2003). Many of these streams are impaired by more than one activity. However, information on the possible occurrence of westslope cutthroat trout in these streams is presently unavailable.

LINKS

For a map showing barriers to fish passage in the Montana portion of the Kootenai go to Appendix 98.

Click Here

Although harvest of westslope cutthroat trout may have caused appreciable declines in some westslope stocks during the 1900s, angler harvest is now closely regulated in Montana and is not considered a threat to the subspecies (USFWS 2002). In many waters in the Kootenai River drainage, fishing for westslope cutthroat trout is restricted to catch-and-release. Elsewhere in the drainage, harvest is greatly restricted.

Whirling disease has not been found in the Kootenai River drainage (Montana Whirling Disease Task Force Website 2003). We are aware of no other diseases or predators that pose threats to westslope cutthroat trout in the drainage.

There are no 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 on 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 habitats or by chronic, adverse effects that remain unabated.

As the result of stocking for recreational purposes, nonnative brook trout, brown trout, and rainbow trout became established long ago in many streams and lakes throughout the Kootenai River drainage. Although such stocking 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 Montana (MFWP*,* in litt. 1999).

Idaho Portion of the Kootenai

Forest management practices, including timber harvest and road construction, both past and current, are major contributors to degraded watershed conditions and aquatic habitats on public lands in Idaho. Baseline data on watershed conditions throughout this drainage are not available to precisely quantify the rates of change.

The development of road systems in the Kootenai River drainage have contributed to extensive sediment input and poor channel conditions throughout the drainage. Road densities have been used to correlate the probability of a stream to support bull trout populations (Lee et al. 1997b in USFS, in litt. 1998e)—the higher the road densities, the lower the probability of finding strong bull trout populations. Baseline environmental conditions for road densities were considered good if densities were less than 0.7 m/m^2, moderate if densities were between 0.7 m/m^2 and 1.7 m/m^2, and poor if densities were greater than 1.7 m/m^2 (Lee et al. 1997b in USFS, in litt. 1998e). While these determinations were made for bull trout, they may also be used for assessing threats to westslope cutthroat and other trout species. Until road densities are reduced significantly in this drainage, threats to westslope cutthroat trout are considerable.

The mainstem Kootenai River habitat has had dramatic changes beginning in the late 1800s. Attempts at diking began as early as 1892 in order to claim land for agricultural purposes (Paragamian 1995). Today, approximately 30 miles of the Kootenai River have been diked. In 1966, construction of Libby Dam in Montana was initiated and impoundment of Koocanusa Reservoir and regulation of downstream flows began in 1972. From 1972 to the fall of 1975, while the turbine installation was being completed, water discharge was through the sluiceways or spillways (Partridge 1983). The main purpose of Libby Dam is flood control; hydropower and recreation are secondary benefits. The flow regime of the Kootenai River has changed dramatically due to the operation of Libby Dam, and mean winter water temperatures have increased, whereas mean summer water temperatures have decreased (Partridge 1983; Paragamian 1995).

Hybridization with coastal rainbow trout and Columbia River redband trout threatens the genetic integrity of westslope cutthroat trout in the Kootenai River drainage of Idaho. Stocking of coastal rainbow trout and Yellowstone cutthroat trout in several streams and lakes in the Kootenai River drainage was common in the past (IDFG stocking records database). As stated earlier, there is evidence of introgression from nonnative species such as coastal rainbow trout and Yellowstone cutthroat trout, as well as hybridization with Columbia River redband trout (Sage 1993, 1995; Leary 1997).

The threat of hybridization to pure westslope cutthroat trout stream populations is great where pure populations of westslope cutthroat trout occupy headwater streams and hybrids or stocked nonnative fish occupy the lower portion of the same stream, and there is no migration barrier to prevent the movement upstream (Perkinson, USFS, pers. comm. 1998). Compounding this threat is the stocking of high-mountain lakes. Even where upstream migration barriers exist to prevent hybridization, if high-mountain lakes are stocked with nonnative trout species, downstream migration and subsequent gene flow from the lake are possible; hybridization and introgression may then occur throughout the stream.

Based on creel surveys, harvest does not appear to be a limiting factor in the mainstem Kootenai River, Idaho (Partridge 1983; Paragamian 1995a; Walters 2003). Although fishing pressure for westslope cutthroat trout in tributaries does not appear to be a limiting factor, no quantitative creel data exists.

Predation on westslope cutthroat trout by numerous native and non-native species is an important source of mortality and can act as a destabilizing force when habitat loss and overexploitation is experienced (Rieman and Apperson 1989). No quantitative data exists on the affects of predation on westslope cutthroat trout in the Kootenai drainage.

Diseases are potential limiting factors of fish populations. The water source for the former Clark Fork Hatchery was inhabited by brook trout that had Infectious Pancreatic Necrosis (IPN). The broodstock fish (including rainbow trout and westslope cutthroat trout) from the Clark Fork Hatchery that were used for stocking lakes, rivers, and streams in the Idaho Panhandle region were known to be infected with IPN (Horner, IDFG, pers. comm. 1999). This is a contagious virus that affects young fish, generally 80-90 mm in length, and may cause large losses (Van Duijn 1967; Horner, IDFG, pers. comm. 1999). The extent of this threat in the Kootenai River drainage is unknown. Since 1999, IDFG no longer stocks rivers and streams in the Kootenai drainage with fish from this hatchery. Available information does not identify any other disease threats in this drainage.

Heavy metals could potentially limit westslope cutthroat trout populations in the Kootenai subbasin. Metals, including copper, accumulated in food chain items in the Clark Fork River have resulted in reduced growth, deformity and death in juvenile cutthroat trout (Woodward 1993). Heavy metals released from past mining activities have been documented in the lower Kootenai River. Of those identified, copper appears to be the greatest concern biologically. Copper was found to have accumulated in oocytes of Kootenai River white sturgeon, water, and sediments from the lower Kootenai River (Apperson and Anders 1991). Although sturgeon appeared to hatch normally, potential impacts to other aquatic biota have not been evaluated. Water-quality monitoring conducted on the Kootenai River and several tributary streams by the Kootenai Tribe of Idaho indicated that mercury, lead, and selenium exceeded EPA aquatic criteria at several sites and that arsenic, copper, and lead were found in the river sediment (Kruse and Scarnecchia 2001a; Kruse and Scarnecchia 2001b).

Rieman and Apperson (1989) summarized that while competition between westslope cutthroat trout and nonnative fish is minimized in streams by habitat segregation, the loss of suitable westslope cutthroat trout habitat has allowed for nonnative fishes to expand into altered habitats. Brook trout tend to replace westslope cutthroat trout where westslope cutthroat trout have declined, whereas rainbow trout (once established and naturally reproducing) can displace westslope cutthroat trout where the two exist sympatrically. These threats occur in the Kootenai River drainage, where rainbow trout and brook trout have been observed in a few of the tributary streams surveyed.

Table 4.38, from USFWS (1999), presents the threats to westslope cutthroat trout by 4th-field HUC for the Kootenai Subbasin.

Table 4.38. 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, or as low (L), moderate (M), or extensive (E). Harvest is given as catch and release only (C & R), restricted (R), low (L), moderate (M), or extensive (E). Nonnative fish are given as yellowstone cutthroat trout (YCT), brook trout (BKT) and rainbow trout (RBT). Source: USFWS 1999.

Watershed	Upper Kootenai River	Fisher River	Yaak River	Lower Kootenai River	Moyie River
Dams	1			M/E	L
Forestry	12	3	8	M	M
Agriculture	7	2			
Water Withdrawls	10		8	M	L
Roads	3		1	E	M/E
Channelization	1	2		M	L
Mining	5			L	L
Natural Sources	3				
Water Quality	17	3	7		
Harvest	R	R	R	L/M	L
Non-native Fish	BKT RBT	BKT RBT	BKT RBT	YCT, BKT, RBT	YCT, BKT, RBT

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4.3 Columbia River Redband Trout

4.3.1 Background

Reasons for Selection as Focal Species

Globally, redband trout (*Oncorhynchus mykiss gairdneri*), a subspecies of rainbow, have a G5T4 ranking, meaning that the subspecies is apparently secure, although it may be quite rare in parts of its range, especially at the periphery. A recent status report estimated that in Oregon, Washington, Idaho, western Montana, and northern Nevada, only 4.6 percent of subwatersheds within the subspecies historic range are currently occupied by known strong populations, and 75 percent of subwatershed populations with known status are depressed (Bradley et al. 2002). Columbia River redband trout in the Kootenai River drainage in Montana represent the farthest inland penetration of native rainbow trout in the Columbia River drainage (Hensler and Muhlfeld 1999).

Region I of the US Forest Service lists Columbia River redband trout as a sensitive species. The state rank for Montana is S1, for Idaho S2S3, and the provincial rank for B.C. is S4. The S1 rank means the subspecies is critically imperiled because of extreme rarity or because of some factor(s) of its biology making it especially vulnerable to extinction. The S2 rank 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. An S3 rank means it 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 factor(s). The American Fisheries Society has listed Columbia River redband trout as a Class A Species of Special Concern since 1993. A Class A species of special concern is defined as a species or subspecies that has "limited numbers and/or habitats both in Montana and elsewhere in North America and elimination from Montana would be a significant loss to the gene pool of the species or subspecies". The USFWS also classifies Columbia River redband trout as a species of special concern (Muhlfeld 2003).

The Biodiversity Legal Fund of Colorado and Mr. Donald Kern of Kalispell, Montana, formally petitioned the USFWS to consider the Kootenai River population of Columbia River redband trout as an endangered species under the ESA on April 4, 1994. However, the petition was dismissed due to lack of information. Concern has arisen in recent years that Columbia River redband trout in the Kootenai River basin are at a high risk of extinction (Muhlfeld 1999).

Columbia River redband trout were selected as a focal species in this assessment because of their conservation rankings, current concerns over their

LINKS

Columbia River redband trout information generated by state, federal, and tribal biologists working in Montana is available from 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 fisheries information in the Kootenai in British Columbia, go to: http://srmwww.gov.bc.ca/aib/

Click Here

For an electronic library of aquatic information (including reports pertaining to Kamloop 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 go to: http://srmwww.gov.bc.ca/cdc/

Click Here

status, and their considerable evolutionary and recreational fishery importance in the Kootenai River Subbasin.

Summary of Population Data

In its Analysis of the Management Situation for the Kootenai and Idaho Panhandle National Forests, the USFS reports that current populations range from strong to depressed. In all but five of the 6-field HUCs on the Idaho Panhandle National Forest, Columbia River redband trout status is described as "presence unknown." In three HUCs, redbands are known to be present but their population status is unknown, and in two they are present but depressed. In the Upper Kootenai Subbasin, Muhlfeld (2003) reports that genetically pure stocks of Columbia River redband trout have been identified in Callahan Creek, Basin Creek, the upper north (British Columbia) and east forks of the Yaak River, and upper Big Cherry Creek and Wolf Creek (Allendorf et al. 1980; Leary et al. 1991; Huston 1995; Hensler et al. 1996). Recent results of additional genetic testing conducted by MFWP (Allendorf 2003 unpublished) show the range of genetically pure populations of redband also includes upper Libby Creek and the upper Fisher River (including the Pleasant Valley Fisher, East Fisher River drainages). The status of these Montana Columbia River redband trout populations is presumed to be stable (J. Dunnigan, MFWP, pers. comm. 2004).

LINKS

For information on the relationship between Gerrard rainbow, Kamloops, and Columbia River redband trout, see section 4.3.2.

Click Here

Columbia River redband trout are native to the lower Kootenai River in Idaho, although it is unclear how extensively the subspecies used the river below Kootenai Falls during pre-settlement times (PWI 1999). In the Kootenai River mainstem, introgression from hatchery (coastal) rainbow trout that have been stocked in the drainage is likely.

No specific trend data is available for Columbia River redband trout populations in Idaho, though there is some abundance data. In North Callahan Creek, the minimum estimated Columbia River redband trout density was 8.7 fish/100m^2, while in South Callahan Creek the minimum density was 9.3 fish/100m^2 based on electrofishing in August 2003 (IDFG unpublished data). In Boulder Creek, estimated summer Columbia River redband trout densities ranged from 5.5 fish/100m^2 to 44.7 fish/100m^2 (Fredericks and Hendricks 1997; Walters 2002, 2003). In the Deep Creek drainage, densities ranged from 7.8 fish/100m^2 to 108.5 fish/100m^2 in summer 1996 (Fredericks and Hendricks 1997). In the Kootenai River, Idaho, Columbia River redband trout densities (age-2 and older) ranged from 33 fish/km (0.03 fish/100m^2) to 73 fish/km (0.07 fish/100m^2) (Paragamian 1995a and b; Downs 2000; Walters and Downs 2001).

Historic Distribution

Redband trout of the Columbia River basin (*Oncorhynchus mykiss gairdneri)* are a subspecies of the rainbow trout evolutionary line (*Oncorhynchus mykiss*) native to the Fraser River Basin and Columbia River Basin east of the Cascade Mountains to barrier falls on the Pend Oreille, Spokane, Snake and Kootenai rivers (Allendorf et al. 1980; Behnke 1992). They are also native to Kootenay Lake, B.C. and the Kootenai River in Idaho and Montana.

In its Analysis of the Management Situation (KIPNF 2003), the USFS reported that historically, Columbia River redband trout were the most widely distributed salmonid in the Columbia River Basin, but that they were not naturally widespread in areas within the Kootenai and Idaho Panhandle National Forests. For years, the upper distribution of redband trout in the Columbia River Basin was believed to extend upstream to Kootenai Falls, which was considered a barrier falls (Allendorf et al. 1980; Chapman and May 1986), but it is now thought the barrier was not Kootenai Falls, but one that existed in geologic time near the present day Libby Dam or Fisher River (Hensler et al. 1996). Genetic surveys also indicate that Columbia River redband trout were not just found in headwater reaches as they are now, but were native to low-gradient valley-bottom streams throughout the Kootenai River drainage (Muhlfeld 1999). This range contraction may have occurred in response to past and present land use and fishery management practices.

Appendices 32 and 33 list streams and selected lakes in the Kootenai Subbasin (B.C., ID, and MT portions) that were thought to support populations of Columbia River redband trout prior to European settlement.

LINKS

For Columbia River redband trout abundance and distribution information for the U.S. portion of the subbasin go to Appendix 55.

Click Here

Current Distribution[1]

Based on genetic analyses in Montana, populations of Columbia River redband trout have been identified in Callahan Creek, the East Fork Yaak River and its tributaries, the Yaak River (downstream from Yaak Falls), the North Fork Yaak River, and tributaries to Libby Creek and the upper Fisher River (including the Pleasant Valley Fisher, East Fisher River drainages) (Allendorf et al. 1980; Leary et al. 1991; Huston 1995; Hensler et al. 1996; Knudsen 2002). Currently, unintrogressed Columbia River redband trout populations are restricted to headwater reaches. Columbia River redband trout inhabiting Callahan Creek and the upper Yaak drainage are isolated into two separate regions by Yaak River Falls, a falls-chute barrier located 4 km from the mouth of Callahan Creek and a barrier falls located in the lower East Fork of the Yaak river. Telemetry-based research conducted by MFWP (1999) suggest that Columbia River redband trout

[1] *Excerpted from Muhlfeld 1999.*

in Basin Creek and East Fork Yaak River (upstream from the barrier falls) may represent a metapopulation of Columbia River redband trout that includes both resident and fluvial life history forms.

Columbia River redband trout did not occur in the section of the Kootenai River above the current site of Libby Dam prior to impoundment but are now present, and they continue to be stocked. Five thousand Gerrard rainbow trout were stocked annually into Kikomun Creek, a tributary to Koocanusa Reservoir, between 1986 and 1998 by the B.C. Ministry of the Environment. This practice was discontinued because of concerns with hybridization of stocked rainbow trout with westslope cutthroat trout. (For more information on the relationship between Gerrard rainbow, Kamloops, and Columbia River redband trout, see section 4.3.2: Population Delineation and Characterization.) MFWP continues to stock rainbow trout into the reservoir; MFWP stocks hatchery-reared Duncan strain from the Murray Springs Fish Hatchery (Dalbey et al. 1998; B. Marotz, MFWP, pers. comm. 2003).

In Idaho, genetics studies have documented Columbia River redband trout in the Boulder, Boundary, and Deep creek drainages, and North and South Callahan Creeks (Sage 1993, 1995; Leary 1997; Knudsen et al. 2002; M. Powell, U. of Idaho, pers. comm.). Spawning and rearing habitat in several Idaho tributaries has been lost or is now inaccessible to fluvial Columbia River redband trout due to anthropogenic factors (Partridge 1983). These streams include, but are not limited to, Caboose, Cow, Debt, and Twenty-Mile creeks. In addition, mining activities in Boundary Creek may be detrimental to fish populations due to heavy metal concentrations (Partridge 1983).

LINKS

For a MFWP map showing Columbia River redband trout genetic distribution in the Montana portion of the Kootenai, see Appendix 74.

Click Here

QHA spreadsheets contain current and historic Columbia River redband trout distribution by lifestage for HUC-6 watersheds and selected lakes in the U.S. and B.C. portions of the Kootenai. These data are a compilation put together by our Technical Team. Go to Appendices 32 and 33.

Click Here

Status of Columbia River Redband Trout Introductions, Artificial Production and Captive Breeding Programs

MFWP has developed an isolation facility for the conservation of Columbia River redband trout at the Libby Field Station. Existing ponds were restored and the inlet stream was enhanced for natural outdoor rearing. The agency treated the newly renovated spring creek and pond with antimycin on November 1, 2000, to remove eastern brook trout and non-native rainbow trout. Native Columbia River redband trout from Basin Creek were stocked into the pond and spring creek in early May 2001 to provide a future source of eggs for restoring redband stocks within their historic range in the Kootenai River basin. The isolation facility also provides a source of native redband for use as an alternative to stocking lakes and private ponds with non-native fish.

Koocanusa Reservoir is currently stocked with redband trout from Murray Springs State Trout Hatchery. Those fish are presumed to be Duncan Kamloops redband trout (Knudsen et al. 2002).

Table 4.39. Angling pressure on waters in the Kootenai Subbasin (in angler days per year). Source: MFWP 2003

Watershed	1997	1999	2001
17010101 Upper Kootenai	66,191	61,074	61,687
17010102 Fisher	8534	8399	5589
17010103 Yaak	6513	4557	5,650
Totals	81,238	74,030	72,926

Historic and Current Harvest

Fisheries managers in the Montana portion of the Kootenai River Subbasin have actively protected Columbia River redband trout with increasingly restrictive harvest regulations: i.e., a shortened season (July 1 to Nov. 30 and a combined trout limit of 3 daily). Specific data on the extent of historic and current harvest of Columbia River redband trout in Montana are not available. Table 4.39 presents annual angler-day estimates in the Montana portion of the Kootenai Subbasin.

In the Kootenai River in Idaho, an estimated 1,040 (95% C.I. = ± 905) Columbia River redband trout were harvested in 1993, and 1,882 (95% C.I. = ± 1,209) were harvested in 2001 (Paragamian 1995a; Walters 2003). In the 1993 survey, Columbia River redband trout was the second most abundant species in the harvest following mountain whitefish, and in 2001, Columbia River redband trout was the most common species harvested. On January 1, 2002, new regulations for trout in the Kootenai River in Idaho were initiated. The bag limit is now two trout (redband, westslope cutthroat, or hybrids) with a 16" (406 mm) minimum length limit. There is no closed season for trout in the mainstem Kootenai River, Idaho. Regulations prior to 2002 included a 6-trout bag limit with no minimum length limit. Kootenai River Idaho tributaries have a Memorial Day weekend opener (last weekend in May) and November 30, season closure. A 6-fish bag limit is allowed in the tributaries. However, fishing pressure for Columbia River redband trout in the tributaries appears to be minimal due to limited access or private property (J. Walters, Idaho Department of Fish and Game, pers. comm. 2003).

4.3.2 Population Delineation and Characterization

Population Units

Behnke (1992) separated rainbow trout into the following three separate evolutionary significant groups: 1) the redband trout of the Sacramento, Kern, and McCloud Rivers in California, 2) the Columbia River redband trout of the Columbia and Fraser River basins located east of the Cascade Mountains to barrier falls on the Kootenai, Pend Oreille, Spokane, and Snake rivers and 3) coastal rainbow trout. Under this taxonomy, all redband trout of the Columbia and Fraser River basins are classified as *O. mykiss gairdneri* (Muhlfeld 2003).

Based on MFWP genetics and behavioral data, we conclude that there are (at least) two distinct Columbia River redband trout population units in the Montana portion of the Kootenai: the Yaak (above Yaak Falls) and the Kootenai populations, like Callahan Creek (Knudsen et al. 2002; Muhlfeld et al. 2001). These populations are genetically distinct and isolated from genetic exchange. They constitute separate, naturally reproducing populations (Clint Mulfield, MFWP, pers. comm. 2003). The Gerrard strain (Kamloops) native to Kootenay Lake, a large adfluvial form, is likely the parent stock to the Montana resident populations and is genetically distinct from the Yaak population (Clint Mulfield MFWP pers. comm. 2003). The Kamloops redband trout is more similar genetically to the Callahan Creek fish (Knudsen et al. 2002). Gene flow between Kootenay Lake and Callahan Creek redband trout is possible because migratory Kamloops redband trout have been found in the Kootenai River upstream of the mouth of Callahan Creek, and the barriers on Callahan Creek could have been breached by migrating Kamloops redband trout in the past (Knudsen et al. 2002). At present there is not sufficient information to determine if Callahan Creek redband and Kamloops redband constitute distinct population units.

In Idaho, redband trout in the Boundary Creek drainage are also likely similar to the Kamloops strain. Adfluvial fish from Kootenay Lake should have access to this drainage, as Partridge (1983) reported there were no known migration barriers. The Boulder Creek population could be considered a distinct population unit because a waterfall approximately 2 km from the mouth (and downstream of the E. Fork Boulder Creek) is a barrier to upstream migration (Partridge 1983).

LINKS

For current and historic fish stocking records in Montana, go to: *http://www.fwp.state.mt.us/fishing/stock02.asp*

Click Here

For stocking information for Idaho, go to: http://www2.state.id.us/fishgame/fish/fishstocking/stocking/year.cfm?region=1

Click Here

Life History[2]

A variety of life history strategies can be found among Columbia River redband trout. Anadromous stocks (which are known commonly as steelhead) historically migrated to the middle and upper Columbia River drainage, but this range probably became more restricted when barriers formed during the last (Tahoe stage) glacial advance (Behnke 1992). So there are presently redband trout populations isolated from anadromous influence, such as in Kootenay Lake and the Kootenai River upstream. An adfluvial form, the Kamloops redband trout of Kootenay Lake, British Columbia, has a piscivorous diet and therefore grows quite large and exhibits an advanced size at sexual maturity. Kamloops redband trout spawn in Kootenai River tributaries in Montana and Idaho but do not migrate upstream from Kootenai Falls (Huston 1995). Fluvial stocks occupy large rivers and spawn in smaller

[2] *The first paragraph of this section is adapted from Mulfeld (2002)*

tributaries. Resident forms complete their entire life cycles in smaller tributaries and headwater areas. The Kootenai River drainage supports all three life histories (Downs 1999, 2000; Muhlfeld et al. 2001b; Walters and Downs 2001; Knudsen 2002). The different redband trout life history forms are indistinguishable using meristic counts, coloration patterns, or allozyme data (Knudsen et al. 2002).

Columbia River redband trout generally spawn between March and June depending on water temperatures. In Basin Creek, Montana, adult Columbia River redband trout commenced spawning (e.g. redd construction) during June as spring flows subsided following peak runoff. (Muhlfeld 2002). In the Deep Creek drainage of Idaho, Columbia River redband trout spawned during April and May (Downs 2000). Emerging from the redd about two months after spawning, the fry occupy the stream anywhere from one year to the rest of their life (depending on their life-history form). Adfluvial and migratory fluvial juveniles typically move downstream to their ancestral lake or river after 1 to 3 years of headwater residence. Most juveniles out-migrate from the Deep Creek drainage at age-1 or 2 (Fredericks and Hendricks 1997; Downs 1999, 2000) Out-migrants from the Boundary Creek drainage were mainly age-2 and age-3 (Walters and Downs 2001). In Idaho tributaries upstream of Deep Creek, a large proportion of Columbia River redband trout may out-migrate at age-0 (Walters 2002, 2003). Sexual maturity typically occurs at 3 to 5 years. Sympatric interior redband and westslope cutthroat trout populations appear to have evolved strategies to limit introgression, as observed in Yaak River tributaries.

Genetic Integrity

Allendorf and others (1980) surmised that "planting of hatchery rainbow trout has created a situation of tremendous genetic divergence among local populations." Muhlfeld (2003) reported that genetically pure stocks of Columbia River redband trout have been identified in Callahan Creek, Basin Creek, the upper north (British Columbia) and east forks of the Yaak River, and upper Big Cherry Creek and Wolf Creek (Allendorf et al. 1980; Leary et al. 1991; Huston 1995; Hensler et al. 1996). Recent genetic testing conducted by MFWP (Allendorf 2003 unpublished) shows the range of genetically pure populations of redband also includes upper Libby Creek and the upper Fisher River (including the Pleasant Valley Fisher and East Fisher River drainages). Those inhabiting Callahan Creek and the upper Yaak River Drainage are isolated into two separate regions by Yaak River Falls, a falls-chute barrier located 4 km from the mouth of Callahan Creek and a barrier falls located in the lower East Fork of the Yaak River.

Rainbow trout in the Boulder Creek drainage of Idaho had alleles of Columbia River redband trout, coastal rainbow trout and westslope cutthroat trout (Sage 1993; Leary 1997). Columbia River redband trout in the Deep Creek

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 69.

Click Here

For a MFWP map showing Columbia River redband trout genetic distribution in the Montana portion of the Kootenai, see Appendix 74.

Click Here

drainage appear to have coastal rainbow trout genes as well (M. Powell, Univ. of Idaho, personal communication). Sage (1995) identified redband X westslope cutthroat trout hybrids from Boundary Creek, with a larger proportion of interior (redband) rainbow trout genes. Sage (1995) determined that samples from Grass and Saddle creeks (Boundary Creek drainage) were Columbia River redband trout. Fish from North and South Callahan creeks were identified as pure Columbia River redband trout (Sage 1995; Knudsen et al. 2002). Genetic testing of fish from the mainstem Kootenai River in Idaho has not been conducted.

Our QHA analysis for the U.S. portion of the Kootenai River drainage (Montana and Idaho), showed that Columbia River redband trout from thirty-seven of the 6th-code HUCs were estimated to be genetically pure. Eighteen (43 percent) of those had stocks believed to be less than 10% introgressed, and 21 (57 percent) had stocks believed to be greater than 10% introgressed.

It is interesting to note that several tributaries in the Yaak River in Montana currently contain Columbia River redband trout and westslope cutthroat trout that have apparently coexisted with no introgression. Apparently when humans have not tampered with the fish community, the redband and westslope cutthroats segregate temporally and physically in their respective spawning areas (Marotz, MFWP, pers. comm. 2003), and where hatchery fish have been introduced, this segregation breaks down and hybridization occurs. The currently unintrogressed population in Callahan Creek, Montana, is apparently protected by a passage barrier created by two falls/cataracts in the lower reach of this Kootenai River tributary.

4.3.3 Population Status

Current Status

Though redband trout are broadly distributed (they occur in Idaho, Oregon, Washington, Nevada, California and Montana), few strong populations remain. Lee and others (1997) reported that known or predicted secure populations inhabit 17 percent of the historic range and 24 percent of the present range and that only 30 percent of the watersheds currently supporting spawning and rearing populations are considered strong. Populations in Montana, Oregon, and California have been petitioned for listing under the Endangered Species Act (ESA). The California petition is currently under review, the 1994 petition in Montana was dismissed due to lack of information, and the 1999 petition to list the Great Basin redband trout in Oregon was deemed unwarranted at this time.

The status of Montana Columbia River redband trout populations is presumed to be stable (J. Dunnigan, MFWP, pers. comm. 2004). On the Idaho Panhandle National Forest, little is known about the status of Kootenai-drainage

Columbia River redband trout populations. In all but five of the 6-field HUCs in the Idaho portion of the Kootenai, the Columbia River redband trout status is described by the USFS as "presence unknown". In three HUCs, redbands are known to be present but their population status is unknown, and in two they are present but depressed. PWI (1999) reports that the rainbow trout population in the lower Kootenai River itself (downstream of Kootenai Falls) may be the strongest stock of all the salmonids, but that the genetic integrity of the native interior redband has been significantly compromised through stocking of non-native rainbow strains and hybridization with cutthroat trout.

Some abundance data has been collected, but little is known about capacity or productivity from the Idaho portion of the drainage. In North Callahan Creek, the minimum estimated Columbia River redband trout density was 8.7 fish/100m^2, while in South Callahan Creek the minimum density was 9.3 fish/100m^2 based on electrofishing in August 2003 (Idaho Department of Fish and Game unpublished data). In Boulder Creek, estimated summer Columbia River redband trout densities (age-2 and older) ranged from 5.5 fish/100m^2 to 44.7 fish/100m^2 (Fredericks and Hendricks 1997; Walters 2002, 2003). Boulder Creek is the largest source of juvenile redband recruitment to the Kootenai River, Idaho upstream of Deep Creek (Walters 2003). In the Deep Creek drainage, densities (age-2 and older) ranged from 7.8 fish/100m^2 to 108.5 fish/100m^2 in the summer of 1996 (Fredericks and Hendricks 1997). In the Kootenai River, Idaho, Columbia River redband trout densities (age-2 and older) ranged from 33 fish/km (0.03 fish/100m^2) to 73 fish/km (0.07 fish/100m^2) (Paragamian 1995a and b; Downs 2000; Walters and Downs 2001).

The Kootenai River drainage supports adfluvial, fluvial, and resident life history forms of Columbia River redband trout (Downs 1999, 2000; Muhlfeld et al. 2001b; Walters and Downs 2001; Knudsen 2002). Some life history forms have probably been eliminated from some tributaries. For example, culverts on Cow and Twentymile Creeks (Deep Creek drainage) are barriers to upstream migration, leaving little if any accessible spawning habitat in those streams for adfluvial fish.

Rainbow trout in the Boulder Creek drainage of Idaho had alleles of Columbia River redband trout, coastal rainbow trout, and westslope cutthroat trout (Sage 1993; Leary 1997). Columbia River redband trout in the Deep Creek drainage appear to have coastal rainbow trout genes as well (M. Powell, Univ. of Idaho, personal communication). Sage (1995) identified redband X westslope cutthroat trout hybrids from Boundary Creek, with a larger proportion of interior (redband) rainbow trout genes. Sage (1995) determined that samples from Grass and Saddle creeks (Boundary Creek drainage) were Columbia River redband trout. Fish from North and South Callahan creeks were identified as pure

LINKS

Columbia River redband trout genetic purity information for the Upper Kootenai in Montana and status information for redbands in Montana and Idaho are summarized in Appendix 55.

Click Here

LINKS

For a more complete discussion of how Mainstem Columbia River operations affect subbasin fisheries, and how those effects might be minimized see Appendix 18.

Click Here

Columbia River redband trout (Sage 1995; Knudsen et al. 2002). Genetic testing of fish from the mainstem Kootenai River in Idaho has not been conducted. As part of a management plan, a drainage-wide analysis of the genetic status of rainbow trout would reduce the uncertainty of the Columbia River redband trout distribution in Idaho.

Given the lack of pre-1970s data for the Kootenai drainage, it is difficult to document population changes and assign a risk rating to Columbia River redband trout. However, as stated earlier, the USFWS was petitioned to consider the Kootenai River population of Columbia River redband trout as an endangered species under the ESA on April 4, 1994. Recent concern has arisen that the Kootenai River Basin Columbia River redband trout population is at a high risk of extinction due to hybridization with non-native coastal rainbow trout, habitat fragmentation, and stream habitat degradation (Perkinson 1993; Muhlfeld 1999). Libby Dam has caused dramatic changes to the river including an altered hydrograph (including higher winter flows and the elimination of flood events) and lower biological productivity. In addition, anthropogenic effects have caused the loss of, or inaccessibility to, Columbia River redband trout habitat in tributaries (Partridge 1983). At best, the risk rating should probably be “unknown” for at least some populations, and possibly “depressed” or “critical” for some in the drainage.

Historic Status

Quantitative empirical data on historic Columbia River redband trout abundance and productivity in the Kootenai Subbasin are not available. It is known that historically, Columbia River redband trout occupied much of the Kootenai River system downstream from Kootenai Falls, including the Yaak River. Isolated populations exist today in the Fisher River drainage, which is upstream from Kootenai Falls, and it is believed the passage barrier preventing upstream movement in the Kootenai system existed in geologic time near the present day Libby Dam or Fisher River (Hensler et al. 1996). It is also assumed that historically (prior to European settlement) most of these streams were generally characterized by optimum habitat conditions and therefore likely supported abundant and productive native fisheries.

Theoretical Reference Condition[3]

Although a specific theoretical reference condition remains unknown for Columbia River redband trout in the Kootenai River Subbasin, the management goal for Columbia River redband trout in the U.S. portion of the subbasin is to ensure the long-term, self-sustaining persistence of the subspecies within the drainages they historically inhabited and to maintain the genetic diversity and life history strategies represented by the remaining local populations.

LINKS

Appendix 76 includes four scientific papers on Montana Columbia River redband trout habitat use and genetic structure.

Click Here

4.3.4 Out-of-Subbasin Effects and Assumptions

Out-of-subbasin effects and assumptions are similar to those described for westslope cutthroat trout (see the focal species description for westslope cutthroat trout).

4.3.5 Environment-Population Relationships

Environmental Factors Particularly Important to Columbia River redband trout Survival or Key Ecological Correlates (KECs)[4]

Seasonal habitat requirements of Columbia River redband trout in the Kootenai River drainage in Montana were investigated during 1997 and 1998 (Muhlfeld 1999; Hensler and Muhlfeld 1999; Muhlfeld et al. 2001a; Muhlfeld et al. 2001b). Summer results demonstrated that juvenile (36-125 mm) and adult (> 126 mm) Columbia River redband trout preferred deep microhabitats (> 0.4 m) with low to moderate velocities (< 0.5 m/s) adjacent to the thalweg. Conversely, age-0 (< 35mm) Columbia River redband trout selected slow water (< 0.1 m/s) and shallow depths (< 0.2 m) located in lateral areas of the channel. Age-0, juvenile and adult Columbia River redband trout strongly selected pools and avoided riffles; runs were used generally as expected (based on availability) by juveniles and adults and more than expected by age-0 Columbia River redband trout. At the macrohabitat scale, a multiple regression model indicated that low-gradient, mid-elevation reaches with an abundance of complex pools were critical areas for the

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[3] *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 Columbia River redband trout, which are not listed under ESA, we have modeled our theoretical reference condition after the"Memorandum of Understanding and Conservation Agreement for Westslope cutthroat trout (Oncorhynchus clarki lewisi) in Montana.*

[4] *This section adapted from the Muhlfeld (2003).*

production of Columbia River redband trout. Mean reach densities ranged from 0.01-0.10 fish/m2. During the fall and winter period, adult Columbia River redband trout occupied small home ranges and found suitable overwintering habitat in deep pools with extensive amounts of cover in headwater streams. In Basin Creek, adult Columbia River redband trout began spawning (e.g., redd construction) during June as spring flows subsided following peak runoff. Columbia River redband trout generally selected redd sites in shallow pool tail-out areas (mean depth = 0.27 m; range: 0.20-0.46) with moderate water velocities (mean velocity = 0.50 m/s; range: 0.23-0.69 m/s) dominated by gravel substrate.

LINKS

For more detailed results of the QHA assessment, including attribute scores and HUC rankings, see Appendices 32 and 33.

Click Here

Environment s Ability to Provide Key Ecological Correlates

As part of our assessment, the Kootenai Subbasin (MT, ID, and B.C.) Technical Teams[5] evaluated all the sixth code HUCs and selected lakes in the Montana, Idaho, and Canadian[6] portions of the 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 4.40). Those used in LQHA are the ones considered by our Technical Team to be the main habitat drivers in lakes in the subbasin (table 4.41). For each 6th Code HUC, the Technical Team used quantitative data (when it existed) and professional knowledge and judgement to score each of the attributes for each HUC. We did the same for selected lakes (table 4.42).

Table 4.43 provides a ranking of stream habitat-attributes for Columbia River redband trout averaged across the regulated mainstem HUCs in the U.S. portion of the subbasin. Tables 4.44 and 4.45 show the rankings for stream habitat-attributes for Columbia River redband trout averaged across all tributary 6th-code HUCs in the U.S. and B.C. portions of the subbasin, respectively. Tables

[5] *The Technical Team included fisheries biologists and hydrologists from the KTOI, MFWP, IDFG, IDEQ, USACE, USFWS, the IPNF, KNF, two provincial Canadian ministries, and a consulting firm.*

[6] *In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portions 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 4.40. 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 4.41. Habitat attributes used in the Kootenai Subbasin Lacustrine 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 4.42. Lakes assessed in the Kootenai Subbasin using the Lacustrine QHA spreadsheet tool.

Lake	Location
Kootenay Lake	Canada
Moyie Lakes	Canada
Duncan Lake	Canada
Trout Lake	Canada
Koocanusa Reservoir	U.S./Canada
Kilbrennan	U.S.
Loon Lake	U.S.
Bull Lake	U.S.
Sophie Lake	U.S.
Boulder Lake	U.S.
Granite Lake	U.S.
Leigh Lake	U.S.
Therriault Lake	U.S.
McArthur Lake	U.S.

Table 4.43. Ranking of key habitat attributes for the regulated mainstem in the U.S. portion of the Kootenai Subbasin for Columbia River redband trout based on a QHA analysis.

Habitat Attribute	Score	Rank
Oxygen	0.00	1
Obstructions	0.16	2
Pollutants	0.17	3
Habitat Diversity	0.26	4
High Temperature	0.33	5
Channel stability	0.38	6
Fine sediment	0.40	7
Low Temperature	0.45	8
High Flow	0.51	9
Riparian Condition	0.64	10
Low Flow	0.86	11

Table 4.44. Ranking of key habitat attributes for 6th-code HUC tributary watersheds in the U.S. portion of the Kootenai Subbasin for Columbia River redband trout based on a QHA analysis.

Habitat Attribute	Score	Rank
Low Temperature	0.03	1
Oxygen	0.03	1
Obstructions	0.07	2
Pollutants	0.08	3
High Flow	0.21	4
Low Flow	0.25	5
Habitat Diversity	0.28	6
Channel stability	0.40	7
High Temperature	0.41	8
Riparian Condition	0.52	9
Fine sediment	0.52	9

Table 4.45. Ranking of key habitat attributes for 6th-code HUC watersheds in the B.C. portion of the Kootenai Subbasin for Columbia River redband trout.

Habitat Attribute	Score	Rank
Low Temperature	0.00	1
Obstructions	0.00	1
Pollutants	0.01	2
Oxygen	0.01	2
High Temperature	0.02	3
Low Flow	0.04	4
High Flow	0.05	5
Habitat Diversity	0.17	6
Fine sediment	0.20	7
Channel stability	0.21	8
Riparian Condition	0.26	9

Table 4.46. Ranking of key stream-habitat attributes for the regulated mainstem and tributaries at the HUC-4 scale for Columbia River redband trout in the U.S. portion of the subbasin based on a QHA analysis of all 6th-field HUCs. The most limiting attributes are highlighted in yellow.

	Regulated Mainstem		Upper Kootenai		Fisher		Yaak		Lower Kootenai		Moyie	
Habitat Attribute	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Channel stability	0.38	6	0.48	9	0.42	6	0.25	6	0.45	8	0.38	7
Fine sediment	0.40	7	0.16	5	0.89	9	0.39	7	0.42	7	0.33	6
Habitat Diversity	0.26	4	0.32	7	0.33	5	0.13	3	0.31	6	0.29	5
High Flow	0.51	9	0.14	4	0.26	3	0.19	4	0.22	5	0.13	2
High Temperature	0.33	5	0.39	8	0.51	7	0.25	6	0.46	9	0.33	6
Low Flow	0.86	11	0.30	6	0.32	4	0.24	5	0.19	4	0.19	4
Low Temperature	0.45	8	0.05	2	0.00	1	0.00	1	0.09	1	0.00	1
Obstructions	0.16	2	0.06	3	0.05	2	0.03	2	0.11	2	0.15	3
Oxygen	0.00	1	0.00	1	0.00	1	0.00	1	0.13	3	0.00	1
Pollutants	0.17	3	0.00	1	0.00	1	0.00	1	0.22	5	0.29	5
Riparian Condition	0.64	10	0.50	10	0.58	8	0.61	8	0.42	7	0.46	8

4.46 and 4.47 show the ranking by 4th-code HUC for the U.S. and B.C. portions of the subbasin. Table 4.48 ranks habitat attributes for selected subbasin reservoirs and lakes in both Canada and the U.S. The rankings provide a good indication of the subbasin's ability to provide key ecological correlates required for Columbia River redband trout viability and persistence and the habitat attributes that may be the most limiting for Columbia River redband trout in the subbasin.

Based on this analysis, of the eleven stream habitat attributes considered key to resident salmonids, the most degraded for Columbia River redband trout in tributaries in the U.S. portion of the subbasin (when averaged across all the

Table 4.47. Ranking of key stream-habitat attributes at the HUC-4 scale for Columbia River redband trout in the B.C. portion of the subbasin based on a QHA analysis of all 6th-field HUCs.

	Duncan Lake		Kootenay Lake		Kootenay River		Slocan	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
Channel stability	0.22	6	0.20	7	0.14	3	0.25	8
Fine sediment	0.17	4	0.20	7	0.14	3	0.32	9
Habitat Diversity	0.14	3	0.18	6	0.10	2	0.22	7
High Flow	0.01	2	0.09	5	0.00	1	0.08	6
High Temperature	0.00	1	0.00	1	0.00	1	0.08	6
Low Flow	0.00	1	0.08	4	0.00	1	0.05	5
Low Temperature	0.00	1	0.00	1	0.00	1	0.00	1
Obstructions	0.00	1	0.00	1	0.00	1	0.01	2
Oxygen	0.00	1	0.03	3	0.00	1	0.02	3
Pollutants	0.00	1	0.01	2	0.00	1	0.03	4
Riparian Condition	0.20	5	0.30	8	0.14	3	0.34	10

Table 4.48. Ranking of habitat attributes for selected lakes and reservoirs for Columbia River redband trout based on a LQHA analysis. Note lake scores are much lower than reservoir scores.

Reservoirs	**Score**	**Rank**
Gas saturation	0.00	1
Macrophytes	0.04	2
Habitat diversity	0.07	3
Pollutants	0.08	4
Entrainment	0.17	5
Oxygen	0.19	6
Trophic status	0.21	7
Substrate condition	0.24	8
Volumetric turnover rates	0.26	9
Temperature	0.27	10
Shoreline condition	0.28	11
Migratory obstruction	0.37	12
Hydraulic regime	0.46	13
Lakes	**Score**	**Rank**
Oxygen	0.00	1
Gas saturation	0.00	1
Volumetric turnover rates	0.00	1
Entrainment	0.00	1
Hydraulic regime	0.00	1
Macrophytes	0.00	1
Habitat diversity	0.01	2
Trophic status	0.01	2
Substrate condition	0.01	2
Pollutants	0.02	3
Temperature	0.02	3
Shoreline condition	0.03	4
Migratory obstruction	0.03	4

tributary HUCs) are fine sediment, riparian condition, altered thermal regime, and channel stability, in that order. In the regulated mainstem they are altered hydrograph, riparian condition, altered thermal regime, and fine sediment. In the B.C. portion of the subbasin they are riparian condition, channel stability, fine sediment, and habitat diversity. The rankings vary at the HUC-4 scale. Of the thirteen lake/reservoir-habitat attributes considered key to resident salmonids, the four most limiting to Columbia River redband trout in reservoirs are hydraulic regime, migratory obstructions, shoreline condition, and temperature. The habitat in lakes is in significantly better condition, and none of the lake habitat attributes scored low enough to be considered limiting.

Long-term Viability of Columbia River redband trout Populations Based on Habitat Availability and Condition

Region I of the US Forest Service lists Columbia River redband trout as a sensitive species. The state rank for Montana is S1, for Idaho S2S3, and for B.C. S4. The S1 rank means the subspecies is critically imperiled because of extreme rarity or because of some factor(s) of its biology making it especially vulnerable to extinction. The S2 rank 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. An S3 rank means 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 factor(s). The American Fisheries Society has listed Columbia River redband trout as a Class A Species of Special Concern since 1993. A Class A species of special concern is defined as a species or subspecies that has "limited numbers and/or habitats both in Montana and elsewhere in North America and elimination from Montana would be a significant loss to the gene pool of the species or subspecies." Monitoring of at least some populations will be crucial in determining long-term viability.

4.3.6 Columbia River Redband Trout Limiting Factors and Conditions

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 assessment of Kootenai Subbasin 6th field HUCs, we concluded the most limiting habitat attributes for Columbia River redband trout in U.S. tributaries are riparian condition, fine sediment, high temperature, and channel stability, in that order. In the mainstem, the most limiting were altered hydrograph

LINKS

Appendix 62 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 63 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

Appendix 64 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

due to Libby Dam, riparian condition, low temperature, and fine sediment. In the B.C. portion of the subbasin the most limiting habitat attributes include riparian condition, channel stability, fine sediment, and habitat diversity. The rankings vary at the HUC-4 scale. Biological limiting factors in U. S. tributaries include non-native species, system productivity, and connectivity between the mainstem and tributaries. Biological limiting factors in the U. S. mainstem include non-native species and system productivity. In lakes the most limiting attributes are hydraulic regime, migratory obstructions, shoreline condition, and temperature. 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).

Land and water use practices[7], habitat loss, over harvest, hybridization and a geographical restricted range are leading factors contributing to the decline of Columbia River redband trout abundance, distribution and genetic diversity in the Columbia River basin (Williams et al. 1989; Behnke 1992). Habitat degradation has been primarily attributed to poor land management practices, construction of dams and diversions, and floodplain development. Land development activities such as road construction, logging and grazing can alter substrate composition and reduce the frequency and area of pools, which may have very deleterious effects to the abundance and distribution of Columbia River redband trout. Recent concern has arisen that Kootenai River Basin Columbia River redband trout populations are at a high risk of extinction due to hybridization with non-native coastal rainbow trout, habitat fragmentation, and stream habitat degradation (Perkinson 1993; Muhlfeld 1999). Genetic introgression with coastal rainbow trout has been documented in both Idaho and Montana (Sage 1993; Leary 1997; Knudsen et al. 2002; M. Powell, Univ. of Idaho, personal communication). Habitat fragmentation examples include aggraded alluvial fans preventing migration from tributary streams, and culvert barriers preventing upstream migration of adults to spawning habitat (Partridge 1983; Downs 2000; Walters 2002, 2003). Introductions of non-native trout including coastal rainbow trout, brown trout (*Salmo trutta*), and eastern brook trout (*Salvelinus fontinalis*), could lead to competition and species replacement. Stocking non-native fish upstream from geologic barriers and in adjacent drainages poses a threat to the genetic purity and population persistence of isolated populations of Columbia River redband trout.

Libby Dam is responsible for several physical (habitat) and biological changes that together are probable limiting factors for Columbia River redband

[7] *Portions of this paragraph are excerpted from Muhlfeld (2003). See also the section titled Westslope Cutthroat Trout Limiting Factors.*

trout. For example, Koocanusa Reservoir is a nutrient sink, limiting biological productivity downstream of the dam (Woods 1982; Snyder and Minshall 1996). Abundance and diversity of important aquatic invertebrates has declined since construction of Libby Dam (Hauser and Stanford 1997), reducing food abundance for trout. Limited food resources could affect survival of Columbia River redband trout, especially juveniles. The altered hydrograph (e.g., high winter flows, fluctuating daily flows, no flood events) may also have affected Columbia River redband trout through loss of mainstem juvenile habitat and possibly mainstem spawning habitat. Direct affects of other changes due to Libby Dam including the hydrograph and lack of flood events to flush and sort substrates are difficult to measure due to the lack of pre-Libby Dam data, but aquatic ecosystems are not resistant to changes of this magnitude.

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4.4 Kokanee *(Onchorynchus nerka)*

4.4.1 Background

Reasons for Selection as Focal Species

We selected kokanee salmon (*Onchorynchus nerka*) as a focal species in the Kootenai River Subbasin because they represent the biological engines for most large lake and river systems in the Pacific Northwest, including those in the Kootenai Subbasin. In these systems, piscivores such as rainbow trout, bull trout, burbot, lake trout, sturgeon and lesser-known species are highly dependent on kokanee as forage; hence the reference to kokanee as biological engines. Kokanee also nourish small freshwater streams with their carcasses after spawning, providing an adfluvial nutrient pump effect, analogous to the important marine nutrient pump in functional anadromous salmon ecosystems.

Native kokanee in the Kootenai Basin are found downstream from Kootenai Falls in Montana. All populations upstream from Libby Dam, in Lake Koocanusa and elsewhere were introduced, and are not considered native. Much of the former lower Kootenai River fish assemblage was historically oriented toward kokanee as forage. This would certainly be the case for adfluvial rainbow trout, bull trout, sturgeon and burbot that occupied Kootenay Lake. It is most likely that Kootenai burbot and sturgeon also targeted on spawning kokanee when they migrated into tributary streams in the Kootenai Basin. Fraser River sturgeon are known to follow and forage on sockeye salmon runs that migrate upriver during August and September (M. Rosenau, U.B.C. Research Biologist, Vancouver, B.C., pers. comm.). In an analogous fashion, white sturgeon in Kootenay Lake appear to move to the mouth of the Lardeau River to prey on staging kokanee prior to their upriver spawning migration. Loss of these spawning migrations as a potential food source could unquestionably impact these two species. Furthermore, kokanee were an important component of the diet of Native Americans and First Nations peoples in the U.S. and Canada. This traditional food source remains culturally important to the Kootenai Tribe of Idaho and the Lower Kootenay First Nation Bands in southeastern British Columbia.

LINKS

For kokanee information in the Kootenai in British Columbia, go to: http://srmwww.gov.bc.ca/aib/

Click Here

For an electronic library of aquatic information (including reports pertaining to kokanee) 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 for B.C., go to: http://srmwww.gov.bc.ca/cdc/

Click Here

Summary of Population Data

From a Subbasin perspective, most kokanee populations appear relatively stable and abundant, bearing in mind that the impacts of the Duncan and Libby dams were never fully assessed. Therefore pre-dam population levels are unknown. Abundance is a relative term, with today's observations of abundance most likely

LINKS

For various kokanee reports from the B.C. Ministry of Water, Land, and Air Protection, go to Appendix 113.

Click Here

considered sparse by previous generations of Native Americans and early Europeans. There are currently six populations of kokanee in the Kootenai River Subbasin in Idaho, Montana, and British Columbia:

1) Trout Lake
2) Duncan Reservoir
3) Kootenay Lake main lake,
4) West Arm of Kootenay Lake
5) Moyie Lake
6) Koocanusa Reservoir

In addition to the above water bodies, Bull, Crystal, Glen, Dikey, and Spar Lakes, among others hold kokanee. All these lakes, the Kootenai River, and their tributaries support kokanee populations, although the Koocanusa population and most likely the Moyie Lake population are naturalized as a result of earlier introductions (Appendix 88). In addition to the above six kokanee populations, a native South Arm (Kootenay Lake) kokanee stock historically reared in the lake's South Arm, and ascended upstream Kootenai River tributaries to spawn in B.C. and Idaho. However, this stock is thought to have been extirpated (Ashley and Thompson 1994).

Trout Lake even today remains relatively pristine, although impacts of turn of the century mining and logging were never assessed. Regardless, there are no historical data and very little current data on kokanee numbers. This lake is oligotrophic and the primary spawning stream (Wilkie Creek) usually supports from 5 to 12,000 spawners. Based on a biostandard (5.6 kg•ha•yr) used to calculate theoretical kokanee yield (Anon 1987) in large lakes of B.C. suggests this lake could produce about 16,000 spawners per year.

Duncan (alias Howser) Lake was known to support a natural population of kokanee prior to development of the Duncan Dam (Peterson and Withler 1965). The dam now isolates the reservoir population from those in Kootenay Lake. No comprehensive assessment has ever been conducted on the impacts of Duncan Dam on the fish populations that inhabited the former Duncan Lake. Therefore, historic kokanee numbers are unknown, and very little is known about present day numbers in Duncan Reservoir. Based on a theoretical yield estimate Duncan Reservoir kokanee spawner numbers unlikely exceed 30,000 with the theoretical yield approximating 40,000 fish.

The North Arm of Kootenay Lake kokanee population has been monitored for over forty years (Andrusak 2002). This population has been estimated as high as 4.1 million (Bull 1964) and as low as 200,000 (Andrusak 2003). Currently the population is rebuilding after nutrient enhancement started in the early 1990s. A reduction in fertilizer loading from 1997-2000 resulted in a decline of kokanee from over one million to less than 500,000 (figures 4.4 and 4.5). It is expected that this population will recover during the next four-year cycle to escapement levels of between 1-1.5 million.

Kokanee populations in the West Arm of Kootenay Lake have been well documented in numerous publications. Redfish Consulting, Ltd. (2002) analyzed the upper West Arm kokanee population data available from 1972-2002. Escapement estimates during that time ranged from about 2,000 to nearly 40,000. This population supported the largest kokanee sport fishery in the province in the 1970s but the decline in lake productivity commencing in the early 1980s has reduced this population to less than 10,000 today, compared to over 50,000 in the 1970s (Andrusak 1987). This decline is almost certainly due to nutrient changes in the lake since two spawning channels are now required simply to sustain this population. There has been no measurable positive impact to this population as a result of fertilization of the North Arm. The population size today varies from 10,000 to 30,000 adults, depending on whether or not a fishery is permitted.

Smaller numbers of kokanee spawn in several West Arm tributaries, based on size appear to be distinct from the upper West Arm population. Upper West Arm kokanee are much larger. Escapements to local streams in the lower West Arm have been periodically monitored with only a few hundred to one thousand spawners observed annually.

The South Arm population is virtually nonexistent in the 2000s. Ashley and Thompson (1994) reported that the South Arm kokanee stock as likely functionally extinct by the early 1990s. Andrusak et al. (2004) summarized the limited historic escapement data available. They believe the total numbers even prior to hydro-development impacts likely did not exceed 200,000. In 2003 the total escapement to all streams was < 1,000 spawners.

The virtual absence of South Arm kokanee in Kootenai River tributaries and the South Arm of Kootenay Lake is troublesome considering the positive response of North Arm spawners to lake fertilization (Andrusak 2003). It is suspected that the South Arm kokanee have been driven to near extinction due to comparatively lower stream egg-to-fry survival rates (hence small numbers of fry) combined with competition for food with massive numbers of fry being produced by North Arm kokanee. Further, suspected large numbers of displaced kokanee from the Koocanusa Reservoir rearing in Kootenay Lake could also serve as competitors for the weaker South Arm stock. The total number of kokanee rearing in Kootenay Lake is likely near capacity (40 million in 2003), therefore the South Arm stock as reflected in escapements is unlikely to respond unless some management intervention is undertaken.

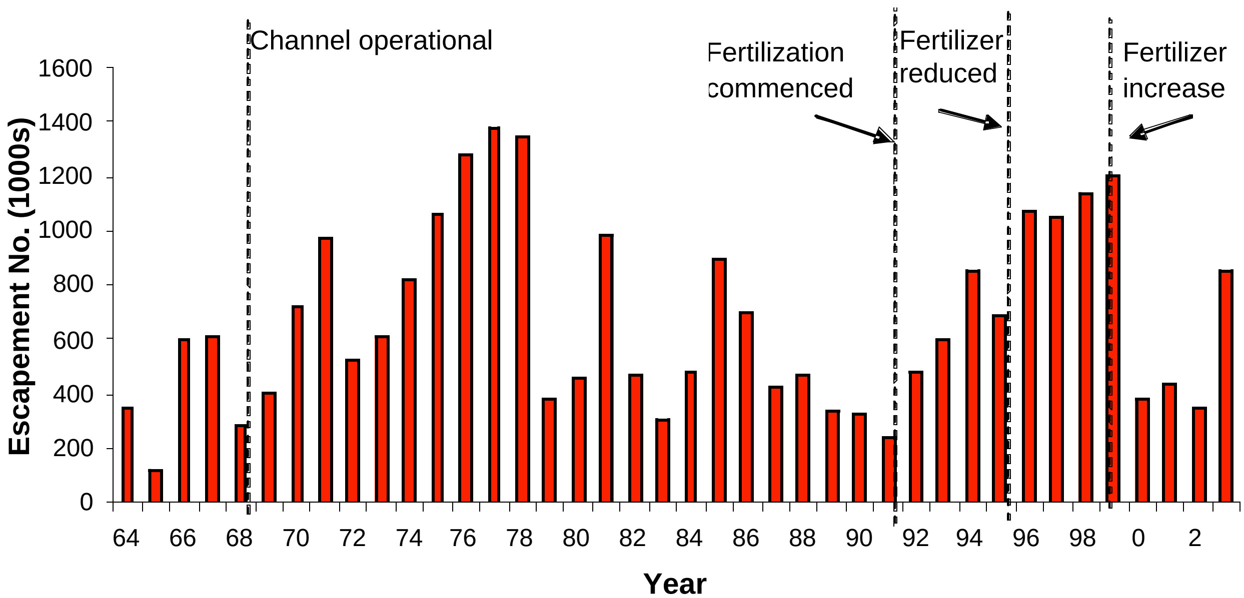

Figure 4.4. Kokanee escapement to Meadow Creek 1964-2003. Vertical dotted lines indicate commencement of Meadow creek spawning channel (1967), commencement of fertilization (1992), reduction in fertilizer (1997-2000) and full fertilizer loading (2001).

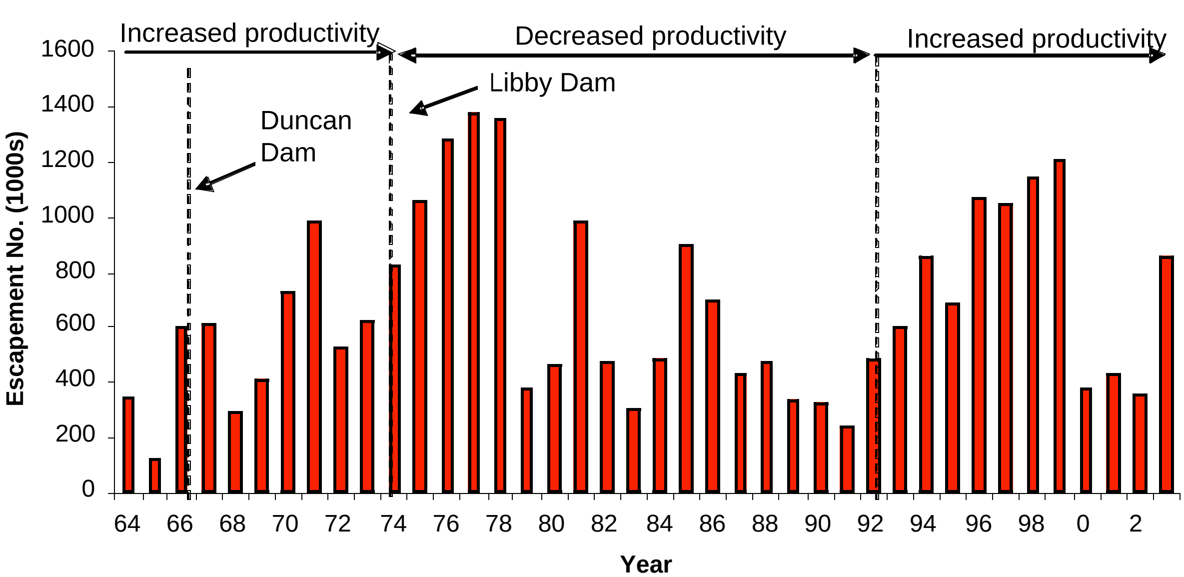

Figure 4.5. Kokanee escapement to Meadow Creek 1964-2003. Vertical dotted lines indicate major changes in lake productivity due to: a) fertilizer plant in operation in 1950s and 1960s; b) reduction in lake productivity due to elimination of fertilizerfrom upstream plant and c) Increased lake productivity due to lake fertilization. Note: decrease in escapements 2000-2002 believed due to reduction in fertilizer loading.

Little is known of the origin of Moyie Lake kokanee, although historical stocking (Appendix 88) dates back to the 1940s, possibly suggesting that none were present prior to this time. A major fish barrier exists on the lower Moyie River in Idaho preventing any Kootenay Lake kokanee from migrating up the river to Moyie Lake. Moyie Lake is ultra oligotrophic so it is not surprising that some informal assessments (periodic counts) of spawner numbers places escapement estimates at < 5,000, most of which can be found in Lamb and Cotton Creeks. Moyie Lakes have been stocked since 2000 with approximately 90,000 kokanee fry annually. Mysids are also present in Moyie Lake.

Koocanusa Reservoir was fully formed by 1974. Due to accidental introduction from British Columbia's Wardner Hatchery via discharge into Norbury Creek, and Kootenay River, kokanee initially entered the reservoir as early as 1973 (file note, B.C. Fisheries Nelson, B.C.). Additional releases probably occurred until 1979 when kokanee no longer were reared in this hatchery. The reservoir population rapidly expanded and kokanee spawners were initially observed in Norbury Creek in the early 1980s. This population continues to expand and by 2002 a cumulative peak count of 450,000 spawners was made for eleven index streams tributary to the upper Kootenay River (Westover 2003).

Quantitative population abundance and escapement data are lacking for kokanee in Montana waters of the Kootenai Subbasin. However, kokanee exist in Koocanusa reservoir, which largely reproduce upstream in Canadian waters of the Subbasin. Alternatively, entrainment studies at Libby Dam revealed that approximately 98 percent of all entrained fish sampled in the draft tubes were kokanee, primarily age-0 fish, with a few age-1 fish. The dynamics of water temperatures and shallow water withdrawals (25-50 from surface) from Libby Dam exacerbates kokanee entrainment. As surface waters in the reservoir warm in the spring, they attract kokanee. Along with freshet plumes of turbid water, which pushs fish downstream to the dam ahead of the turbid water avoided by the fish, these two elements increase probability and magnitude of kokanee entrainment at Libby Dam (B. Marotz, FWP, personal communication).

Marotz (FWP, personal communication) also suggested that survival of these entrained fish may be as high as 70 percent. After entraining, some fish appear to stay in the tail waters areas, where zooplankton are suitable, available forage. Following entrainment, kokanee can either stay in Montana waters from Kootenai Falls to the dam, below the falls, or they can migrate downstream to rear in Kootenay Lake. Quantification of these habitat use patterns has not occurred with much accuracy due to limited empirical data, and high associated variability of existing data. Kokanee that mature following entrainment upstream from Kootenai Falls converge in the Libby Dam tailrace, which blocks their upstream migration tendencies; fish that have reared downstream from Kootenai Falls converge on the falls following upstream spawning migrations. During some years, snag fisheries produced kokanee harvests ranging from thousands to tens of thousands of fish, depending on production and entrainment rates of previous years.

It is unclear how many entrained kokanee from Koocanusa Reservoir migrate downstream to Kootenay Lake. However, it is thought that considerable numbers may be showing up in hydroacoustic surveys in the lake's South Arm (Ken Ashley, B.C. MWLAP, pers. comm.). Genetic analysis is planned to separate origins of fish from catches in the South Arm during nonreproductive seasons to help address this uncertainty.

Native kokanee salmon runs in lower Kootenai River tributaries in Idaho have experienced dramatic population declines during the past several decades (Ashley and Thompson 1993; Partridge 1983). The kokanee that historically spawned in these tributaries inhabited the South Arm of Kootenay Lake in British Columbia. Native kokanee are considered an important prey item for white sturgeon and also provided an important fishery in the tributaries of the lower Kootenai River (Partridge 1983; Hammond, J., B.C. MELP, per. comm. 2000). Kokanee runs into North Idaho tributaries of the Kootenai River that numbered into the thousands of fish as recently as the early 1980s have now become "functionally extinct" (Anders 1993; KTOI, unpublished data). Since 1996, visual observations and redd counts in five tributaries found no spawners returning to Trout, Smith, and Parker Creeks, while Long Canyon and Boundary Creeks had very few kokanee returns.

Historic Distribution

Region-wide

Kokanee are the non-anadromous or land locked form of sockeye salmon that are found in the large lake systems throughout the entire Columbia River Basin (McPhail and Carveth 1992). In British Columbia they are indigenous in all drainages except the Peace River drainage. They overlap the distribution of sockeye salmon in British Columbia, but are also found in lakes that are now cut off to sockeye as a result of human interventions, the best example being the upper Columbia River system. Morphologically, kokanee and sockeye are identical and are considered to be the same species (*Onchorynchus nerka*).

Kokanee are found in the North Pacific region generally distributed between 40 °N and 61 °N from Japan northward on the Asian Coast through the Bering Sea westward along Alaska and southward to just below the Columbia River (Smith et al. 1987). They commonly overlap the distribution of sockeye salmon but twentieth century transplants now have them found as normalized viable populations outside their natural range in the Columbia and Fraser River basins, e.g., the Peace and Colorado River basins. Stock status has been investigated in most states and provinces with some of the best assessments conducted on Pend Oreille Lake (Reiman and Bowler 1980; Reiman and Meyers 1992), Okanagan Lake (Andrusak et al. 2003) and Kootenay Lake (Thompson 1999; Andrusak 2003). Indigenous kokanee populations tend to be found exclusively in the large lake systems of the Columbia and Fraser River systems. However, numerous populations exist in smaller lake systems in Alaska that are accessible to the Pacific Ocean.

Kootenai River Basin

Historically kokanee in the Kootenay Subbasin have been isolated for at least 10,000 years due to a natural barrier located on the lower Kootenay River at Bonnington Falls approximately 20 km upstream from the confluence with the Columbia River (Northcote 1973). Discrete natural populations are currently found in Trout, and Kootenay lakes, and Duncan reservoir, whereas the Moyie and Koocanusa reservoir kokanee populations are naturalized from hatchery introductions.

The Duncan Dam, completed in 1967, isolated Kootenay Lake kokanee from those inhabiting the Duncan Reservoir. A major waterfall on the lower Moyie River in Northern Idaho prevents fish movement to Moyie Lake. Kootenai Falls in Montana serves as a barrier to all upstream movement of kokanee. However, kokanee introductions into the Koocanusa (Libby) Reservoir in the 1970s have resulted in an extension of their distribution to the very upper reaches of the Upper Kootenay River and tributaries.

Some of the earliest kokanee research in British Columbia was actually conducted by the federal government while assessing sockeye salmon stocks in several Fraser River nursery systems. Ironically kokanee data were collected on some lakes such as Quesnel, Shuswap and Adams in the 1940s and 1950s, due to concern by salmon biologists who considered kokanee to be a competitor with sockeye. Several investigations were conducted by the International Pacific Salmon Commission (IPSC) to determine the extent of the “kokanee problem.” One report written on Quesnel Lake entitled “An Outline of the Kokanee Problem” (Idyll 1944) discussed the possible origin of kokanee with mention of how kokanee may impact sockeye numbers through interspecific competition. Several other IPSC reports in the 1940s and 1950s expressed interest and concern about kokanee and their impact on sockeye. Goodman (1958) summarized the 1950s work on Quesnel, Shuswap, and other important interior sockeye nursery lakes and concluded that kokanee and sockeye seldom compete for spawning sites and that there was no correlation between kokanee abundance and sockeye cyclical dominance at least in Quesnel Lake (a theory pursued by the IPSC for a number of years during the 1950s).

Following this early work of the Federal sockeye biologists, the province began to show some interest in kokanee. The first major study was conducted on Kootenay Lake by Vernon (1954, 1957), who provided an excellent account of the biology of kokanee in Kootenay Lake. His work demonstrated that there were three stocks of kokanee within the lake that were morphologically distinct. Size, growth and age at maturity were distinguishing features between the three stocks. Bull (1964) conducted the initial estimates of kokanee spawner abundance in the Lardeau-Duncan River system in 1964, in an effort to determine impacts of the Duncan Dam. His estimate through mark (tagging) and recapture was placed at just over 4.1 million (Lardeau River 1.4 million, Duncan River 2.7 million) with an additional 0.35 million in Meadow Creek. Acara (1970 Unpublished MS) estimated that the Lardeau-Duncan River system escapements ranged from 0.6 to 1.3 million between 1965-1968. It should be noted that at that time Kootenay Lake was undergoing cultural eutrophication due to huge discharges of phosphorous from an unregulated fertilizer plant located upstream on the St. Mary's River, a tributary to the upper Kootenay River (Northcote 1973; Daley et al. 1981). In other words, the lake was at historically and artificially high levels of productivity.

Current Distribution

Within the Kootenai Subbasin kokanee populations are generally abundant and flourishing, although much of this is due to significant management intervention in the form of spawning channels and lake fertilization. The one exception to this generally healthy status is the kokanee population that inhabits the south end of Kootenay Lake and spawns in South Arm tributary streams, including a number of streams in Northern Idaho. These kokanee are in serious decline, on the edge of extinction, or functionally extinct.

Current escapement estimates to Trout and Moyie Lake streams, and Duncan Reservoir are unavailable. Escapement levels to these three systems are unlikely to exceed 40,000 (Duncan Reservoir), 16,000 (Trout Lake) or 5,000 (Moyie Lake).

Kokanee populations can vary considerably within one or two cycles, and they can be highly variable from one year to the next. Hydroacoustic estimates on Kootenay, Arrow and Okanagan lakes show that numbers as low as 50 fish/hectare and as high as 1500/ha (all age groups) are possible. By way of comparison, values up to 7000/ha have been recorded in Quesnel Lake (Sebastian et al. 2004, draft report) but most of these (≈ 90 percent) were sockeye fry. Kootenay Lake usually ranges from 250-750 fish/ha and of this total about 5-7 percent are usually adult size fish. Good population estimates have been made for Kootenay, Okanagan, Shuswap, and Quesnel Lakes and Arrow Lakes Reservoir (Wright et al. 2003; Andrusak et al. 2003; Sebastian et al. 2000; Redfish Consulting Ltd. 2003; Sebastian et al. 2004, draft report). Total lake population numbers (all age groups) vary from Quesnel Lake (3-4 million), Okanagan (5-10 million), Arrow lakes Reservoir (12-20 million) and Kootenay Lake (25-40 million). However, in Kootenay Lake and Arrow Lakes Reservoir, these numbers are currently being supported by ongoing fertilization operations.

Annual escapements for these lakes range between 0.5 million and 1.5 million. The current estimates for Kootenay Lake (main lake) range from 0.5 - 1.2 million spawners with over 99 percent of these found in the North Arm tributaries and very few in the South Arm streams. The North Arm population is rapidly expanding as a result of increased lake fertilization loading commencing in 2001. Further discussion on this work is described below. Currently the total escapements to South Arm tributary streams including those in Northern Idaho are < 1000 fish.

The most studied kokanee populations in British Columbia are those that inhabit Kootenay Lake. For nearly a century Meadow Creek has been the primary kokanee egg collection site for the province of B.C. (Northcote 1973). The Meadow Creek stock has been planted in many systems throughout B.C. including egg and fry plants in streams tributary to the South Arm of Kootenay Lake (Andrusak and Slaney 2004).

During the mid-1960s Meadow Creek was selected as the site for construction of the largest kokanee spawning channel found anywhere in the Pacific Northwest (Redfish Consulting, Ltd. 1999). This channel became operational in 1967 and its production history is discussed in more detail below.

Escapements of kokanee to Meadow Creek have been monitored for nearly a half a century and these estimates provide an excellent graphic of the dramatic changes that have taken place in Kootenay Lake (figures 4.4 and 4.5). During the 1950s and 1960s the lake was at a very high level of productivity and the North Arm escapement levels were high as documented by Bull (1964) and Acara (1970). Meadow Creek numbers were < 350,000 in 1964-1965 but increased thereafter due to Duncan River kokanee displacement. Spawning channel operation began in 1967 and the escapement levels gradually increased over two cycles until the late 1970s when escapements exceeded 1 million. During this same period the fertilizer loading to the lake began to decline with closure of the St. Mary's fertilizer plant, and concurrent pollution abatement activities. Coincidentally, Libby dam also became operational, and while there were concerns

LINKS

QHA spreadsheets contain current and historic kokanee distribution by lifestage for HUC-6 watersheds and selected lakes in the U.S. and B.C. portions of the Kootenai. These data are a compilation put together by the Kootenai Subbasin Aquatic Technical Team. Go to Appendices 32 and 33.

Click Here

about the impact of this dam on Kootenay Lake, the combined impact of reduction in P loadings and nutrient retention in Koocanusa Reservoir were largely unforeseen. Daley et al. (1981) documented the changes that resulted in a significant decline in lake productivity by 1980. Nutrient input to the lake declined below pre-dam conditions and the lake underwent a gradual decline in productivity through the early 1990s and Meadow Creek escapements reflected this decline. Lake fertilization commenced in 1992 and an immediate response was observed in kokanee escapements with numbers again exceeding 1 million by the late 1990s. Reduction in fertilizer loading rates began during 1997 were reflected in a dramatic decline in escapements from 2000-2002. The increased numbers in 2003 reflect increased productivity when fertilization rates were increased to the 1992 level.

Hydroacoustic and trawl surveys have been carried out on the main body of Kootenay Lake since the mid 1980s, providing some excellent data on whole lake kokanee numbers and population trends. (The following data were provided by D. Sebastian B.C. Fisheries population biologist Victoria B.C.). The lake supported less than 10 million kokanee through most of the 1980s and early 1990s (figures 4.6 and 4.7). Such low abundance was the reason lake fertilization was initiated in 1992. An initial response to fertilization was evident by 1994 when total numbers shot up over 35 million and ranged between 25-35 million until the amount of fertilizer was reduced in 1997 (figure 4.8). A decreasing trend was evident through 2000 when the estimate was only 11.6 million. The fertilizer loading rate was increased in 2000 and by 2002 and 2003 the numbers were again in excess of 35 million.

Distribution of kokanee within the main lake basin is of particular interest. Despite fertilization only taking place in the upper North Arm, the kokanee are

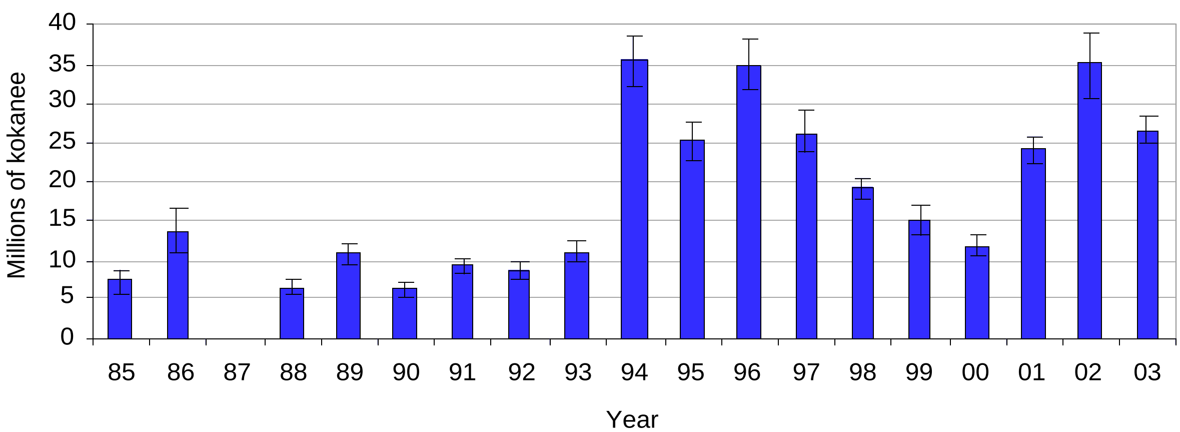

Figure 4.6. Hydroacoustic estimates of total numbers of kokanee in Kootenay Lake.

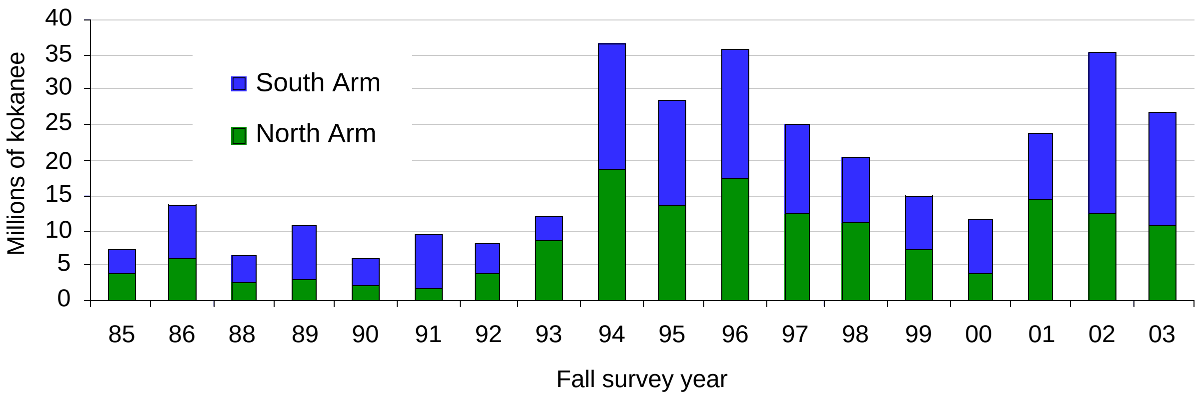

Figure 4.7. Hydroacoustic estimates of total kokanee numbers in the North vs. South Arms.

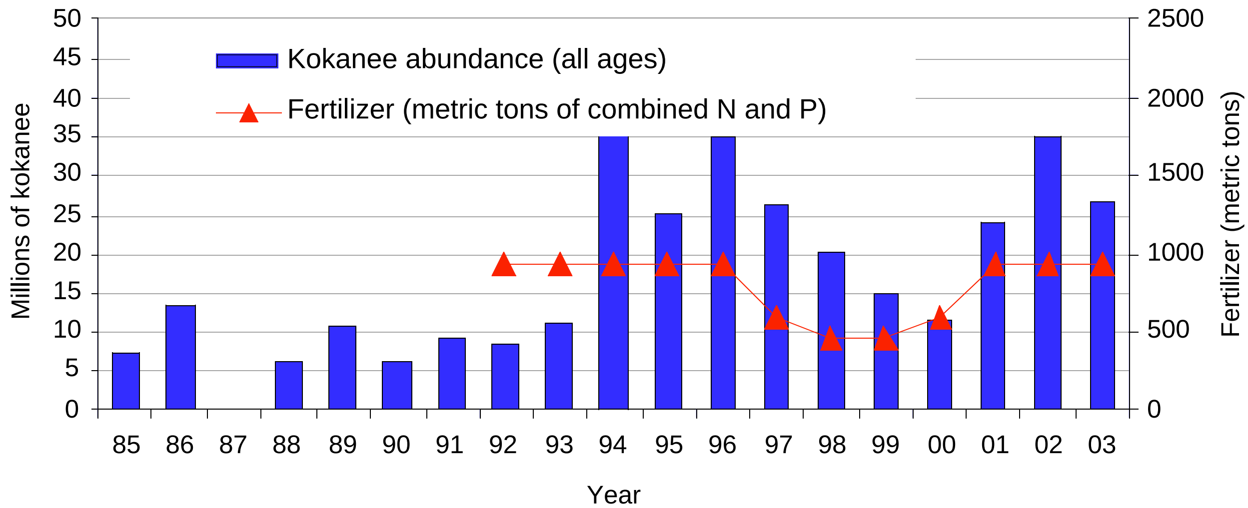

Figure 4.8. Hydroacosutic estimates of kokanee abundance in Kootenay Lake and amount of fertilizer added since 1992.

fairly evenly distributed throughout the lake (figure 4.7) In fact, the 2002 data indicated that more kokanee were in the South Arm. There is some speculation that in some years a good proportion of the kokanee in the South Arm may be displaced Koocanusa Reservoir kokanee. At the time of this writing, the 2003 data had not been completely analyzed but there is some thought that the 40 million estimate may reflect lake carrying capacity. Genetic analysis (microsatellites) is planned to further assess kokanee stock (origin) composition in Kootenay Lake.

West Arm kokanee were larger than North or South Arm kokanee prior to mysid introduction or lake fertilization as evidenced in Vernon's data (Vernon 1957). Mysids were introduced into the lake in 1949 but were not discovered until 1961 (Sparrow et al. 1961), whereas the fertilizer plant began operation in 1953 (Northcote 1973). It is unlikely that the lake was fully populated with mysids by 1952 when Vernon collected his spawner samples. Northcote (1973) also shows some kokanee data from 1949-1950 where the size of West Arm kokanee is greater than those sampled in other parts of the lake. What is clear is that West Arm kokanee were the primary beneficiary of the mysid introduction (Northcote 1973) largely due to the unique flow features of the West Arm. Mysids in the vicinity of the outlet move to the surface at night where they are caught up in the current and displaced over the sill where they are highly vulnerable to kokanee predation (Thurber Consultants 1981). North and South Arm kokanee did not respond with much increased growth as a result of the mysid introduction (Northcote 1973). Martin and Northcote (1991) attributed the significant increase in size of West Arm kokanee during the 1970s and 1980s to the availability of mysids at the lakes' outlet.

The escapement pattern for upper West Arm kokanee (figure 4.9) is similar but does not completely match that of North Arm kokanee, primarily because the West Arm stock has been greatly influenced by harvest levels. Certainly in the 1960s and early 1970s the West Arm stock was quite abundant as was the North Arm stock, but this is not reflected in escapements due to the intensive sport fishery that annually harvested between 30,000-100,000 fish from 1968-1978 (Andrusak 1987). The decline during the 1980s is similar for both stocks but the West Arm stock did recover in the late 1980s and early 1990s as a result of the fishery being closed and enormous fry production from two spawning channels built in the mid 1980s. Trend in escapements to Meadow Creek show increases during the period of fertilization, whereas there has been no increase by West Arm kokanee (figure 4.10). Fry-to-adult survival rates for North Arm kokanee initially increased substantially to an average of 6 percent at the onset of fertilization but have declined to just over 2 percent with the lake at capacity (Andrusak 2002). On the other hand West Arm fry-to-adult survival rates have remained low (average 1.7 percent), just sufficient for any allowable harvest (Andrusak 2002).

As mentioned, the Upper West Arm kokanee population at one time supported British Columbia's most productive, inland sport fishery with an annual catch exceeding 100,000 and sizes up to 4 kg (Andrusak 1981; Andrusak and Brown 1987). The resort industry at Balfour rapidly expanded in response to this fishery and overcrowding at the resorts and on the West Arm was a common sight. This fishery was very intensive but not sustainable, with overfishing evident

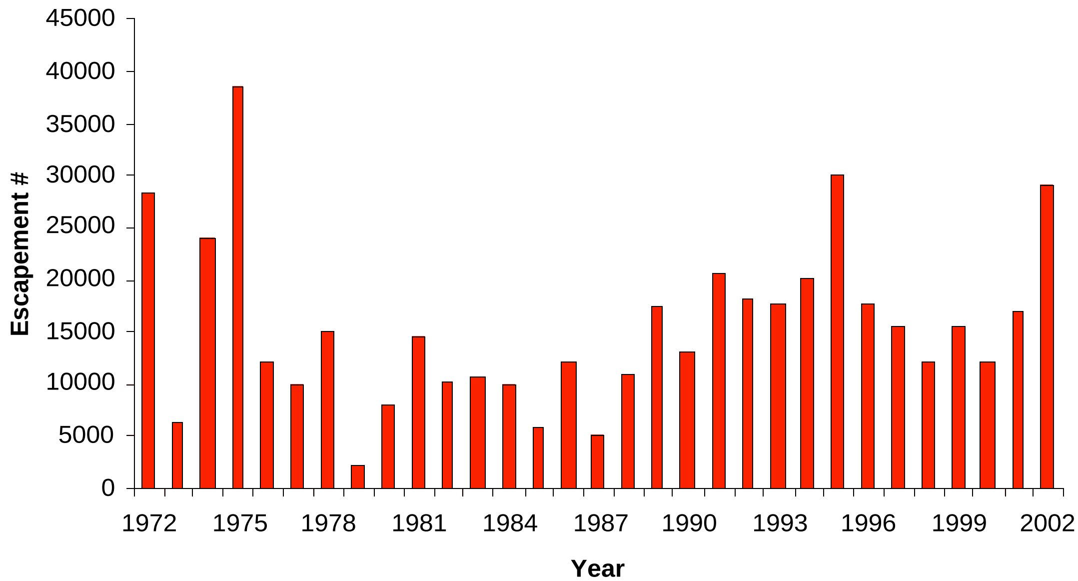

Figure 4.9. Total escapement numbers for the three major kokanee spawning streams in the Upper West Arm of Kootenay Lake, 1972-2002.

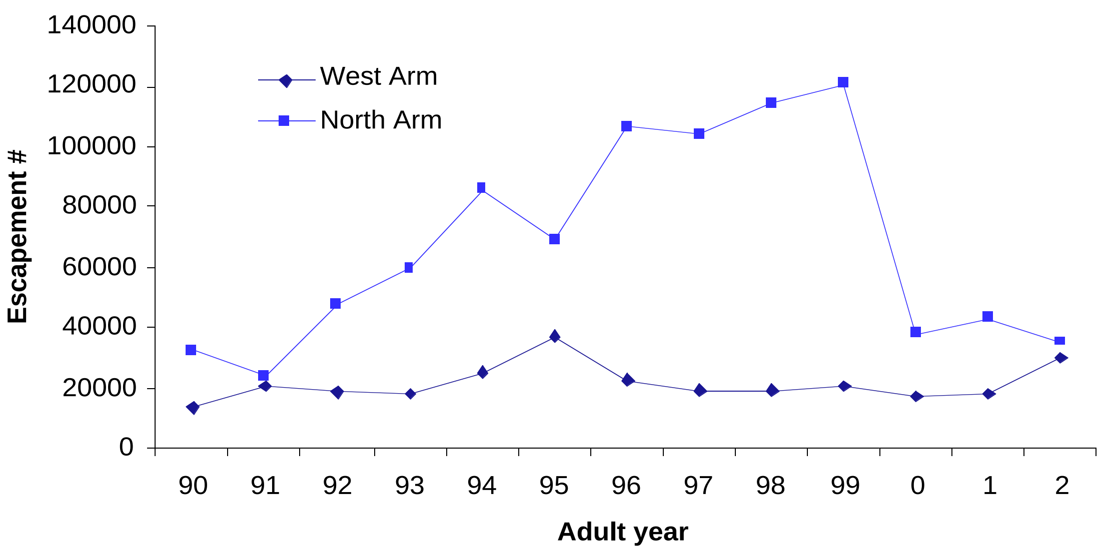

Figure 4.10. North Arm kokanee escapements compared to the West Arm escapements for the last four cycles that have grown in the lake during lake fertilization. Note: for purposes of comparison North Arm numbers were scaled down to 10% and the West Arm numbers include harvest estimates.

by the end of the 1970s (Andrusak 1981). In the 1980s, this fishery collapsed and the tourist industry underwent a dramatic change, resulting in most resorts closing. Today the fishery is largely enjoyed by local residents who comprise 95 percent of all anglers compared to only 50 percent in the 1970s (Redfish Consulting, Ltd. 2002). The obvious decline of nonresident anglers is an economic impact often overlooked.

Decline of West Arm kokanee numbers was initially addressed in the early 1980s by closing the fishery and constructing small spawning channels on the two key spawning streams—Kokanee and Redfish Creeks. The feasibility of rearing West Arm kokanee using net pens was also examined by Perrin and Levy (1990) and a small-scale experimental fertilization of the upper West Arm was also attempted (Perrin 1989). The upper West Arm fertilization experiment and the net pen rearing strategies did not appear to work and they were abandoned (J. Hammond, Fisheries Biologist, Nelson, B.C., pers. comm.).

Low fry-to-adult survival rates in the primary spawning streams combined with high harvest rates in the West Arm kokanee fishery forced a prolonged closure of the fishery from 1980 until 1994 with the exception of short seasonal fisheries in 1983 and 1985. Stock recovery over nearly five cycles was very slow despite excellent fry production from two spawning channels built in the 1980s and virtually no sport catch in nearly 15 years. With stock recovery evident, B.C. Fisheries was confident enough to open a short-term annual fishery commencing in 1994. In April 1994, the West Arm was reopened to kokanee fishing with a harvest quota set at 5,000. The quota for 1995 and 1996 was 8,000 and from 1997 – 2003 it has been 5,000. West Arm kokanee are highly vulnerable to sport fishing and with such a small margin of error it is essential that angler effort and harvest be closely monitored each year.

Presently, the size of the upper West Arm kokanee fishery is only a fraction of what existed in the 1970s. However, the size and high catch rate of these fish in a somewhat unique, riverine habitat make them exceptionally attractive to anglers. The fishery in April 2000 was so popular that the entire quota (~5,000 fish) was reached in 11 days and the fishery had to be closed. Poor fry production from the Kokanee Creek spawning channel in 2000 and poor test fishery results in the spring of 2002 led to the decision by fisheries managers not to open the fishery in 2002, but it was reopened in 2003 with an estimated harvest of nearly 8,000. Regardless of how well the spawning channels perform, this population is driven by in-lake survival rates that are extremely low, declining from rates > 3 percent in the late 1970s to < 1.5 percent in the 1990s and early 2000s (Redfish Consulting, Ltd. 2002).

In retrospect, it is now quite apparent that West Arm in-lake survival limits its kokanee population and there is no evidence to-date that the North

Arm fertilization experiment has had any beneficial effect on the West Arm stock (Redfish Consulting, Ltd. 2002).

South Arm kokanee have not fared as well as North Arm or West Arm kokanee. Andrusak and Slaney (2004) summarized all available kokanee escapement data for South Arm tributaries including five Northern Idaho streams. While the data is sparse, there is an unmistakable trend in what they found. Kokanee numbers were evidently never that large in South Arm streams. However, empirical data indicated that all spawning runs have declined from numbers in the tens of thousands in the 1970s to less than 1,000 in all streams today. Despite North Arm fertilization for over ten years there has been no measurable response by South Arm kokanee. It is arguable that no response could be expected since the runs have virtually disappeared. However, there were enough kokanee counted and spawned in 1996 and 1997 that some increase in recruits should have occurred in 2000 and 2001.

Current kokanee escapement levels to tributaries of the upper Kootenay River from Koocanusa Reservoir are in the order of 150,000-450,000 (figure 4.11). This population is expanding with more and more spawners found in the very upper reaches of the Upper Kootenay River (B. Westover, B.C. Fisheries Biologist, Cranbrook B.C., pers. comm.). The Tobacco and Grave creeks provide the only kokanee spawning habitat in Koocanusa Reservoir tributaries in Montana (Jay DeShazer, MFWP, personal communication), and fish that have entrained through Libby Dam have not colonized tributaries to spawn in Idaho or Montana downstream from Libby Dam.

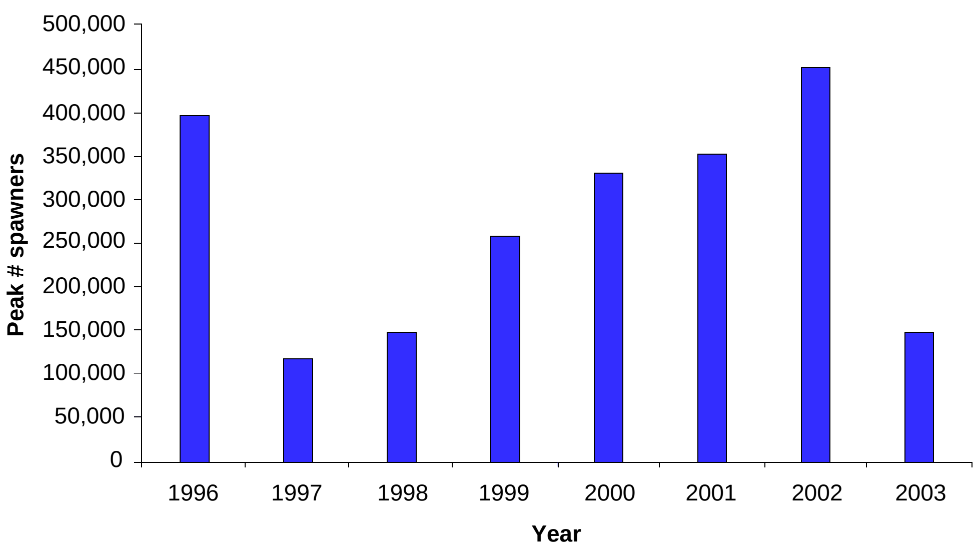

Figure 4.11. Peak number of kokanee spawners in 11 selected tributaries of the upper Kootenay River 1996-2003.

LINKS

For current and historic fish stocking records in Montana, go to: http://www.fwp.state.mt.us/fishing/stock02.asp

Click Here

For Idaho stocking information, go to: http://www2.state.id.us/fishgame/fish/fishstocking/stocking/year.cfm?region=1

Click Here

For the Moyie Lake, B.C. Kokanee stocking history, go to Appendix 88.

Click Here

In summary, kokanee populations within the Kootenai Subbasin are generally abundant and flourishing, although much of this is due to significant management intervention in the form of spawning channels and lake fertilization. The one exception to this generally healthy status is the southern kokanee population that inhabits Kootenay Lake and spawns in South Arm tributary streams, including a number of streams in Northern Idaho. These kokanee are in serious decline and on the edge of extinction.

Status of Kokanee Introductions, Artificial Production and Captive Breeding Programs

Kootenay Lake

Kokanee eggs from Meadow Creek have been the primary source of kokanee transplants throughout the province as well as many systems in Idaho. Slaney and Andrusak (2004) show that kokanee eggs were planted in some North and South Arm tributaries as early as 1929 and particularly during the 1940s. The most recent egg plants into B.C. tributary streams were in 1988 and 1989 (Goat River and Summit Creek). Most recently, the Kootenai Tribe of Idaho obtained Meadow Creek eggs and planted them in Long Canyon, Parker, Myrtle and Trout creeks (table 4.49). Some 15,000 fed fry were released into Parker Creek in 1998. Otherwise, all introductions have been eyed eggs. Unfortunately, eggs were not available from 2000-2002, but 1.5 million were made available during 2003.

Table 4.49. Meadow Creek kokanee egg and fry plants into four Northern Idaho streams 1997-2003 (data provided by the Kootenai Tribe of Idaho).

Year	Long Canyon	Parker	Trout	Myrtle
1997	100,000 EE			
1998	100,000 EE	15,000 Fry 100,000 EE	100,000 EE	
1999	200,000 EE	150,000 EE	150,000 EE	
2003	400,000 EE	400,000 EE	400,000 EE	400,000 EE

EE = Eyed eggs

Koocanusa

Kokanee were accidentally introduced into the Upper Kootenay River via Norbury creek, the receiving waters of Wardner Hatchery flows. It is believed that fry or egg "leakage" from the rearing ponds resulted in viable fish entering the hatchery discharge system as early as 1972 (table 4.50). Returning fish to Norbury Creek were initially evident in the early 1980s.

Table 4.50. Year, egg source and estimated number of mortalities that may have contributed to origin of Koocanusa Reservoir kokanee. (data from P. Brown B.C. Fisheries, Fish Culturist, Wardner Hatchery, Wardner, B.C. pers. comm.).

Brood year	Release year	Source	Mortalities
1971	1972	No kokanee reared	
1972	1973	Okanagan River	302,000
1973	1974	Okanagan River	488,000
1974	1975	No kokanee reared	
1975	1976	No kokanee reared	
1976	1977	Meadow Creek	112,000
1977	1978	Meadow Creek	34,000
1978	1979	Meadow Creek	101,000
1979	1980	Kokanee rearing ceased @ Wardner hatchery	

It is suspected that kokanee in Moyie Lake were also the result of hatchery introductions during the 1940s (Appendix 88).

Historic and current harvest

British Columbia

Kokanee harvest data are unavailable for Trout Lake, Moyie Lake and Duncan Reservoir. Recreational fishing is very light with rainbow trout and bull trout the target species for those who do fish there, i.e., kokanee are infrequently targeted and harvested incidentally. An informed "guesstimate" of harvest would be < 1000 for Trout Lake, < 2000 for Moyie Lake and <2,000 for Duncan Reservoir (H. Andrusak, Redfish Consulting, Ltd., Nelson, B.C., pers. comm.).

The sport fishery on Kootenay Lake was monitored by an extensive creel census program from 1967-1986 but budget constraints resulted in cessation of this program in 1987. Prior to the 1960s Kootenay Lake was well known for its excellent fishing, particularly for the large-size Gerrard rainbow trout. It wasn't until the mid 1960s that angler effort rapidly grew (figure 4.5), largely because of the discovery of large kokanee at the outlet area (Balfour, B.C.). During the 1970s this freshwater sport fishery was the most intensive in all of British Columbia, attracting anglers from throughout North America. The peak of angling activity was from 1972-1977 with a gradual decline in kokanee catch commencing in 1978, resulting in angler effort decreasing to less than 50 percent of the mid-1970s level by 1986. Most of the decline in effort and catch was due to the collapse of the West Arm kokanee fishery.

Main lake (north and south arm) kokanee fishery

The main lake kokanee fishery is quite different from that described for the West Arm. Virtually all the fishing takes place in the summer months (July-August) largely by family fishing using small trolling gear. The kokanee are small (20-25 cm), abundant and high success rates are common, but angler interest wanes if the size is < 22 cm. The annual census on the lake from 1968-1986 separated angler effort by species and therefore catch (almost entirely harvest). Low levels of angler effort were recorded during the late 1960s and 1970s, primarily because most anglers preferred the much larger-sized West Arm kokanee, and so most fished the West Arm. With the West Arm kokanee fishery collapsing in the late 1970s, a shift in effort to the main lake occurred (figure 4.12). This much higher level of fishing on the main lake only occurred for a few years and was not sustainable, not because of over fishing, but largely because of the dramatic decline (figures 4.4 and 4.5) in the main lake stock(s) due to nutrient impoverishment as a result of upstream reservoir formation (Duncan and Libby dams). Although no catch data is available for the main lake today, it probably is in the order of 30-40,000.

North and South Arm kokanee stocks decreased in the 1980s with virtually no South Arm fish evident, while North Arm escapements declined from a range of 0.5-3.5M in the 1960s and 1970s to 0.3 - 0.5 M in the late 1980s and early 1990s (Ashley et al. 1999). This decline led researchers to consider a method for

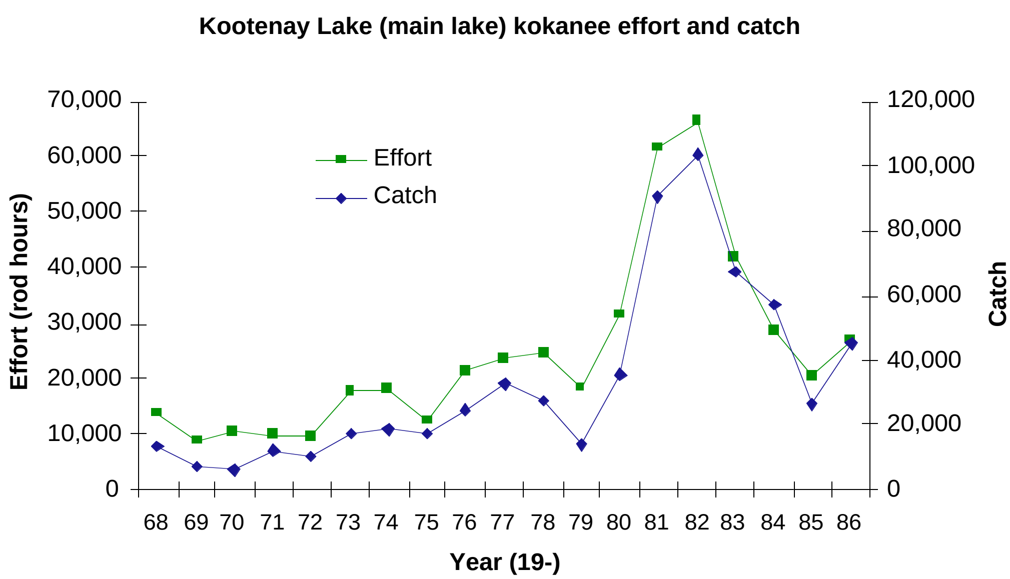

Figure 4.12. Kootenay Lake (main lake) kokanee effort and catch 1968-1986.

reversing this trend, especially since the world famous Gerrard rainbow trout were so dependent upon kokanee as their food source (Andrusak and Parkinson 1984). Initial results of experimental fertilization have been reported by Ashley (in Murphy and Munawar 1999) and the response by North Arm kokanee has been very positive. Kokanee escapements to the North Arm's Lardeau River and Meadow Creek systems are once again over one million, and these escapements are very comparable to those of the 1960s and 1970s (Ashley et al. in Murphy and Munawar 1999; Andrusak 2002). The introduction of fertilizers to the North Arm of Kootenay Lake that has resulted in increased numbers of kokanee brings into question how large of a role mysids had in the 1980s kokanee decline.

West Arm kokanee fishery

The West Arm serves as an outlet river for Kootenay Lake with water chemistry very similar to that of the epilimnion of the main lake (Daley et al. 1981). Elimination of spring peak flows, higher winter flows, and lower spring water levels reducing important littoral areas were identified as major changes to the West Arm as a result of the upstream dams (Daley et al. 1981). The main beneficiaries of the 1949 mysid introduction have been West Arm kokanee, which feed heavily on them as they are displaced downstream of the main lake. Over the last three decades, their size has been much larger (Redfish Consulting, Ltd. 2000), although size in 2001 (Redfish Consulting, Ltd. 2002) was similar to those originally reported by Vernon (1957). Martin and Northcote (1991) attributed the significant increase in size of West Arm kokanee during the 1970s and 1980s to the availability of mysids.

One obvious result of the change in the hydrological regime of the West Arm since the dams became operational in the mid 1970s has been a reduction in *Mysis relicta* displacement (Thurber Consultants 1981; Martin and Northcote 1991). During peak discharge, mysids were easily observed at the surface but this is usually no longer the case. It is unclear if reduction in mysid transport into the West Arm has adversely affected West Arm kokanee numbers but analysis of food habit in 2001 indicates less consumption of mysids compared to the 1960s (Redfish Consulting, Ltd. 2002).

It was the unusually large size of kokanee that began to attract the attention of anglers in the mid 1960s. Prior to then, few anglers had been interested in kokanee. They preferred to target the big Gerrard rainbow trout. By the end of the 1960s, word of big kokanee at Balfour had spread and a classic boom and bust fishery occurred within a ten-year period. At its peak, this fishery annually harvested 80-100,000 kokanee (figure 4.13), many of which were 1-2 kg in size with a few individuals exceeding 4 kg. The fishery was concentrated in the upper

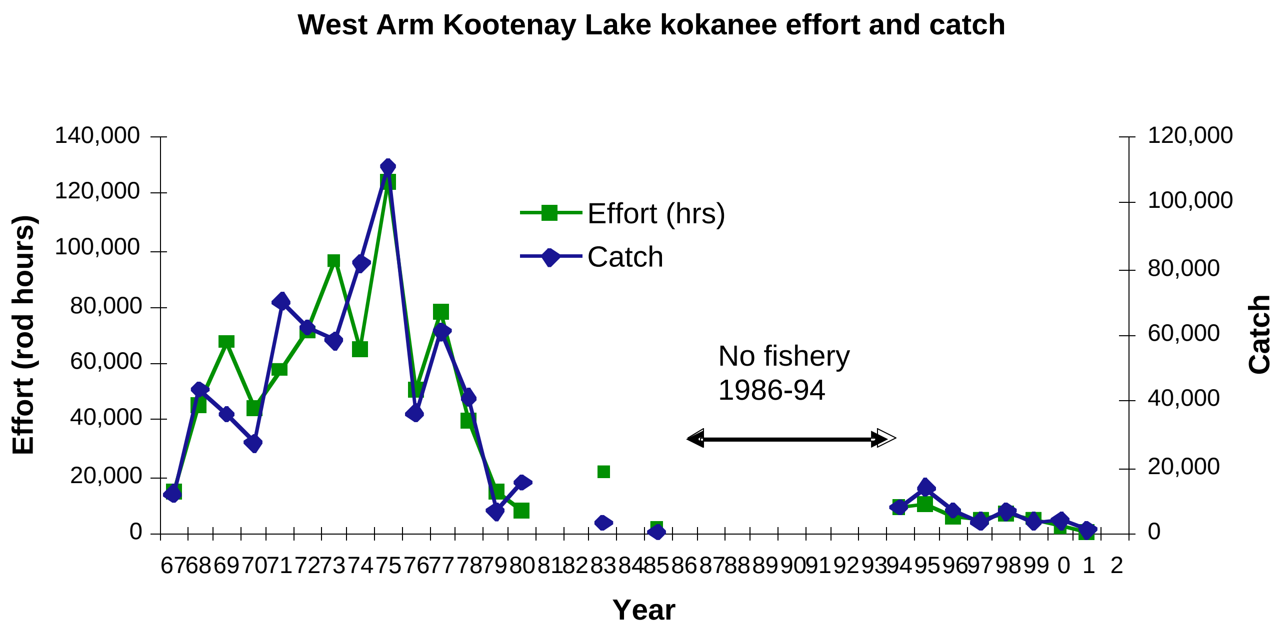

Figure 4.13. West Arm of Kootenay Lake kokanee effort and catch 1967-2002. No fishery from 1986-1994 and 2002.

5 km of the West Arm and it was not unusual to see 400-500 boats at one time fishing during the summer in this small area. These much larger kokanee offered some excellent spin cast fishing in the winter-spring months, changing to trolling as the summer advanced. The resort industry at Balfour rapidly expanded in response to this fishery and overcrowding at the resorts and on the West Arm was a common sight. This fishery was very intensive but not sustainable, with overfishing evident by the end of the 1970s (Andrusak 1981). A major reason the West Arm stock was over fished was due to large numbers of main lake kokanee entering the West Arm during the summer months (Martin 1984) creating a mixed stock fishery. The more abundant main lake stock mixed with the weaker stock (West Arm) and masked the impact of fishing on the weaker stock. In the 1980s this fishery collapsed and the tourist industry underwent a dramatic change, resulting in most resorts closing. Today, the fishery is limited to a few weeks largely enjoyed by local residents who comprise 95 percent of all anglers compared to only 50 percent in the 1970s (Redfish Consulting, Ltd. 2002). The obvious decline of nonresident anglers is an economic impact often overlooked.

Decline of West Arm kokanee numbers was initially addressed in the early 1980s by closing the fishery and constructing small spawning channels on the two key spawning streams - Kokanee and Redfish creeks. The feasibility of rearing West Arm kokanee using net pens was also examined by Perrin and Levy

(1990) and a small-scale experimental fertilization of the upper West Arm was also attempted (Perrin 1989). The upper West Arm fertilization experiment and the net-pen-rearing strategies did not work, and they were abandoned (former Regional Fisheries Biologist, J. Hammond, Vancouver, B.C., pers. comm.).

Fry-to-adult survival rates (figures 4.14 and 4.15) have been determined from fry production estimates and adult returns to the primary spawning channel streams (Kokanee and Redfish creeks). Very low survival rates combined with high harvest rates in the West Arm kokanee fishery forced a prolonged closure of the fishery from 1980 until 1994 with the exception of short seasonal fisheries in 1983 and 1985. Stock recovery over nearly five cycles was very slow despite excellent fry production from two spawning channels built in the 1980s and virtually no sport catch for nearly 15 years. With stock recovery evident, B.C. Fisheries[1] was confident enough to open a short-term annual fishery commencing in 1994. In April 1994, the West Arm was reopened to kokanee fishing with a harvest quota set at 5,000. The quota for 1995 and 1996 was 8,000 and from 1997 – 2003 it has been 5,000. West Arm kokanee are highly vulnerable to sport fishing and with such a small margin of error it is essential that angler effort and harvest be closely monitored each year.

Presently, the size of the upper West Arm kokanee fishery is only a fraction of what existed in the 1970s. However, the size and high catch rate of these fish in a somewhat unique, riverine habitat make them exceptionally attractive to anglers. The fishery in April 2000 was so popular that the entire quota (~5,000 fish) was reached in 11 days and the fishery had to be closed. Poor fry production from the Kokanee Creek spawning channel in 2000 and poor test fishery results in the spring, 2002 led to the decision by fisheries managers not to open the fishery in 2002 (B. Lindsay, Ministry of Water, Land and Air Protection, Fisheries Biologist, Nelson, B.C., pers. comm.). The 2003 fishery was quite successful with approximately 7800 fish harvested in a three week period.

In retrospect, it is now quite apparent that in-lake survival limits this kokanee population and there is no evidence to-date that the North Arm fertilization experiment has had any beneficial effect on the West Arm stock (Redfish Consulting, Ltd. 2000, 2002).

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[1] *In recent years, numerous provincial government organizational changes have occurred resulting in several name changes. Throughout this report, reference is made to B.C. Fisheries, the former provincial Fish and Wildlife Branch presently located in the Ministry of Water, Land and Air Protection.*

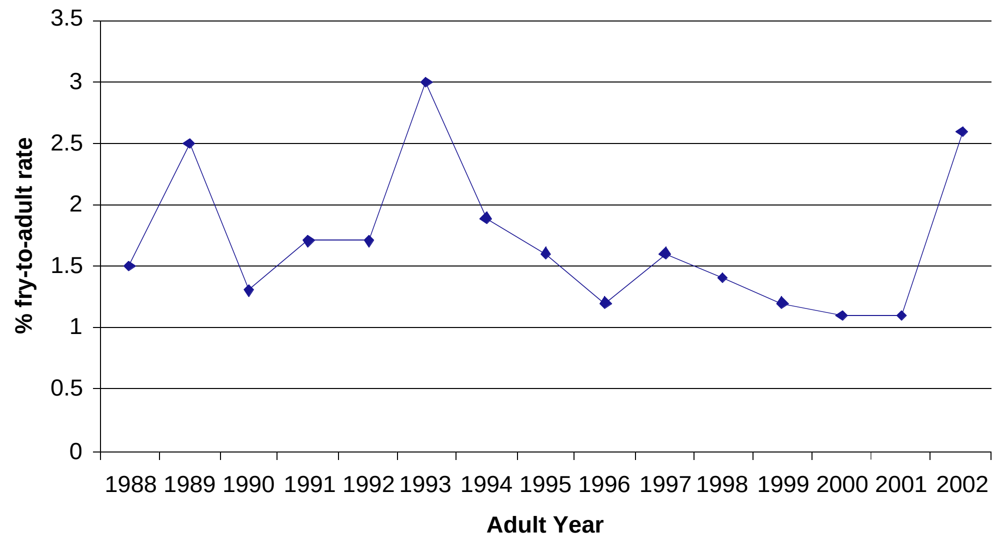

Figure 4.14. Percent survival rate fry-to-adult from Kokanee and Redfish Creek spawning channels.

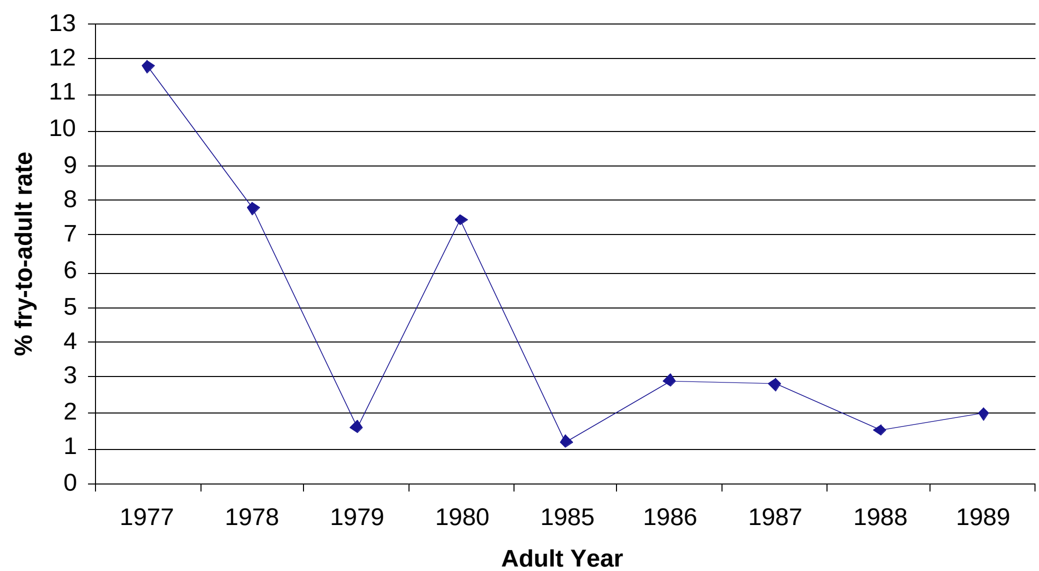

Figure 4.15. Percent survival rate fry-to-adult from Redfish Creek 1975-1989.

Koocanusa Reservoir

Kokanee in Koocanusa Reservoir often grow to 30 cm, thus providing excellent fishing. The most recent survey of the kokanee fishery on the Canadian portion of the Koocanusa Reservoir was in 1996 for the months of June-September. Angler effort was ≈ 27,000 angler days (≈ 80,000 hours) with an estimated catch of ≈ 114,000 and harvest of ≈ 103,000 (B. Westover, B.C. Fisheries Biologist, Cranbrook B.C., pers. comm.).

MFWP conducts an angler mail survey in odd-numbered years. The Montana portion of Koocanusa Reservoir was estimated by MWP to have supported 35,588 angler days of use in 1995, 48,750 in 1997, 57,493 in 1999, and 38,217 in 2001. Thus, Koocanusa Reservoir was either the first or second (only to Flathead Lake) most heavily fished lake in northwest Montana during those years.

As previously mentioned, this fishery resulted from accidental releases of Okanagan and Meadow Creek stocks from Wardner Hatchery in B.C. Entrainment affects natural production upstream from Koocanusa Reservoir, mainly in B.C., and downstream from the dam in Montana and Idaho. The non-native kokanee population in Koocanusa Reservoir appears to be stable and persistent.

4.4.2 Population Delineation and Characterization

Population Units

Genetic analysis of the kokanee populations within the Subbasin is incomplete. Morphometric differences were evident for the three subpopulations within Kootenay Lake as demonstrated by Vernon (1957). Genetic analysis conducted in 1994 by the University of Montana indicated a difference between West Arm kokanee and those from the North and South Arms, but no difference was detected between North and South Arm kokanee. No analyses have been conducted between Kootenay, Duncan, Moyie and Trout Lake stocks, although there are some obvious spatial as well as temporal differences in run timing.

Five new microsatellite loci have been identified and tested for *O. nerka*. The University of Idaho's Aquaculture research Institute is currently arranging microsatellite analyses on kokanee from numerous spawning populations throughout the Kootenai River Basin (M. Powell, UI, ARI, pers. comm.).

Life History

Spawning

Many aspects of kokanee life history, the non-anadromous form of Pacific sockeye salmon, have been well documented (Vernon 1957; Northcote and Lorz 1966; Northcote 1973; Thompson 1999; Sebastian et al 2000; Andrusak and Sebastian in Andrusak et al. 2000). Most kokanee populations found in the large lakes of British Columbia migrate up tributary streams to spawn, usually in September. Information and documentation of shore spawning kokanee in British Columbia has been quite limited, but recent investigations have identified several shore spawning populations that were previously unknown. The best documented examples of kokanee shore spawning are those in Okanagan, Kalamalka and Quesnel lakes but recently studies have shown that kokanee are also capable of spawning in reservoirs with sizeable drawdowns (e.g., Alouette, Seton and Anderson reservoirs). It is now known that the majority of kokanee in Okanagan Lake, Seton, Anderson and Alouette Reservoirs are in fact shore spawners (Andrusak and Sebastian in Andrusak et al. 2000; G. Wilson Fisheries Biologist U.B.C. Vancouver, B.C. pers. comm.). Surveys in Seton and Anderson lakes in late November 2003 have confirmed kokanee were spawning on shore at water depths of 30-50 m.

Kokanee prefer low gradient streams for spawning, and while some will utilize streams that have gradients of 1 to 5 percent, they generally will select the lower gradient sites. Most often kokanee that ascend larger rivers will utilize the side channels for spawning with the exception being in a regulated stream system where spawning coincides with lower flows, e.g., Mabel Lake kokanee in the middle Shuswap River (A. Caverly, MWLAP Biologist, Kamloops, B.C., pers. comm.). For example, in most years the Lardeau River that flows into Kootenay Lake supports 0.5-1.0 million kokanee. The river gradient averages 1.0 percent but despite this low gradient spawning kokanee will select side channels where the grade is <0.5 percent, gravel size is < 5 cm and the flow is much less than the mainstem river. The six kokanee spawning channels in British Columbia were all designed with reach gradients <0.25 percent and gravel size of 1-5 cm (Redfish Consulting, Ltd 1999).

Run timing

Most kokanee in the southern interior large lakes such as Arrow, Okanagan, Slocan and Kootenay spawn from late August to early October with the peak of spawning around the third week of September. Most Quesnel Lake stream spawning kokanee spawn slightly later (early October). Kokanee in the West

Arm of Kootenay Lake spawn quite early, commencing in mid-August and completed by mid-September. The peak of Okanagan Lake shore spawning kokanee usually occurs in the third week of October, a month later than their stream spawning counterparts (Andrusak and Sebastian in Andrusak et al. 2000). Some very late shore spawning (mid-December) has been observed in Adams Lake that is similar in timing to those in Anderson Reservoir (A. Caverly, MWLAP Biologist, Kamloops, B.C., pers. comm.)

The South Arm of Kootenay Lake kokanee spawn earlier than their northern counterparts, usually from mid-August to mid-September whereas Lardeau River kokanee spawn in the latter part of September until late October.

Size at maturity

Okanagan Lake supports two populations of kokanee, with the stream spawning component slightly larger (Mission Creek mean 28.9 cm) than the shore spawners (mean 25 cm). The length of spawning kokanee sampled in Quesnel Lake are similar in size to those of Okanagan Lake, ranging from about 22-30 cm with the means ranging from 24.6-27.7 cm. Lorz and Northcote (1965) reported a variation in the size of spawning kokanee in Nicola Lake ranging from 22-29 cm with an average of 27 cm during most years. Spawning kokanee in Arrow and Kootenay lakes are typically 20-23 cm in size, slightly smaller than Okanagan, Quesnel and Nicola lake kokanee. Vernon (1957) reported that South Arm kokanee were slightly smaller than North Arm fish and much smaller than the West Arm kokanee.

There are a few kokanee populations that grow larger than the usual 23-27 cm size found in most B.C. lakes. West Arm of Kootenay Lake kokanee have ranged in mean size from 22-38 cm but in most years the mean exceeds 30 cm (Redfish Consulting, Ltd. 2000). Mission Creek (Okanagan Lake) kokanee in the last two decades have ranged in size from 25-37 cm with an average of 28.7 cm (Andrusak et al. 2003). In addition, there are some unproductive lakes such as Slocan, Moyie and Whatshan lakes in the Kootenay area of B.C. that have very small kokanee with size at maturity of < 22 cm. Coastal lakes are generally unproductive, oligotrophic lakes that support small kokanee populations with spawner size typically around 20 -22 cm e.g., Alouette Reservoir prior to fertilization (G. Wilson, Fisheries Biologist, U.B.C. Vancouver, B.C., per. comm.).

Age at maturity

Okanagan, Quesnel, Arrow and Kootenay Lake kokanee usually spawn at age 3+ (Vernon 1957, Martin 1984, Andrusak and Sebastian in Andrusak et al 2000, Redfish Consulting, Ltd. 2003, Pieters et al. 2003). Mission Creek kokanee are primarily age 3+ but a few larger fish appear annually in the spawning population and these have been aged as 4+ and 5+ (Andrusak and Sebastian in Andrusak et al. 2000). Alouette Reservoir kokanee appear to be primarily 3+ at maturity but this may have changed as a result of fertilization that began in 1999 (Wilson 2000). West Arm of Kootenay Lake kokanee spawn as age 2+ with a few (<10 percent) spawning at age 3+ (Redfish Consulting, Ltd. 2000). Recent investigations on Adams, Shuswap and Bonaparte lakes in the upper Thompson River drainage indicate the majority of kokanee spawn as age 3+ (Redfish Consulting, Ltd. 2003).

Vernon (1957) determined that South Arm kokanee matured mostly at age 2+ whereas North Arm kokanee were primarily age 3+. Hydroacoustic and trawl surveys have been conducted on the main lake annually since 1985. Ageing of juveniles has been carried out for most years through length frequency analysis and scale reading. Three age groups are typically found in the trawl samples (ages 0-2+) while age 3+ fish make up the majority of spawners. Thompson (1999) reported that Meadow Creek spawners in 1994-96 were primarily age 2+ most likely in response to lake fertilization. More recent data (Andrusak 2003) indicates that age of maturity is once again age 3+.

Fecundity

The number of eggs found in a gravid female is size dependent and there are a number of data sources that provide detail on kokanee fecundity including good estimates on Arrow Reservoir (Sebastian et al. 2000), Kootenay Lake (Andrusak 2001) and Okanagan Lake (Sebastian and Andrusak in Andrusak et al. 2000). Arrow Reservoir kokanee usually are about 22 cm and the twenty year average fecundity is 277 (Sebastian et al. 2000). Twenty two years of data on Meadow Creek kokanee (Kootenay Lake) indicate that the mean length is 22.2 cm and that mean fecundity determined from 35 years of data is 260 (Andrusak 2003). Okanagan Lake kokanee (Mission Creek) are somewhat larger (mean size 28.8 cm) with a mean fecundity of 774 but over the fourteen years that data has been collected fecundity has ranged from 425 to 1586 (Andrusak in Andrusak et al. 2003).

West Arm kokanee are far more fecund than their main lake counterparts. Mean fecundity over the last fifteen years has been 739 compared to 260 for Meadow Creek. No fecundity data are available for South Arm kokanee.

Food Habits

It is generally understood that kokanee fry move immediately to open waters after emergence from spawning areas, whether from tributaries or beach spawning sites. This rapid dispersion of fry to the open water is consistent with many anadromous sockeye populations. There are well documented examples of sockeye fry undergoing rapid and intricate dispersion patterns into nursery lakes upon emergence (McCart 1967; McDonald and Hume 1984). Babine Lake populations have been studied extensively and McDonald and Hume (1984) demonstrated that fry migrating from tributary streams might either remain on the lakeshore for weeks or move directly into open water. There are also examples of sockeye stocks in which the juveniles initially reside on-shore in the littoral area for a period of months (see Burgner 1991). Kokanee fry in the West Arm of Kootenay Lake remain on-shore for two months before moving to the limnetic area (Redfish Consulting, Ltd. 1999) but most kokanee fry do seem to move directly to open water, usually coinciding with increased production of zooplankton (Reiman and Bowler 1980; Thompson 1999).

Once in the limnetic area, both kokanee and sockeye feed primarily on zooplankton, especially copepods and cladocerans. In lakes that are cohabited with sockeye, it appears that kokanee potentially experience intraspecific competition with underyearling sockeye since they prey upon the same macrozooplanktors such as *Daphnia* and *Diaptomus* (Stockner and Shortreed 1989; Hume et al. 1996). Northcote and Lorz (1966) found that Nicola Lake kokanee utilized copepods and cladocerans during the spring and fall months, but chironomid pupae were the dominant food source during June and July. Thompson (1999) found that Kootenay Lake kokanee fry preferred *Daphnia sp.* and *Diaphanasoma* spp., but *Mysis relicta* were also consumed. In Quesnel Lake, under yearling sockeye are found at dusk in the same layers of the lake as juvenile kokanee (D. Sebastian, Ministry of Water, Air and Lands Protection, Fisheries Victoria, B.C., pers. comm.). In Okanagan Lake it is generally believed that kokanee compete with *Mysis relicta* for preferred zooplanktors (*Diaphanasoma* and *Daphnia* spp.) (Whall and Lasenby in Ashley et al. 1999).

The West Arm of Kootenay Lake kokanee behave differently than most studied kokanee populations. The fry move from the natal streams and associate themselves with the shoreline for the first two months before moving to open water within the West Arm (Redfish Consulting, Ltd 1999). Benthic organisms, aquatic insects and littoral zooplankton are consumed in addition to pelagic zooplankton. As the summer advances, the fry move off shore and utilize macrozooplanktors and mysids.

Genetic Integrity

Within the Subbasin, only Kootenay Lake kokanee have been investigated for genetic composition, although the origin of non-native Koocanusa Reservoir kokanee is also known. Prior to the Duncan Dam, kokanee could readily intermingle and move to and from Kootenay Lake to Duncan Lake and or Trout Lake. However, it is clear from Vernon's work (Vernon 1957) that reproductive segregation due to strong homing tendencies had resulted in some genotypic divergence and strong phenotypic variability between the three spawning populations in Kootenay Lake. Electrophoretic analysis by the University of Montana (G.K. Sage letter on file) in 1994 of kokanee samples captured in the North, Central, West and South areas of the lake determined some significant differences amongst the samples. West Arm kokanee had significant allele frequency differences compared to the other samples and were considered separate from the others. No difference was detected between North and South Arm samples, perhaps not surprising since North Arm stock had been used for egg plants and the fact that very little South Arm spawning had occurred for two decades. Further genetic analysis is required of spawners from each of the three arms of the lake to determine with certainty if a South Arm stock persists as it did when Vernon (1957) did his work.

Koocanusa Reservoir kokanee originated from accidental releases from the Kootenay Trout hatchery located on the upper Kootenay River near Cranbrook, B.C. Two strains of kokanee likely contributed to the eventual population that now resides in the reservoir. Kokanee eggs from Okanagan River adults were in the hatchery in 1972 and 1973 and could have entered the newly forming reservoir in 1973 and 1974 through accidental releases when disposing of mortalities (P. Brown Fish Culturist Wardner Hatchery pers. comm.). Meadow Creek stock is the more likely contributor to the Koocanusa population since these eggs were reared in the hatchery from 1976-1979, the period of time when the reservoir was fully formed and most likely quite productive.

4.4.3 Population Status

Native kokanee salmon runs in lower Kootenai River tributaries in Idaho have experienced dramatic population declines during the past several decades (Ashley and Thompson 1993; Partridge 1983). The kokanee that historically spawned in these tributaries inhabited the South Arm of Kootenay Lake in British Columbia. Native kokanee are considered an important prey item for white sturgeon and also provided an important fishery in the tributaries of the lower Kootenai River (Partridge 1983; Hammond, J., B.C. MELP, per. comm. 2000). Kokanee runs into North Idaho tributaries of the Kootenai River, numbering into the thousands of fish as recently as the early 1980s, have now become "functionally extinct" (Anders 1993; KTOI, unpublished data; Ashley and Thompson 1994) (figure 4.16, table 4.51). Since 1996, visual observations and redd counts in five tributaries found no spawners returning to Trout, Smith, and Parker Creeks, while Long Canyon and Boundary Creeks had very few kokanee returns (figure 4.16, table 4.51).

Table 4.51. Estimated peak number of kokanee spawners for stream reaches in six tributaries to the Kootenai River in Idaho (N/S = not surveyed)

Year	Boundary Creek (610 m)	Smith Creek (380 m)	Long Canyon Creek (700 m)	Parker Parker Creek (790 m)	Trout Creek
1981	1,100	600	1,600	350	N/S
1993	0	N/S	12	64	0
1996	0	0	0	0	0
1997	0	0	3	0	0
1998	8	0	0	0	0
1999	38	0	0	0	0
2000	15	N/S	30	7	0
2001	31	N/S	25	0	0
2002	N/S	N/S	0*	30+	0*
2003	N/S	N/S	40+	55+	0*

** Survey time and effort minimal.*
+ Conservative estimate, based on production from introduced Meadow Cr. stock.

However, a series of kokanee stream restoration activities lead by the Kootenai Tribe of Idaho appears to be contributing to recent increases in spawner counts in Long Canyon and Parker creeks (table 4.51). These activities included:

- 1997 – In cooperation with the B.C. Ministry of Environment, Land, and Parks, Idaho Fish and Game, and the US Fish and Wildlife Service, the Kootenai Tribe began a reintroduction program for kokanee in the westside tributaries to the Kootenai River in Idaho.

- Fall 1997 – Obtained 100,000 disease-free eyed kokanee eggs from Canada (Meadow Creek stock from Kootenay Lake). Planted eggs in Long Canyon Creek using instream incubation techniques demonstrated by employees from the B.C. Ministry of Environment Fisheries.

- Spring 1998 – Released approximately 15,000 kokanee fry in Parker Creek (incubated at tribal Sturgeon hatchery in Bonners Ferry).

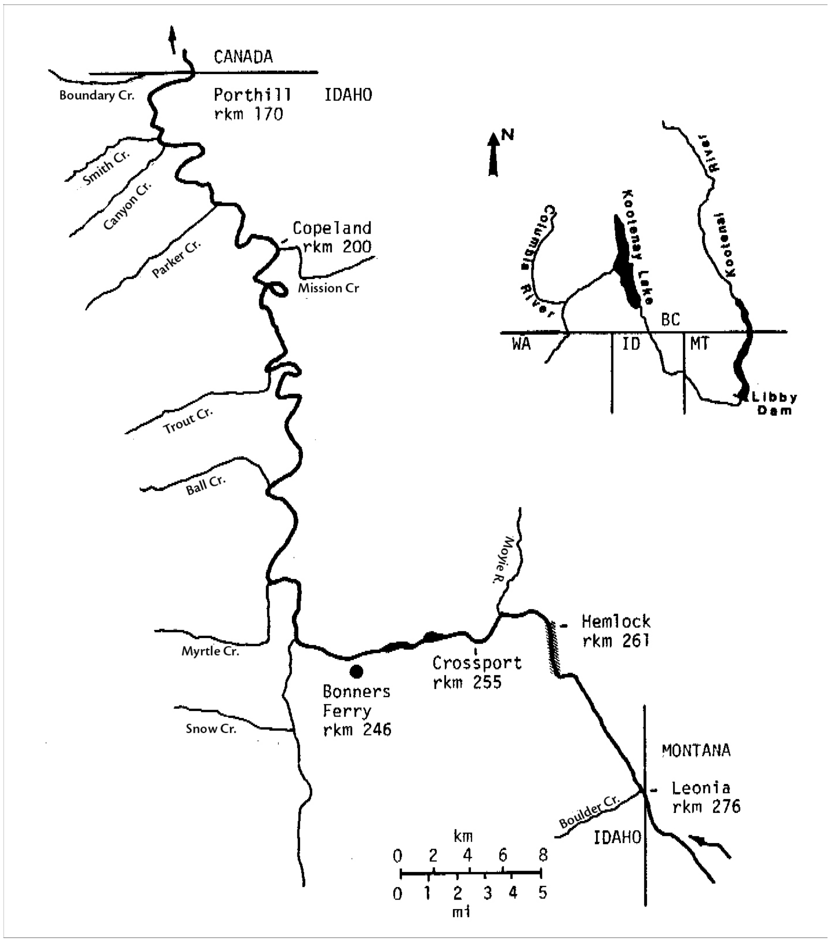

Figure 4.16. Location of Idaho Kootenai River tributaries where visual

LINKS

For a more complete discussion of how Mainstem Columbia River operations affect subbasin fisheries, and how those effects might be minimized see Appendix 18.

Click Here

- Fall 1998 – Planted 300,000 eyed kokanee eggs in Long Canyon, Parker, and Trout Creeks in October using instream incubation techniques (100,000 eggs per creek). Kokanee originated from the North Arm Kootenay Lake stock (Meadow Creek) in British Columbia. Placed thermographs in each creek.

- Fall 1999 – In October, reintroduction (instream incubation) of kokanee occurred in three tributaries (200,000 – Long Canyon; 150,000 – Parker Creek; and 150,000 – Trout Creek) using eyed eggs from the North Arm of Kootenay Lake stock (Meadow Creek)with assistance from staff from the B.C. Ministry of Fisheries.

- Fall 2000, 2001, and 2002 – no kokanee eggs were available for reintroduction.

- Fall 2003 – In October, reintroduction of eyed kokanee eggs occurred in four tributaries (1.5 million eyed eggs from Meadow Creek stock, B.C.) with assistance from staff from the B.C. Ministry of Water, Land and Air Protection (Freshwater Fisheries Society). Eggs were planted in Long Canyon, Parker, Trout (north and south forks), and Myrtle Creeks.

Human impacts

The Kootenay Lake watershed has been the subject of a great deal of attention from the scientific community for well over fifty years due to a series of human influences that have resulted in dramatic changes to lake productivity. These changes have had profound impacts on several fish species, most notably kokanee (*Onchorynchus nerka*). Kootenay Lake has also been well studied by fisheries scientists because it supports what is arguably the largest rainbow trout found in the world. These trout, known as Gerrard rainbow trout (*Onchorynchus mykiss*) are exceptional predators that can grow up to 15 kg. They are reliant almost entirely on kokanee for food and therefore any significant decline in kokanee has been a major cause for public concern and fisheries managers. Gerrard rainbow trout and kokanee are also sought by anglers in what has been one of the most popular and intensive inland sport fisheries in British Columbia.

LINKS

For information on the relationship between Columbia River redband trout and Gerrard (kamloops) rainbow, see the section on population delineation in the redband focal species description.

Click Here

Northcote (1973) summarized the historical impacts endured by Kootenay Lake as a result of early European settlement and subsequent “development" through agriculture, mining, forestry, cultural eutrophication, fishing and hydro-development. By far, hydro-development has had the most significant impacts. Kootenay Lake was initially affected by hydro-development in 1932 with completion of the Corra Linn dam that had the ability to store up to 2.5 m of water on the lake (Daley et al. 1981). The Columbia River Treaty signed between the United Sates and Canada in 1961 put into motion development of the Duncan Dam completed in 1967. The Libby Dam on the Kootenai River in Montana was completed in 1974, although the reservoir began forming in 1972.

One of the earliest changes to the ecology of Kootenay Lake noted by various researchers was the introduction of *Mysis relicta* in 1949 by P.A. Larkin (Northcote 1991). Successful introduction of these macrozooplanktors was not confirmed until 1964 when they were observed drifting through the outlet of the lake (Sparrow et al. 1964). Northcote (1991) concluded that this introduction was only partially successful since the targeted species—Gerrard rainbow trout—have not benefited to any measurable degree. West Arm kokanee have benefited from the mysid introduction (Northcote 1973; Martin and Northcote 1991) but main lake kokanee have not (Martin and Northcote 1991). Many researchers including Ashley et al. (1997) and Walters et al. (1991) suggested that mysids may have been at least partially responsible for the dramatic decline in main lake kokanee stocks in the 1980s.

Northcote (1973) described the cultural eutrophication of the lake in the 1960s and 1970s due to phosphorous introduction from a fertilizer plant into a tributary of the Kootenay River some 400 km upstream from the lake. Daley et al. (1981) described in considerable detail the reversal of eutrophication during the late 1970s and early 1980s. Cessation of phosphorous discharge and nutrient retention due to formation of reservoirs on the two major inflow rivers (Kootenay and Duncan) were the primary reasons for the reversal process and the lake once again became oligotrophic (Daley et al., 1981; Ashley et al. 1999).

By the mid-1980s it had become apparent that lake productivity had declined to such an extent that the main lake kokanee population was on the verge of collapse. The potential for a decline in the economically important rainbow trout sport fishery (Andrusak and Brown 1987, MS; Korman et al. 1990) and fear of a kokanee collapse were impetus for increased research. Also, the opportunity to measure trophic level responses to short term productivity changes on such a large system was of considerable scientific interest.

Main lake kokanee stocks actually began to decline in the mid 1980s (Andrusak 1987, MS; Ashley et al. 1997). North and South Arm kokanee stocks decreased with virtually no South Arm fish evident while North Arm stock escapements dropped from a range of 0.5 - 4.1 million in the 1960s and 1970s to 0.3-0.5 million in the late 1980s and early 1990s (Ashley et al. 1999). This decline led researchers to consider means of reversing this trend, especially since the world-renowned Gerrard rainbow trout are so dependent upon kokanee as their food source (Andrusak and Parkinson 1984).

In 1990, a series of meetings were held amongst fisheries researchers and managers to consider what, if anything, could be done to reverse the downward trend in main lake kokanee numbers. Korman et al. (1990) describes the various alternatives that were contemplated. The Kootenay Lake Fertilization Response Model (Walters et al. 1991) was developed to understand what would happen if the lake was fertilized to pre-impoundment and pre-cultural enrichment levels. The model predicted that fertilization would not likely be successful, but fisheries management, faced with no other option, proceeded to initiate a five-year fertilization experiment commencing in 1992. Results of this experiment have been reported in a series of technical reports (Ashley et al. 1999; Wright et al.

2003), and the response by North Arm kokanee has been very positive. Kokanee escapements to the North Arm's Lardeau River and Meadow Creek systems are once again over 1 million and comparable to escapements of the 1960s and 1970s (Ashley et al. 1999). A reduction in fertilizer loading from 1997-2000 resulted in a decline in the kokanee population, prompting fisheries managers to increase the loading rate in 2000 and 2001 (Andrusak 2002).

LINKS

For the website containing descriptions of surface waters included in the Montana water quality assessment database go to: http://nris.state.mt.us/wis/environet/2002_305bhome.html.

Click Here

For the website listing 303(d) water-quality impaired streams and lakes for the Idaho portion of the subbasin, go to: http://inside3.uidaho.edu/WebMapping/IDEQ/

Click Here

Environment s Ability to Provide Key Ecological Correlates

In most of the Subbasin there are adequate numbers of kokanee in each of the described subpopulations with the notable exception of the South Arm of Kootenay Lake. Despite North Arm fertilization, the South Arm stock has not responded, most likely due to a much smaller initial population size, lower stream egg-to-fry survival rates and interspecific competition for preferred food items. Timing of fry out-migration from the southern tributary streams is unknown, but if Koocanusa Reservoir kokanee fry move into Kootenay Lake prior to South Arm stream-kokanee fry, South Arm kokanee may be at a disadvantage. South Arm kokanee are unlikely to recover without improvement to the productivity of the South Arm combined with egg transplants and restoration of some key spawning habitat. At the same time, it is possible that fertilization of the South Arm may provide some benefits to upper West Arm kokanee. Increased zooplankton production may result in greater outwash of zooplankters to the West Arm.

Habitat availability and condition

Slaney and Andrusak (2004) evaluated a number of South Arm tributaries during September 2003. Several streams, completely void of kokanee spawners, were deemed to have suitable kokanee spawning habitat. Good kokanee habitat was documented in Boulder, Boundary, and Summit Creeks. Habitat restoration measures have been recommended to improve the quality of kokanee spawning habitat as well as improve rainbow trout rearing habitat.

The Kootenai Tribe of Idaho is conducting habitat restoration work on lower Kootenai River tributaries through the Lower Kootenai River Model Watershed Restoration Project. The tribe is working on restoring riparian and instream habitat on Trout, Long Canyon and Parker Creek and will be working with USFWS on Myrtle Creek and Anheiser-Busch on Fisher Creek.

QHA Results for Kokanee

As part of this assessment, the Kootenai Subbasin (MT, ID, and B.C.) Technical Teams[2] evaluated all the 6th-code HUCs and selected lakes in the Montana, Idaho, and Canadian[3] portions of the 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 the QHA and LQHA spreadsheet tools. 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 4.52). Those used in LQHA are the ones considered by our Technical Team to be the main

Table 4.52. Eleven habitat attributes used in the Kootenai Subbasin QHA analysis of 6th-code 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

LINKS

For more detailed results of the QHA assessment, including attribute scores and HUC rankings, see Appendices 32 and 33.

Click Here

[2] The Kootenai Subbasin Technical Team members particiapating in the HUC-by-HUC assessment included fisheries biologists and hydrologists from the Kootenai Tribe of Idaho, Montana Fish, Wildlife and Parks, Idaho Fish and Game, Idaho Department of Environmental Quality, US Army Corps of Engineers, US Fish and Wildlife Service, the Idaho Panhandle and Kootenai National Forests, the B.C. Ministry of Sustainable Resource Management, the B.C. Ministry of Land, Water, and Air Protection, and a private consulting firm.

[3] In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portions 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.

habitat drivers in lakes within the subbasin (table 4.53). For each 6th-code HUC, the technical team used quantitative data (when it existed) and professional knowledge and judgement to score each of the attributes for each HUC. We did the same for selected lakes (table 4.54).

Table 4.55 ranks stream habitat attributes for kokanee averaged across the regulated mainstem HUCs in the U.S. portion of the subbasin. Tables 4.56 and 4.57 rank stream habitat-attributes for kokanee averaged across all tributary 6th-code HUCs in the U.S. and B.C. portions of the subbasin, respectively. Tables 4.58 and 4.59 show the ranking by 4th-code HUC for the U.S. and B.C. portions of the subbasin. Table 4.60 ranks habitat attributes for subbasin reservoirs in both Canada and the U.S. The rankings provide a good indication of the subbasin's ability to provide key ecological correlates required for kokanee viability and persistence and the habitat attributes that may be the most limiting for kokanee in the subbasin.

Based on this analysis, of the eleven stream habitat attributes considered key to resident salmonids, the most degraded for kokanee trout in tributaries in the U.S.

LINKS

Appendix 62 presents the results of a GIS-based fisheries vulnerability analysis conducted by the Cohesive Strategy Team of Region 1 of the USFS.

Click Here

Table 4.53. Habitat attributes used in the Kootenai Subbasin Lacustrine 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

Appendix 63 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

Table 4.54. Lakes assessed in the Kootenai Subbasin using the Lacustrine QHA spreadsheet tool.

Lake	Location
Kootenay Lake	Canada
Moyie Lakes	Canada
Duncan Lake	Canada
Trout Lake	Canada
Koocanusa Reservoir	U.S./Canada
Kilbrennan	U.S.
Loon Lake	U.S.
Bull Lake	U.S.
Sophie Lake	U.S.
Boulder Lake	U.S.
Granite Lake	U.S.
Leigh Lake	U.S.
Therriault Lake	U.S.
McArthur Lake	U.S.

Table 4.55. Ranking of key habitat attributes for the regulated mainstem in the U.S. portion of the Kootenai Subbasin for kokanee based on a QHA analysis.

Habitat Attributes	Score	Rank
Oxygen	0.00	1
High Temperature	0.13	2
Obstructions	0.27	3
Habitat Diversity	0.50	4
Pollutants	0.50	4
Riparian Condition	0.67	5
Channel stability	0.80	6
Fine sediment	0.80	6
Low Temperature	0.80	6
High Flow	1.07	7
Low Flow	1.33	8

Table 4.56. Ranking of key habitat attributes for 6th-code HUC tributary watersheds in the U.S. portion of the Kootenai Subbasin for kokanee based on a QHA analysis.

Habitat Attributes	Score	Rank
Low Temperature	0.05	1
Oxygen	0.07	2
Obstructions	0.08	3
Habitat Diversity	0.23	4
High Flow	0.27	5
Low Flow	0.27	5
Riparian Condition	0.30	6
Fine sediment	0.37	7
Channel stability	0.43	8
High Temperature	0.43	8
Pollutants	0.47	9

Table 4.57. Ranking of key habitat attributes for 6th-code HUC watersheds in the B.C. portion of the Kootenai Subbasin for kokanee.

Habitat Attribute	Score	Rank
Low Flow	0.00	1
Oxygen	0.00	1
Low Temperature	0.00	1
High Temperature	0.00	1
Pollutants	0.00	1
Obstructions	0.00	1
High Flow	0.04	2
Habitat Diversity	0.14	3
Riparian Condition	0.17	4
Fine sediment	0.21	5
Channel stability	0.22	6

Table 4.58. Ranking of key stream-habitat attributes for the regulated mainstem and tributaries at the HUC-4 scale for kokanee in the U.S. portion of the subbasin based on a QHA analysis of all 6th-field HUCs. The most limiting attributes are highlighted in yellow.

	Regulated Mainstem		Lower Kootenai		Moyie	
Habitat Attribute	Score	Rank	Score	Rank	Score	Rank
Channel stability	0.80	6	0.47	9	0.27	3
Fine sediment	0.80	6	0.40	7	0.27	3
Habitat Diversity	0.50	4	0.25	4	0.17	2
High Flow	1.07	7	0.27	5	0.27	3
High Temperature	0.13	2	0.47	9	0.27	3
Low Flow	1.33	8	0.25	4	0.33	4
Low Temperature	0.80	6	0.07	1	0.00	1
Obstructions	0.27	3	0.10	3	0.00	1
Oxygen	0.00	1	0.08	2	0.00	1
Pollutants	0.50	4	0.42	8	0.67	5
Riparian Condition	0.67	5	0.29	6	0.33	4

Table 4.59. Ranking of key stream-habitat attributes at the HUC-4 scale for kokanee in the B.C. portion of the subbasin based on a QHA analysis of all 6th-field HUCs.

	Duncan Lake		Kootenay Lake		Slocan	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
Channel stability	0.29	5	0.14	4	0.30	6
Fine sediment	0.22	4	0.14	4	0.40	7
Habitat Diversity	0.13	2	0.13	3	0.19	4
High Flow	0.00	1	0.06	2	0.13	3
High Temperature	0.00	1	0.00	1	0.00	1
Low Flow	0.00	1	0.00	1	0.00	1
Low Temperature	0.00	1	0.00	1	0.00	1
Obstructions	0.00	1	0.00	1	0.02	2
Oxygen	0.00	1	0.00	1	0.00	1
Pollutants	0.00	1	0.00	1	0.00	1
Riparian Condition	0.15	3	0.17	5	0.25	5

Table 4.60. Ranking of key habitat attributes for reservoirs in the Kootenai Subbasin for kokanee based on an LQHA analysis.

Reservoirs	Score	Rank
Oxygen	0.00	1
Gas saturation	0.00	1
Macrophytes	0.00	1
Habitat diversity	0.01	2
Pollutants	0.03	3
Shoreline condition	0.05	4
Substrate condition	0.05	4
Temperature	0.06	5
Entrainment	0.08	6
Trophic status	0.12	7
Migratory obstruction	0.12	7
Volumetric turnover rates	0.31	8
Hydraulic regime	0.40	9

portion of the subbasin (when averaged across all the tributary HUCs) are pollutants, altered thermal regime, channel stability, and fine sediment, in that order. In the regulated mainstem they are altered hydrograph, altered thermal regime, fine sediment, and channel stability. In the B.C. portion of the subbasin they are channel stability, fine sediment, riparian condition, and habitat diversity. The rankings vary at the HUC-4 scale. Of the thirteen lake-habitat attributes considered key to resident salmonids, the four most limiting to kokanee in reservoirs are hydraulic regime, volumetric turnover rates, migratory obstructions, and trophic status.

4.4.4 Kokanee Limiting Factors and Conditions

Dams

As previously mentioned, hydro-developments have by far had the greatest impact on kokanee populations in the Subbasin. Three types of impacts are evident:

1. Physical displacement: The loss of the lower Duncan River due to construction of the dam just below the outlet of the former Duncan Lake resulted in theloss of approximately 10 km of spawning habitat that supported an estimated 2.8 million kokanee in 1964 and approximately 1 million kokanee annually from 1965-1967. There are no known shore spawners in the main portion of Kootenay Lake, therefore annual drawdown regulation does not impact kokanee. Some shore spawning in the West Arm is affected by the drawdown.

2. Nutrient uptake in upstream reservoirs: Koocanusa reservoir is relatively productive and ties up much of the nutrients that would otherwise flow into Kootenay Lake. The Arrow Lakes Reservoir has experienced a similar fate due to nutrient uptake in upstream Mica and Revelstoke Reservoirs (Pieters et al. 2003). The response of kokanee to lake fertilization in Kootenay and Arrow Lakes Reservoir has been well documented (Ashley et al. 1997; Andrusak 2003; Andrusak 2002).

3. Lake level drawdown: Most noticeable in the West Arm of Kootenay Lake. Dewatering of extensive littoral zones impacts rearing kokanee fry that inhabit and feed in the shallow areas of the West Arm after out-migrating from the streams (Andrusak 2000). Reduction in the peak of the hydrograph has resulted in fewer mysids being swept over the sill at Balfour, B.C. thus adversely affecting growth and survival rates.

LINKS

Appendix 64 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

Grazing and agricultural practices

Lower floodplain reaches of several streams in northern Idaho have been adversely impacted by the grazing of domestic animals in the riparian zone (EcoAnalysts, Inc. 1998; KTOI and Kruse 2002; KTOI and Kruse 2004a; and KTOI and Kruse 2004b). Due to the use of spring to fall seasonal grazing practices, riparian use by animals probably affects rearing salmonids more so than spawning kokanee. However, animals do affect the quality of spawning habitat during the spring and summer by grazing down the riparian vegetation, increasing erosion and bedload movement, and disrupting stream substrates.

The Results of QHA

In our HUC-by-HUC assessment of all Kootenai Subbasin 6th-code HUCs in the U.S., the technical team concluded that of the habitat attributes considered most important to resident salmonids, the most limiting for kokanee, when averaged across all the HUCs in the U.S. portion of the subbasin, were low flow, channel stability, high flow, and fine sediment, in that order. In the B.C. portion of the subbasin they were channel stability, fine sediment, riparian condition, and habitat diversity. In the lakes assessed, the limiting factors were hydraulic regime, volumetric turnover rates, migratory obstructions, and trophic status. This phase of the HUC assessment considered only habitat factors.

4.5 Burbot (*Lota lota*)

4.5.1 Background

Burbot are common throughout their Holarctic distribution, but in some regions of their natural range they have either been extirpated or are at risk. They are also described as common throughout the upstream reaches of the Columbia River Basin in the northwestern U.S., and in much of Canada (Scott and Crossman 1973; McPhail and Paragamian 2000). McPhail and Lindsey (1970) indicated that burbot were relatively abundant in the other drainages of western Canada. Local distribution and stock status have been investigated throughout the burbot's range. Specific assessments have occurred in Asia (Nelichik 1979; Nikiforov 1992), Canada (Lindsey 1956; Hatfield et al. 1972; Paragamian et al. 2001), Alaska (Hallberg 1986; Peckham 1986; Parker et al. 1987; Parker et al. 1988; Lafferty et al. 1990), and the northern United States (Robins and Deubler 1955; Muth 1973; Clady 1976; Edsall et al. 1993).

The most reliable burbot population estimates come from a stock assessment program on lacustrine populations in Alaska (Bernard et al. 1991; Lafferty et al. 1990, 1991, 1992; Evenson 1993b; Lafferty and Bernard 1993; Parker 1993). Across a variety of lakes, adult burbot (>450mm) density estimates ranged from 0.24-21.9 per ha^{-1}. The highest recorded adult densities (139 per ha^{-1}) were from southwestern Lake Michigan at Julian's Reef (Edsall et al. 1993). Based on most recent (2003) stock assessment modeling of burbot in the Kootenay Lake/lower Kootenai River portion of the Subbasin, abundance estimates ranged between 50 and 500 fish in the Bonners Ferry to Kootenay Lake reach, likely closer to 50 than 500 (Ray Beamesderfer, S.P. Cramer and Associates, pers. comm. Sept. 2003). No other more current population abundance estimates exist for Kootenai Subbasin burbot.

Due to low population abundance and failing natural recruitment, Kootenai River burbot in the Idaho portion of the Kootenai Subbasin were petitioned as threatened under the U.S. Endangered Species Act. However, the USFWS' 12-month finding for the petition reported that: "After reviewing the best available scientific and commercial information, we find that the petitioned action [listing] is not warranted, because the petitioned entity is not a distinct population segment and, therefore, is not a listable entity."

In Kootenay Lake the species has been red-listed by the B.C. Conservation Data Centre, and anglers can no longer harvest burbot from this system.

LINKS

The petition for the listing of burbot under the ESA can be viewed at: http://www.wildlands.org/w_burbot_pet.html

Click Here

The Federal Register 12-month Finding for the Petition to list the Lower Kootenai River Burbot (Lota lota) can be downloaded at: http://a257.g.akamaitech.net/7/257/2422/14mar20010800/edocket.access.gpo.gov/2003/pdf03-5737.pdf

Click Here

LINKS

Burbot information generated by State, federal, and tribal biologists working in Montana is available from 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 fisheries information for the Kootenai 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

Reasons for Selection as Focal Species

Throughout their geographic range, burbot (*Lota lota*) historically exhibited fluvial, adfluvial, and lacustrine life history strategies (Paragamian and Willis 2000, and references therein). Successful expression of these life history strategies required suitable tributary, mainstem river, and/or lake (reservoir) habitat conditions. Burbot populations specifically require functional, cold water, ecosystems to successfully reproduce, recruit, and persist. Kootenai River Subbasin burbot persisted because these conditions existed within the Subbasin following postglacial recolonization by burbot and other native fishes, some 10,000-12,000 years ago, after the retreat of the most recent glaciation (Wisconsin period, Alden 1953). Because of their ecological sensitivity, Kootenai Subbasin burbot serve as a valuable focal species for Subbasin Planning purposes. The imperiled status of some Subbasin burbot stocks indicates compromised aquatic ecosystem health and function within the Subbasin (figure 4.17). The global rank for the Lower Kootenai population is G5T1 because burbot are "likely isolated in the lower Kootenai River in British Columbia, Idaho, and Montana; declining in abundance and in number of spawning sites, likely due to flow, temperature, and nutrient impacts of Libby Dam; current regulations and conservation efforts have not reversed the decline." Also, the burbot is a culturally significant species to the Kootenai Tribe of Idaho and provided vital subsistence use in the winter months. For all of these reasons we have selected burbot as a focal species in this assessment.

Summary of Population Data

Overall, there are very few burbot left in the Kootenai River between Kootenay Lake and Kootenai Falls. The greatest concentration occurs seasonally (spawning migration) near and in the Goat River in B.C., and even there the numbers are quite small. However, burbot currently exist in and upstream from Koocanusa Reservoir, in adjacent downstream areas, and were reported as seasonal inhabitants of Idaho waters of the Kootenai Subbasin (Partridge 1983). Recently, most of the burbot have been collected in the general vicinity of the Goat River confluence, near the town of Creston, B.C. The majority of empirical telemetry data, as they relate to burbot movements in the fall and winter (spawning) period, have been collected in this part of the Kootenay River. With few exceptions, documented upstream migrations were relatively short. Very few burbot have been recently collected in Idaho (table 4.61), and almost all were captured in the Ambush Rock area (figure 4.17). Modeling results suggested that the West Arm (Kootenay Lake) burbot population size prior to 1967 numbered approximately 200,000 individuals (Ahrens and Korman 2002). The estimated trend in age-1 recruitment indicated a substantial increase of recruits in the early 1960s, peaking in 1964

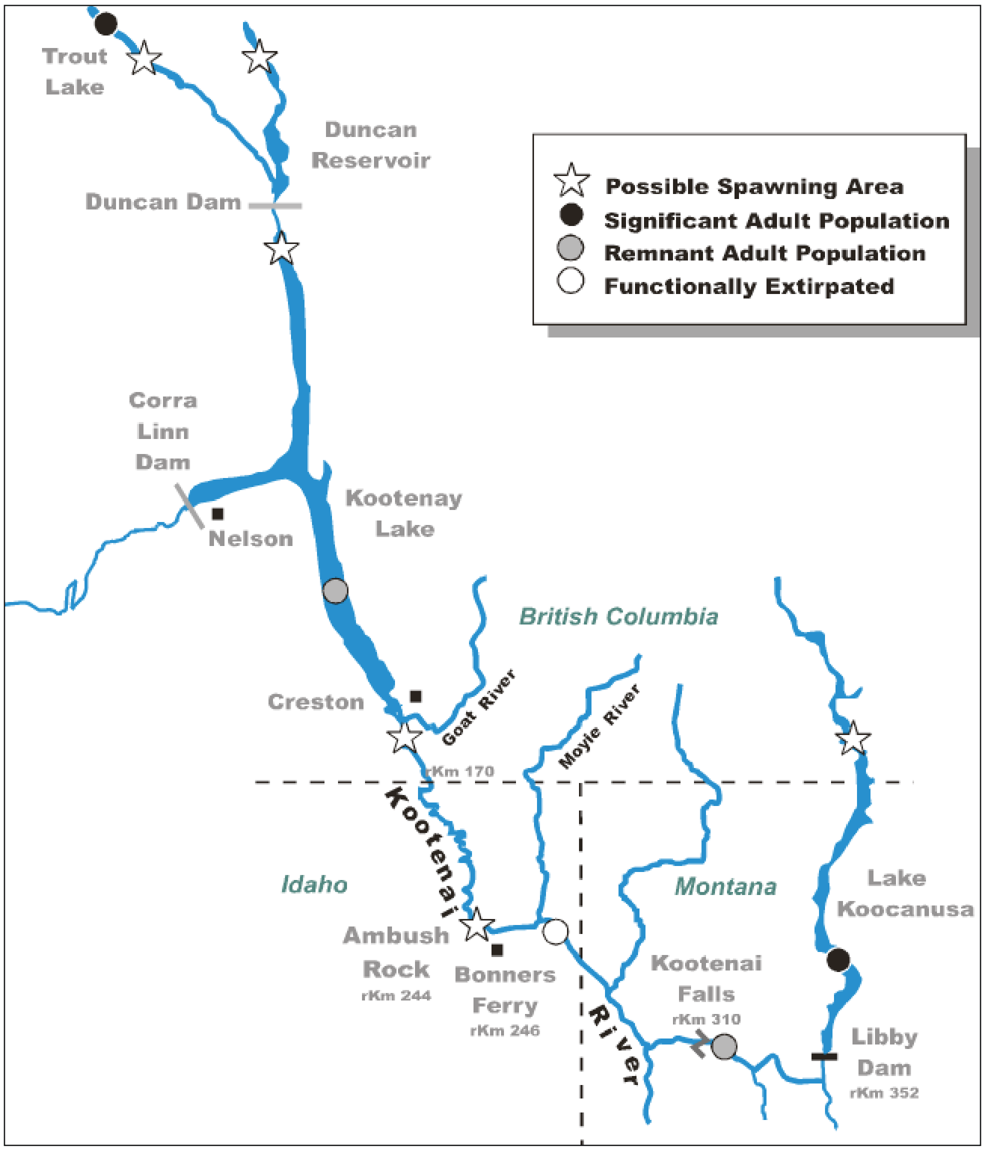

Figure 4.17. Distribution of burbot (Lota lota) within the Kootenai River Subbasin. Symbols indicate general location and status of existing burbot populations. (From KVRI Burbot Committee 2004).

and failing by the late 1960s. It seems reasonable to assume the burbot fishery collapsed as a result of the recruitment failure, but the collapse may have been accelerated substantially by unsustainable harvest rates.

Historic and Current Distribution[1]

Burbot is the single freshwater species of the cod family (Gadidae), and has a wide, circumpolar distribution (McPhail 1997; Scott and Crossman 1973). In North America, burbot are found throughout most of Canada and in the northern third of the U.S. (Scott and Crossman 1973). Owing to its widespread distribution, especially in the remote northern regions of its range, the species as a whole is healthy and thriving. Toward the southern edge of the species range however, some burbot populations are in jeopardy for a variety of reasons. The B.C. and Idaho portion of the Kootenai River Subbasin is one such area where the continued existence of local burbot populations is in question. In Montana, their existence is also questionable in the Kootenai River below Libby Dam, but there is not enough information to whether the species is in peril above Libby Dam.

Historic Distribution

Historically, burbot were distributed throughout the Kootenai River Subbasin, however, their natural distribution does not appear to have been contiguous. Although burbot existed in numerous adjacent watersheds in British Columbia (e.g., Arrow Lakes, Columbia River, Slocan Lake), burbot in the Kootenai system were historically isolated from those watersheds by the impassable Bonnington Falls, located downstream from Nelson, B.C. and now inundated between dams. This geographic isolation is reported to occur post-glacially from 10,000-12,000 years ago (Alden 1953; Northcote 1973). Kootenai Falls in Montana was reported to be a natural upstream barrier to burbot passage. However, burbot and burbot fisheries historically existed upstream from both falls, and burbot can successfully move downstream through this upstream migration barrier. Numerous dams (e.g. Cora Linn, 1931; Duncan, 1967; and Libby, 1972) have further restricted the distribution and movements of Kootenai Subbasin burbot.

The largest burbot concentrations were believed to have inhabited the Balfour area near the inlet to Kootenay Lake's West Arm, and to a lesser extent seasonally inhabited the Kootenai River from Kootenay Lake to Kootenai Falls (figure 4.17). Based on empirical reproductive data collected from fisheries, at least two distinct burbot stocks likely existed in Idaho and British Columbia. One was a lacustrine population in Kootenay Lake, the other a fluvial or adfluvial population in the Kootenai River. Temporal and geographic reproductive isolation appears sufficient to infer reproductive isolation (Martin 1976; Hammond and Anders 2003). However, burbot stock status throughout the entire Subbasin

[1] *The information presented here on historic and current burbot distribution in the Kootenai Subbasin was largely excerpted from Hammond and Anders (2003).*

remains uncertain. Stock separation at Kootenai Falls in Montana has also been suggested based on mtDNA analysis (Paragamian et al. 1999).

Current distribution

Currently, most burbot in the Kootenai River Subbasin exist in three separate lake systems: Koocanusa Reservoir in Montana, Duncan Reservoir in B.C., and Trout Lake in B.C. (figure 4.17). Little is known about the distribution of burbot in Koocanusa Reservoir and the upper Kootenai River upstream from the lake. Distribution of burbot in Duncan Reservoir and Trout Lake was addressed in Spence (2000), Neufeld and Spence (2001), Spence and Neufeld (2002), and Baxter et al. (2002a, 2002b). In addition, Bisset and Cope (2002) indicated that a viable burbot population exists in Moyie Lake based on a 2002 creel survey. There is a modest burbot fishery at Moyie Lakes from mid-January to the end of February, however, over the last 15 years the daily possession limit for burbot in the Kootenay Region has been reduced from 15 to 2 fish. Burbot have been observed during the last few years in the North Arm of Kootenay Lake (Spence 1999), at the confluence of the Goat River and the Kootenai River (Paragamian 1995; Bisset and Cope 2002), and in the mainstem Kootenai River, primarily at Ambush Rock, just downstream from Bonners Ferry, Idaho (rkm 244; Paragamian et al. 2001). However, current burbot abundance in these locations is believed to be a fraction of historic levels. Only two burbot have been captured in the Balfour area of the West Arm of Kootenay Lake in recent years: one in 1997 and one in 1998 (Spence 1999). Recent underwater photography on the historical Balfour "ling beds" revealed that substrates in these areas are now covered (literally) with suckers (Catastomidae), which may have opportunistically filled the demersal niche vacated by lost (overharvested) burbot stocks.

Very few burbot remain in the Kootenai River between Kootenay Lake and Kootenai Falls. The largest concentration, which is actually quite small, occurs seasonally (spawning migration) near and in the Goat River in B.C. However, burbot currently exist in and upstream from Koocanusa Reservoir, in adjacent downstream areas, and were reported as seasonal inhabitants of Idaho waters of the Kootenai Subbasin (Partridge 1983). Recently, most burbot in this section of the Subbasin have been collected in the general vicinity of the Goat River confluence, near the town of Creston, B.C. The majority of empirical telemetry data (as they relate to burbot movements in the fall and winter (spawning) period) have been collected in this part of the Kootenay River. With few exceptions, documented upstream migrations were relatively short. Very few burbot have been collected recently in Idaho (table 4.61), and almost all were captured in the Ambush Rock area (figure 4.17).

Table 4.61. Summary of burbot sampling efforts in Kootenai River and Kootenay Lake.

Year/ Month	Location	Capture Method	Number of Burbot Caught	CPUE	Reference
1957-58	Kootenai River	Unknown	199	Unknown	Paragamian et al. 2000
1979-82	Kootenai River	3 gear types	108	Unknown	Partridge 1983
1993, March-June	Kootenai River, rkm 225-273	Hoop traps	17	0.03 fish/net- day	Paragamian 1994
1994	Kootenai River	Hoop traps	8	0.009	Marcuson et al. 1994
1994-1995, November-February	Kootenay River, B.C., rkm 145-170	Hoop traps	33	0.047 fish/net- day	Paragamian 1995
1995, April-June	Kootenai(y) River, rkm 115-245	Larval fish net, Minnow traps, Beach seine, Electrofishing	0 larval burbot, 1 juvenile burbot	Unknown	Fredericks and Fleck 1995
1995-1996, November-March	Kootenai(y) River, rkm 120-178	Hoop traps	28	0.055 fish/net-day	Paragamian and Whitman 1997
1997	Kootenay River delta, Balfour, Pilot Bay, Duncan River outlet	Set lines, Hoop traps	8	28,000 hook hours; 12,981 hours hoop trap	Redfish Consulting Ltd. 1998
1997, July; 1998, June	West Arm Kootenay Lake (inlet to Akokli Creek)	Hoop traps	1 in 1997 1 in 1998	unknown	Spence 1999
1998, June-August	Kootenay Lake, Duncan River, Goat River	Electrofishing, Minnow traps, Beach seine	1 juvenile	0.01 fish* 100s-1	Spence 1999
1998-1999, January-March	Kootenay Lake, Duncan River	Hoop traps, Cod traps	20	0.051 fish/ 100 h (hoop traps)	Spence 1999
1999-2000, October-April	Kootenai(y) River, rkm 144-244	Hoop traps	36	0.0216 fish/net-day	Paragamian, Kozfkay, and Whitman 2001
2000, April-May; 2001, February-March	Kootenay Lake: Balfour, Sunshine Bay, Queen s Bay	Cod traps	1	0.004	Baxter et al. 2002a
2001, January-March	Kootenay Lake: Balfour, Sunshine Bay, Nine Mile Narrows, Queen s Bay	ROV (remote operated vehicle)	0	0	Baxter et al. 2002a
2002, February	Kootenay Lake	TOV (towable operated video camera)	0	0	Baxter et al. 2002b
2002, January-February	Goat River	Fish fence/trap	15	0.03 fish/hour	Bisset and Cope 2002

Note: Specific information is presented only if provided in the original reference; for example, sampling months and CPUE units are not provided in all references.

In Montana, practically all the burbot information came from the Koocanusa Reservoir area. Telemetry data indicated upstream movements during the winter (spawning) period, some as far as the St. Mary River in B.C. (~ 75 km) (Ostrowski et al. 1997).

Status of Burbot Introductions, Artificial Production and Captive Breeding Programs

No burbot have been introduced into Idaho, Montana, or British Columbia waters of the Kootenai River Subbasin. No within-basin introductions or translocations of native burbot have occurred into these waters, with the following exception, reported in the paragraph that follows. Currently (2003), all burbot inhabiting the Kootenai River Subbasin are wild fish, with no effects from non-native burbot stock introductions, artificial production, or captive breeding programs.

During 2002, twenty burbot from Duncan Reservoir in B.C. were transported to the Kootenai Hatchery near Bonners Ferry, Idaho, to serve as experimental brood stock to help develop burbot conservation aquaculture techniques. An additional twenty fish were transferred during 2003. However, these twenty fish are expected to be subsequently transferred to the University of Idaho's Aquaculture Research Institute for the development of burbot culture techniques and systems based on an international agreement of conditional fish use between the British Columbia Ministry of Water, Land, and Air Protection; the Kootenai Tribe of Idaho; the Idaho Department of Fish and Game; and the University of Idaho (Sue Ireland, KTOI, pers. comm. 2003).

To date (2003), three experimental burbot spawning operations have occurred within the Subbasin: one at Montana Fish, Wildlife & Parks' Libby Field Station during the early 1990s, and two in the Kootenai Hatchery, in Bonners Ferry, Idaho, during the late winters of 2002 and 2003. The spawning attempt at the Libby Field Station produced several larvae that survived only a few days post-hatch. Currently (2003), no artificial burbot production in Idaho, Montana, or B.C. waters of the Kootenai Subbasin has ever resulted in surviving progeny. Thus, all burbot within the Subbasin remain wild, with no effects from artificial production.

No captive breeding programs using reared, captive brood stock have occurred, exist, or are currently (2003) proposed within the Kootenai Subbasin. However, the Kootenai Tribe of Idaho is currently embarking on an experimental culture program to: (1) assess conservation aquaculture as a potential recovery tool for Kootenai River burbot, and (2) possibly help prevent extinction of local burbot stocks (Cain et al. 2003). This experimental program represents the only current burbot culture activities in the Subbasin, but does not rear and spawn captive brood stock.

LINKS

See the 2004 annual report on preliminary investigations into the feasibility of developing conservation aquaculture techniques for burbot.

Click Here

The first year of an experimental burbot aquaculture feasibility study was completed during the summer of 2004 at the University of Idaho's Aquaculture Research Institute (Cain and Jensen 2004). System design, brood stock holding and spawning, fertilization, incubation, and larval and juvenile rearing and feeding were addressed. All 20 burbot brood stock were successfully spawned, using three distinct spawning treatments: (1) natural spawning (no hormone treatment), (2) hormone injection, and (3) hormone implant. Fertilization rates generally exceeded 90 percent across all fertilization trials. Four types of incubators were used for burbot embryos, yielding mixed results. McDonald jars appeared to work best, based on observed hatching success among the different incubator designs. Handling stress contributed to larval mortality until the larvae were clearly eating enriched rotifers, at which time they began to exhibit a slight tolerance to handling stress. This feature made grading fish by size problematic. Cannibalism among larvae and juveniles is an additional challenge to overcome in burbot aquaculture, based on the literature and as was observed in this study. Handling stress and mortality-associated with grading will be evaluated relative to stress and mortality associated with cannibalism to further develop conservation aquaculture techniques that maximize larval and juvenile survival.

Juveniles approximately 20 mm in length exhibited a notable behavioral shift, including consistent attempts to hide and use any available cover, such as air stones, corners, screening, and tank-wall junctions. Primary (exogenous) feeding proved to be a delicate process that included algal cells and rotifers. Larvae fed exclusively artificial feed resulted in high mortality, whereas larvae and juveniles survived better on natural feed.

The first year of conservation aquaculture feasibility assessment provided a wealth of valuable information about culture systems and techniques required to successfully culture burbot. Further testing of methods and apparatus based on the first year of this study (2003-2004) is planned. Based on the first year's results, and the magnitude of challenges already overcome, it appears likely that burbot culture techniques will be successful and suitable for conservation aquaculture purposes

Historic Harvest[2]

Historically, Kootenai River Subbasin burbot supported numerous and varied fisheries between Bonnington Falls and Kootenai Falls. Traditionally, Native Americans targeted burbot during the winter spawning period as a source of

[2] *Parts of the historical harvest section were excerpted from Hammond and Anders (2003), KVRI Burbot Committee (2004), Anders et al. (2002) and Paragamian et al. (2002).*

fresh meat. Recreational burbot fisheries subsequently occurred throughout much of the Subbasin, although most were often highly localized and appear to have been associated with burbot reproductive aggregations.

Numerous credible, independent, written accounts of significant burbot harvest suggest that Dustbowl immigrants to the Idaho portion of the Subbasin were responsible for significant and unregulated burbot harvest during the 1930s (KVRI Burbot Committee 2003). Following harvest during the 1930s and 1940s, a winter commercial burbot fishery persisted into the 1950s and 1960s in the Idaho portion of the Subbasin. Partridge (1983) reported that local residents harvested and canned burbot during the winter months to supply their personal needs through the summer or for sale in local stores. Burbot were still reported to be abundant during the 1950s, with one angler selling 380 kg (838 lbs) in 1951, and a Bonners Ferry market handling 1,800 kg (3,940 lbs) of burbot during 1957. (However, "abundant" in this context is subjective. Without quantified time series burbot abundance data, perspectives can change across human generations. In other words, abundant burbot to one generation of human residents may have constituted a significantly reduced population to the previous generation). Three additional fishermen harvested over 2,000 kg (4,409 lbs) of burbot from the Kootenai River during 1958 (IDFG unpublished data). Anglers reported catching as many as 40 burbot per night during winter setline fishing trips in the Kootenai River, where past annual burbot harvest was estimated at approximately 22,700 kg (50,053 lbs) (Paragamian and Whitman 1996). This annual harvest weight represents just over 10,000 5-lb fish, or 16,684 3-lb fish, which does not appear to be sustainable.

Furthermore, the harvesting of burbot targeted fish in spawning aggregations in or near Kootenai River tributaries in Idaho, further reducing the probability of subsequent population persistence. Because no historical population abundance estimates existed for burbot in Idaho Subbasin waters, burbot catch rates were substituted to infer historical population status in this part of the Subbasin. Repeated annual harvest of the magnitudes reported above, in conjunction with unreported harvest, likely had considerable negative effects on demographic and genetic integrity of burbot stocks that historically reproduced in Idaho waters of the Kootenai Subbasin. This in turn may have negatively affected natural recruitment for subsequent decades during the early to mid 1900s.

In Kootenay Lake in B.C., there was a heavily utilized burbot fishery during the late winter-spring period at the upper end of the West Arm. Although the seasonal timing of these fisheries varied, all of them collapsed and remain so today. This population supported popular sport and commercial fisheries throughout the basin (table 4.62).

Table 4.62. Balfour burbot fishery statistics 1967-1986

Year	Harvest	Effort (hours)	CPUE (fish/hr)
1967	7,567	7,500	1
1968	12,690	15,240	0.83
1969	25,920	17,460	1.48
1970	8,880	15,840	0.56
1971	20,647	21,565	0.96
1972	18,930	31,680	0.6
1973	2,305	8,280	0.28
1974	11,012	10,920	1.01
1975	6,802	7,258	0.94
1976	4,139	6,330	0.65
1977	1,820	3,567	0.51
1978	3,227	4,864	0.66
1979	852	1,259	0.68
1980	1,378	1,874	0.74
1981	443	890	0.5
1982	993	1,213	0.82
1983	689	1,238	0.56
1984	223	359	0.62
1985	296	469	0.63
1986	20	295	0.06

Current harvest

It is illegal to kill a burbot in Kootenay Lake, B.C., however, fishing is allowed for burbot in Lake Koocanusa (although the Montana portion of Koocanusa is closed to burbot retention from January 15 to February 28), the upper Kootenay River in B.C., Duncan Lake, the Kootenai River from Libby Dam downstream to the Montana-Idaho border, and Moyie Lake. Over the last 15 years the daily possession limit for burbot in the Kootenay Region of B.C. has been reduced from 15 to 2 fish. In Montana, the limit is five daily and in possession.

4.5.2 Population Delineation and Characterization

Population Units

Initial mtDNA analysis of burbot population structure in the Subbasin (Paragamian et al. 1999) suggested that fish downstream from Kootenai Falls form a separate genetic group from burbot upstream from the falls. Fisheries managers in Idaho and Montana currently use these findings to manage burbot in these two areas as genetically divergent (different) stocks. This genetic study also reported that burbot from the Idaho portion of the Kootenai River were insignificantly different from those in Kootenay Lake. Hammond and Anders (2003) reviewed the mtDNA analysis of Kootenai Subbasin burbot (Paragamian et al. 1999), and provided additional interpretation of the published findings. Fisheries agencies within the Subbasin are currently (2003) pursuing microsatellite DNA analysis to further refine the current understanding of burbot population structure in the Subbasin.

Life history[3]

Burbot normally complete their life cycle in freshwater and rarely enter marine environments. However, they have been documented in estuaries and brackish lagoons (Preble 1908; Percy 1975; Pulliainen et al. 1992). Burbot residence in saltwater appears transitory, and a high proportion of adult burbot are either sterile or fail to mature under brackish conditions (Pulliainen and Korhonen 1990). Burbot are cold water spawners during highly synchronized communal spawning periods, with reported optimal spawning and incubation temperatures from 0 to 4 °C (Bjorn 1940; Andersson 1942; Clemens 1951b; McCrimmon and Devitt 1954; Lawler 1963; Meshkov 1967; Chen 1969; Johnson 1981; Kouril et al. 1985; Sandlund et al. 1985; Breeser et al. 1988 Boag 1989; Arndt and Hutchison 2000; Evenson 2000). Eggs are thought to drift in the water column and lodge in interstitial spaces in the substrate.

LINKS

For more life history information on burbot, go to the Kootenai River/Kootenay Lake Burbot Conservation Strategy. See Appendix 99.

Click Here

The Kootenai River Burbot Conservation Committee's Conservation Strategy provides a more comprehensive review of burbot life history and habitat requirements and behaviors of all burbot life stages.

Burbot life span varies geographically, and northern populations generally contain older fish than southern populations (McPhail and Paragamian 2000). Maximum ages recorded in northern populations ranged from 20 to 22 years (Hatfield et al. 1972; Nelichik 1979; Guinn and Hallberg 1990). Maximum age of burbot in Canada is likely in the range of 10 to 15 years (Scott and Crossman 1973). In Quebec, Magnin and Fradette (1977) noted that burbot older than 7 years are uncommon at latitude 45 °N, but adults ranged from 8 to 12 years at latitude 55 °N.

Fecundity

Individual female burbot fecundity falls within the upper range for freshwater fishes. Bailey (1972) reported an average of 812,300 eggs per female. Additional estimates ranged from 6,300 to 3,477,699 eggs per female (Miller 1970; Roach and Evenson 1993). However, average fecundity can vary substantially between lakes in the same region (Boag 1989), and a positive relation exits between length

[3] *The life history model (figure 4.18) and some of the text describing burbot life history was excerpted from the Kootenai River/Kootenay Lake Burbot Conservation Strategy (KVRI Burbot Committee 2004).*

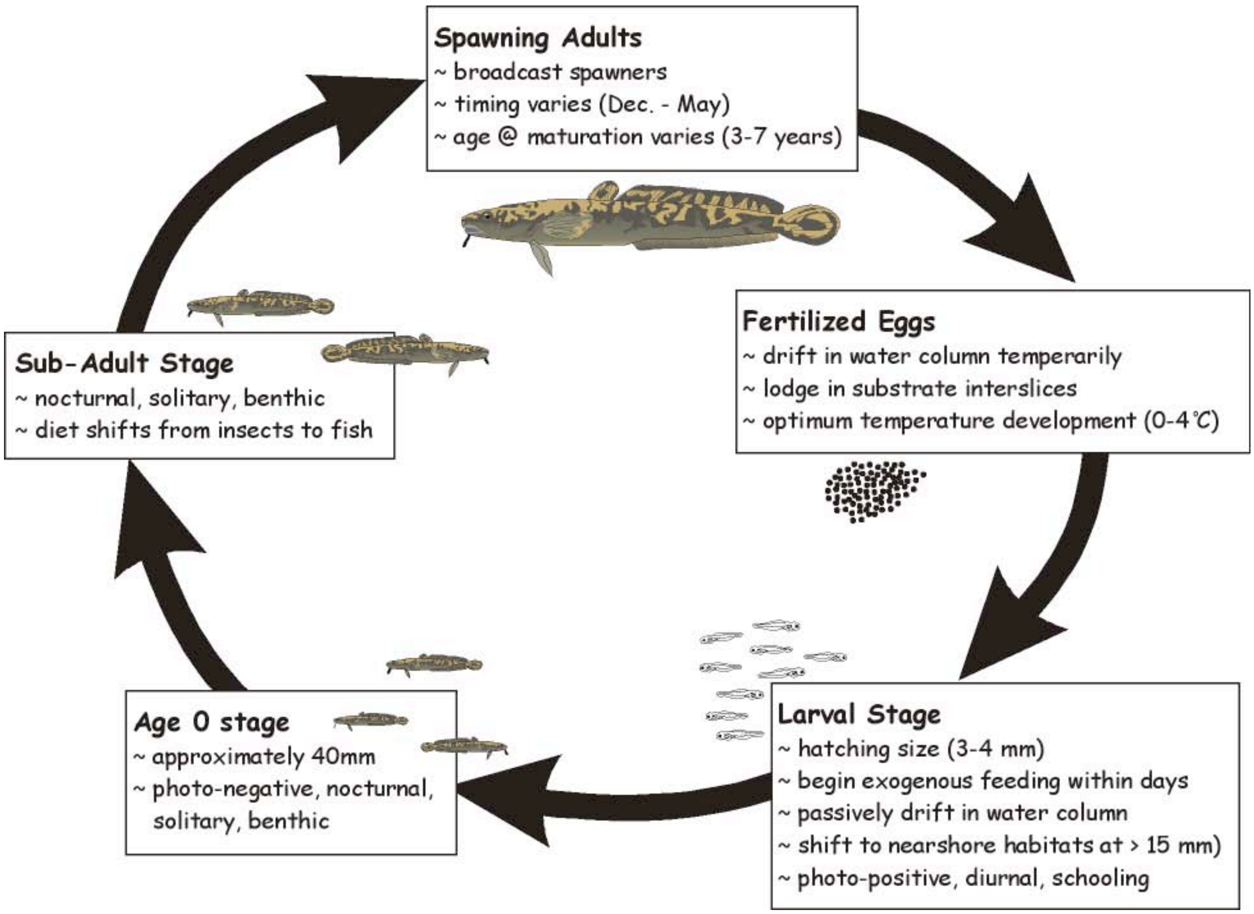

Figure 4.18. A general burbot life history model (From KVRI Burbot Committee 2004).

and fecundity, although the effect of size on fecundity is not as pronounced as in many other fish species (Boag 1989; Roach and Evenson 1993).

Embryo development

As with most fish (poikilotherms), embryo development and mortality rates are temperature dependent, such that development is faster at higher temperatures and mortality increases on either side of an optimal incubation temperature (McPhail and Paragamian 2000). Most researchers agree that the optimum temperature for burbot zygote development is between 0 and 4 °C (Andersson 1942; McCrimmon 1959; Lawler 1963; Meshkov 1967; Sorokin 1971; Ryder and Pesendorfer 1992). Incubation periods have been reported as 41 days at 2 °C (Andersson 1942) and 98-128 days at 0 °C (Meshkov 1967).

Larval Stage

Newly hatched larval burbot were reported to be between 3 and 4 mm long (McCrimmon 1959; Ghan and Sprules 1991; Fischer 1999). Burbot larvae are capable of exogenous feeding within a few days post-hatch (Ghan and Sprules 1991), but endogenous feeding can last between 11 and 23 days post-hatch (Fischer 1999). Larval densities can be high shortly after hatching but reportedly drop within a month (Ghan and Sprules 1991). Larvae are positively phototaxic, and exhibited diurnal and schooling behaviors (Girsa 1972).

In lakes, larval burbot are limnetic and planktonic, drifting passively in the water column (Clady 1976; Ghan and Sprules 1991; Ryder and Pesendorfer 1992; Wang and Appenzeller 1998; Fischer 1999). As they grow, improved swimming performance allows larvae to become more mobile. Larval depth appears to decrease as mobility increases and they are more commonly found feeding near the top of the water column. During early summer, larval burbot (>15 mm TL) seem to undergo a habitat shift to near-shore areas (Clady 1976; Ghan and Sprules 1991; Ghan and Sprules 1993).

Little is known of the fate of larval burbot in rivers, however, they likely drift downstream. This downstream drift may decrease in backwater areas or at physical obstructions that reduce river flow. As swimming performance improves, burbot conceivably are able to maintain position in low velocity areas of the river.

Age-0 Stage

At approximately 40 mm, burbot become negatively phototaxic (Girsa 1972). In lakes, this reversed reaction to light causes larval burbot to exhibit nocturnal, solitary, and benthic habitat use behaviors. Numerous researchers reported observing burbot feeding at night, and seeking shelter under rocks or other debris during the day (Lawler 1963; Boag 1989; Ryder and Pesendorfer 1992; Fischer and Eckmann 1997). The only exception to this appeared to be at latitudes above the Arctic Circle where Kroneld (1976) reported that age-0 burbot were night-active during summer and day-active during winter. Age-0 burbot grow rapidly and can reach 110-120 mm in total length by late fall (Chen 1969; Sandlund et al. 1985). Burbot continue to grow throughout winter (Boag 1989). In lakes, age-0 burbot are found in near-shore areas with adequate cover. Lawler (1963) and Boag (1989) observed age-0 burbot sheltered under stones and debris in shallow bays and along rocky shorelines.

Juveniles

Fischer and Eckmann (1997) documented a strong correlation between juvenile burbot distribution in the littoral zone and the presence of gravel substrate and large stones. Ryder and Pesendorfer (1992) noted that burbot fingerlings sheltered under rocks and debris where they excavated small burrows. In rivers, similar ontogenic habitat use shifts occurred, and age-0 burbot sought shelter in weed beds and under rocks, debris, and cut banks (Robins and Deubler 1955, Hanson and Qadri 1980).

Little is known about larval or juvenile burbot habitat use in the Kootenai River Subbasin because very few larval and juvenile burbot have been captured. Although most sampling focused on capturing adults, extensive juvenile sampling resulted in very low catch (Fredericks and Fleck 1995; Spence 1999; Paragamian et al. 2001). A juvenile burbot of about 350 mm TL was reported captured by backpack electrofishing in the Goat River in 1994 (Paragamian 1995). One YOY burbot (40 mm) was caught in the lower Kootenai River at the mouth of Trout Creek along the bottom at about 4 m depth; no habitat description was provided other than the benthic association (Fredericks and Fleck 1995). Paragamian and Whitman (2000) reported the capture of a larval burbot in the Kootenai River downstream of the confluence of the Goat River. Spence (1999) captured one YOY burbot at the north end of the north arm of Kootenay Lake; this fish was found among a cobble and boulder substrate in 30 cm of water.

Subadults

Subadult burbot were reported to occupy similar habitats as age-0 burbot (Clemens 1951a; Beeton 1956; Bishop 1975; Nagy 1985; Sandlund et al. 1985; Guthruf et al. 1990). Subadult burbot in the Kootenai Subbasin (i.e. <250 mm) were observed during the night at the north end of Kootenay Lake's North Arm. Although detailed habitat descriptions were not possible, substrate in areas used by subadult burbot appeared to consist primarily of fines, with woody cover occasionally in close proximity (Spence 1999; Baxter et al. 2002b). Such habitat may also have been used during nocturnal foraging forays.

Genetic Integrity

Although not affected by introductions, artificial production or captive breeding programs, the genetic integrity of burbot in the lower Kootenai River and Kootenay Lake has likely been compromised by severe demographic bottlenecks (reductions in abundance and natural recruitment) that occurred during the 1900s (See previous "Historical Status" section of this report for more details). Genetic integrity is directly linked to population size and success of reproductive strategies, both of which were largely compromised during the mid to late 1900s. Currently, riverine burbot populations within the Kootenai Subbasin, regardless of geographic population definition or genetic population structure, are in a state of demographic collapse (figure 4.17; KVRI Burbot Committee 2004). Thus, analysis of future or recent samples collected to delineate genetic and geographic population structure of Kootenai Subbasin burbot may not accurately or fully describe historical population structure and the historical range of genetic variability. This failure is proportional to the degree that populations and population components have been reduced or extirpated. Thus, accurate historical characterization of Kootenai Subbasin burbot genetic integrity is currently unavailable, and may be difficult if not impossible to reconstruct.

Because burbot in the Kootenai River Subbasin recolonized after the most recent Pleistocene glacial retreat, one would expect burbot in the Subbasin to be relatively closely related (compared to species that have not undergone recent post-glacial recolonization). However, no phylogenetic studies of Kootenai Subbasin burbot have been conducted, so the number of contributing evolutionary lineages and colonizing events for burbot in the Subbasin is currently unknown. Possible physical isolation mechanisms for burbot in the Subbasin include(d) Bonnington Falls (downstream from Kootenay Lake), Cora Linn Dam (completed in 1930s; formerly the natural Bonnington Falls), Duncan Dam (completed in 1967), Kootenai Falls, and Libby Dam (completed in 1972). Furthermore, temporal and geographic reproductive isolation mechanisms likely existed among burbot in the West Arm of Kootenay Lake that spawned from April to June (Martin 1976), and burbot in the Idaho tributaries of the Kootenai River that historically spawned under the ice during January or February several hundred km upstream. Thus, given adequate geographic isolation and divergence time, a unique genetic signal could have evolved separately in both areas. Maintenance of such differences could maintain genetic integrity. However, West Arm (Kootenay Lake) burbot are functionally extinct (Ashley et al 1992; Ahrens and Korman 2002), and burbot that historically spawned in Idaho reaches of the Kootenai River and their tributaries are currently so rare that it is difficult to estimate their population abundance.

Current genetic integrity of Kootenai River Subbasin burbot is best described by the only genetic study of these fish (Paragamian et al. 1999). In this work, several authors at the University of Idaho performed mitochondrial DNA analysis of burbot captured in four different areas within the Kootenai River Basin: Kootenay Lake, B.C.; Kootenai River in B.C. and Idaho; Kootenai River at the base of Libby Dam, Montana; and Koocanusa Reservoir, Montana. Results indicated that sequence divergence among haplotypes, and significant geographic heterogeneity among haplotype frequency distributions supported the conclusion of two genetically dissimilar burbot populations upstream and downstream from Kootenai Falls.

Various fisheries management entities within and outside of the Kootenai River Subbasin are currently developing higher resolution genetic analysis techniques (microsatellite analysis) for burbot from the Subbasin. Such studies are expected to further reveal population structure if it exists, from which inferences can be derived concerning genetic integrity and stock structure of Kootenai Subbasin burbot.

4.5.3 Population Status

Current Status

Significant adult burbot populations in the Kootenai Subbasin currently exist in Koocanusa Reservoir and Trout Lake, with remnant populations between Libby Dam and Kootenai Falls and in the South Arm of Kootenay Lake (figure 4.17). Populations thought to have been functionally extirpated existed in the riverine portion of the Kootenai Subbasin and in the West Arm of Kootenay Lake. Very few burbot remain in the Kootenai River Subbasin between Kootenay Lake and Kootenai Falls. In this reach of the Subbasin, the greatest concentration occurs near and in the Goat River in B.C., and even there the numbers are quite small.

Imperiled status formed the basis for the petition to list Lower Kootenai River burbot as endangered under the Endangered Species Act (Prepared February 2, 2000, received by the USFWS February 7, 2000) (http://www.wildlands.org/w_burbot_pet.html). Based on most recent (2003) stock assessment modeling of burbot in this portion of the Subbasin, abundance estimates ranged between 50 and 500 fish, likely closer to 50 than 500 (Ray Beamesderfer, S.P. Cramer and Associates, personal communication, September 2003). No other current population abundance estimates exist for Kootenai Subbasin burbot, but extensive demographic analysis is expected within 2004.

Current status of Kootenai Subbasin burbot ranges from common in significant adult populations, to functionally extirpated (figure 4.17). Recent extensive sampling efforts have resulted in very few adult burbot in Kootenay Lake or Kootenai River; juvenile burbot are even more scarce (Redfish Consulting, Ltd. 1997; Spence 1999; Paragamian et al. 2001; Baxter et al. 2002). Burbot spawning activity was observed on the west shore at the north end of Kootenay Lake from 1998 (Spence 1999) to 2000; no spawning burbot were observed at this location in 2001; spawning area potentially becomes dewatered with low lake levels (Baxter et al. 2002). Eight burbot in different stages of sexual maturity were captured at Ambush Rock (rkm 244.5) on March 10, 2000 (Paragamian et al. 2001), and evidence of spawning was documented in the Goat River, B.C. (Paragamian 1995; Paragamian and Whitman 1996, 1997; Bisset and Cope 2002).

Burbot are moderately abundant in Duncan Reservoir and Trout Lake. In a comparison of burbot traps, Spence (2000) captured 13 adult burbot in Duncan Reservoir during February-March 1999. During a radio telemetry study of burbot in Duncan Reservoir, a total of 29 adult burbot were captured in cod traps between November 3 and December 8, 1999 (Spence and Neufeld 2002). Neufeld and Spence (2001) captured 26 burbot in Duncan Reservoir from October-November 2001 during an investigation of decompression procedures. During a 1995 sturgeon set-lining program in Trout Lake, numerous adult and subadult burbot were captured, suggesting the presence of a fairly abundant naturally recruiting population (RL&L 1996). During a subsequent rainbow trout electrofishing study on the Lardeau River in 2000, several young of the year burbot were captured near the outlet of Trout Lake (Redfish Consulting, Ltd. 2000). The MWLAP conducted a baseline trapping and radio telemetry study in Trout Lake during the winter 2001-2002; a total of 44 burbot were captured, 43 in cod traps and one on a baited setline (Baxter et al. 2002b). Twenty burbot were captured in the Kootenai River in the Libby Dam tailrace, and another 34 burbot were captured in Koocanusa Reservoir (Snelson et al. 2000; Dunnigan et al. 2002). Burbot are believed to be relatively abundant in these two areas. Bisset and Cope (2002) also indicated that a viable burbot population exists in Moyie River/Lake based on creel survey data.

Burbot in the Koocanusa Reservoir area of Montana are referred to as common (Hoffman et al. 2001), and make up a substantial adult population in this area (KVRI Burbot Committee 2004).

Historical Status

British Columbia[4]

Modeling suggested that the West Arm (Kootenay Lake) burbot population size prior to 1967 numbered approximately 200,000 individuals. The estimated trend in age-1 recruitment indicated a substantial increase of recruits in the early 1960s, peaking in 1964 and failing by the late 1960s. It seems reasonable to assume the burbot fishery collapsed as a result of the recruitment failure but, the collapse was accelerated, substantially, by unsustainable harvest rates. Recruitment anomalies did not correlate well with environmental indices that changed as a result of dam operations. Recruitment failure occurred before 1970 and changes in the lake environment due to dam operations did not occur until after 1974.

[4] *The section on historical population status in British Columbia was largely excerpted from Ahrens and Korman (2002).*

Changes in nutrient loading to the lake were also a poor correlate with recruitment because nutrient loads peaked in 1967, three years after the predicted recruitment peak. The best correlation resulted when cladoceran densities were compared to burbot recruitment. It is likely that changes in the West Arm community structure, most noticeably the increases in mysid densities, resulting from increased productivity (via nutrient loading) caused a substantial reduction in the cladoceran community through competition and predation. The previous increase and subsequent collapse of the cladoceran community in 1964 likely resulted in a catastrophic reduction in juvenile burbot food resources contributing to or resulting in recruitment failure. The exact mechanism, which resulted in recruitment failure, can only be speculated.

In Kootenay Lake, burbot were concentrated in the Balfour area of the West Arm. The fishery at Balfour occurred primarily during late spring/early summer. In 1969, over 26,000 burbot were caught in the fishery and in 1971, approximately 20,000 were caught. Harvest declined substantially over the subsequent years (table 4.62, figure 4.19). A production and harvest study was conducted during the mid 1970s; the optimum sustainable yield was calculated at 11,680 fish and the optimal fishing effort was estimated at 14,560 rod hours (Martin 1976). Thus, estimated annual harvest (20,000-26,000 fish) more than doubled annual estimates of maximum sustainable yield (Martin 1976). Harvest of burbot continued to decline through the 1970s and 1980s; as of 1987, no burbot have been recorded in the fishery at Balfour. Canadian researchers have conducted extensive sampling in Kootenay Lake since the 1990s (table 4.61). Although recent sampling efforts indicated the complete lack of burbot in the West Arm at Balfour, burbot have been captured in the North Arm. There was evidence of burbot spawning in the North Arm during 1998-2000; however, no potential spawning activity was observed in this area during 2001 or 2002.

Cooperative sampling by US and Canada in Kootenai River in B.C. and Idaho from 1994-1996 indicated burbot density diminishes rapidly upstream of Goat River, BC; during the winter of 1994-95, 2 fish were caught upstream of Goat River and 31 fish were caught in the Goat River and downstream (Paragamian et al. 2000). One larval burbot and one young of the year burbot were captured in extensive sampling in Kootenay Lake and Kootenai River in 1995 and 1999 (Fredericks and Fleck 1995; Paragamian and Whitman 2000).

Idaho

The following historical account describes historical burbot harvest in Idaho, during the 1920s and 1930s, after which local residents considered the Kootenai River burbot gone. The KVRI Burbot Committee is assembling local testimony

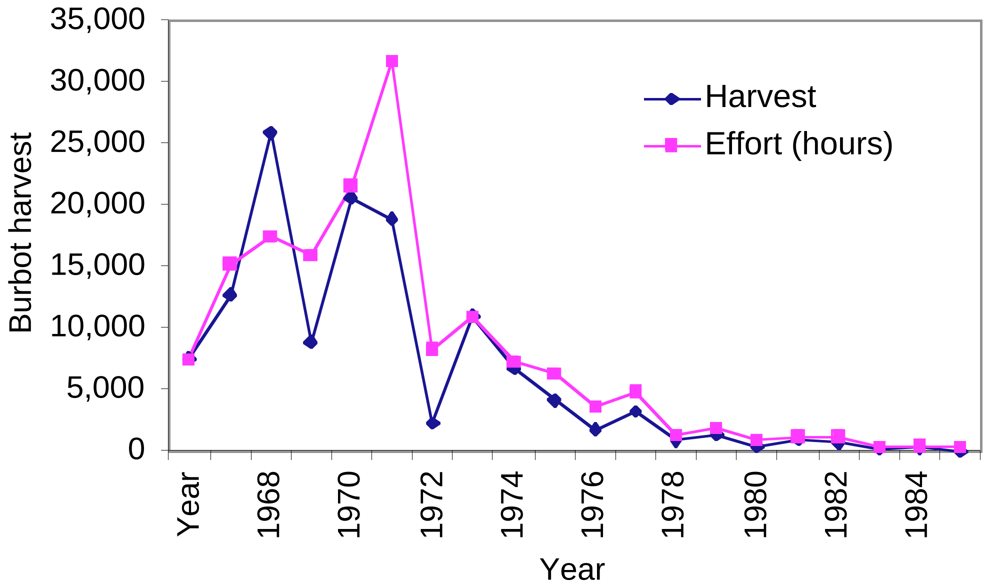

Figure 4.19. Balfour (West Arm Kootenay Lake) burbot fishery trends 1967-1986. Data from Martin (1976) and Redfish Consulting, Ltd. (1988).

and a temporally relevant chronology of the demise of Kootenai River burbot. Important events leading to this collapse likely occurred during the early 1900s, as corroborated by numerous independent historical accounts. One such account is presented below, taken from a letter by Hartley King, lifelong Boundary County resident, written during May, 2003:

> "We lived on the [Kootenai] river bank during the 1920s at Riley Bend, which later became the Ray Sims place. We only knew them as ling. I never heard the name burbot until I grew up years later. The river was full of fish of all kinds in them days. I slept upstairs and in the summertime the fish jumping would wake me up about four in the morning. It was just a paradise for fish.
>
> The ling went up the creeks to spawn, and of course, that's where people could get at them. They used spears and pitchforks to throw them out. They would be piled in there. Some people would take a sack-full and go home, but others would take a wagonload. What they did with that many fish I don't know. I heard of some that fed them to their pigs. They were the finest eating fish I know of. I'd rather have them than halibut or salmon or trout. They had a big head and were shaped something like an eel, with sort of a beard.
>
> They ran up the creeks about in February sometime. The creeks were frozen then, so they had to cut holes in the ice and spear them through the holes. I never heard of any ling going up the creeks south of the Canadian boarder since then. In Canada those creeks have never been disturbed, they still spawn up them.
>
> We lived across the river from Lucas Creek. When they diked District 6, they dammed the creek about 150 feet from the river and put a big drain pipe in about 5 or 6

> feet above the river. We were going to school near there, so we had to go across the river every day.
>
> One day we came by there and there were bass by the thousands trying to get up the creek to spawn, but they couldn't get up there. They were in there 4 to 5 feet deep. I can't imagine how many fish were there. I never saw a bass in the river after that. That's a sample of what happened to the fish, also the ling. We just overfished and muddled with their spawning grounds until we just didn't have any fish left.
>
> We never did go to the creeks to spear them. We cut holes in the river ice and put setlines out overnight. We got bigger ones that way. Some were almost 4 feet long. I can't remember of ever weighing any of them, but we weren't interested in beating somebody else to see who got the bigger fish. We just wanted them to eat.
>
> When they diked the country, I know that knocked the ling and the bass for a loop. The creeks came from the mountains to the river. Some of them, like Smith Creek, ran for 2 or 3 miles. They had been there for thousands of years, and the bed of the creeks was gravel and sand all the way to the river. When they diked, they just ran a ditch from the mountains straight to the river.
>
> I think over fishing hurt them real bad. There weren't too many people who fished them through the 1920s, but during the 1930s, when the dust-bowlers came in, they were hungry for anything. There didn't seem to be any laws for fishing them. We didn't ever hear of licenses. They might have had such a thing, I never knew of anybody who had a fishing license.
>
> The dam is another thing that finished them off. They raise the water and lower it, which is not natural, and the fish can't live that way. We will never get the fish back now. The once bountiful Kootenai River is dead".

LINKS

Appendix 64 lists the waters in Montana Fish, Wildlife & Park's Region One that have tested positive or have questionable results for fish pathogens.

Click Here

Extensive burbot sampling has occurred throughout the Kootenai River basin; a summary of catch statistics is found in table 4.61. In the Kootenai River, burbot were sampled as early as 1957; a total of 199 burbot were captured during a 1957-1958 winter sampling period. The length-frequency distribution of this sample indicated an abundance of young fish and good representation of older fish (Paragamian et al. 2000). In the 1960s, the combined average annual catch of the sport and commercial fisheries was thought to have exceeded thousands of kg. Anecdotal information from historic angler surveys indicated an excellent winter fishery existed from the 1950s through the early 1970s. During a sampling program from 1979 to 1982, Partridge (1983) captured a total of 108 burbot with three different gear types. Although all catchable age classes were represented in this sampling program, Partridge (1983) believed that burbot abundance was substantially lower than in the 1950s. The annual burbot harvest from 1979-1982 was estimated at less than 250 fish (Partridge 1983). A 2-fish daily bag limit adopted in 1983, with a ban on all burbot harvest in 1992 (Paragamian et al. 2000). However, this restriction in the fishery did not result in population recovery (Paragamian et al. 2000).

Catch numbers were low during the early 1990s but numerous age groups were represented, indicating that some burbot recruitment was likely occurring.

Sampling during the winter of 1993-1994 at the mouths of Idaho tributaries resulted in no burbot (table 4.61). One burbot was caught between Bonners Ferry, Idaho, and the Montana border; there was no evidence of reproduction occurring in Idaho. Burbot were nonexistent in a creel survey that extended from spring 1993 to spring 1994 (Paragamian 1993, 1994).

Theoretical Reference Condition

Other than the following conservation goals and issues concerning restoration of Kootenai River subbasin burbot populations, no formal theoretical reference conditions have been proposed or identified.

Kootenai River (ID/BC)

The burbot conservation goal is to maintain and restore multiple life-history strategies and maintain genetic diversity necessary to sustain a viable burbot population in the Kootenai River. Complete restoration of this burbot population will be achieved when monitoring and evaluation of recovery indicates a sufficient surplus of fish to provide a sport harvest (KVRI Burbot Committee 2004). The KVRI Burbot Committee defined a target restoration goal for Kootenai River burbot at 2,500 fish, with natural recruitment in at least 3 areas or populations, and a stable size and age class distribution (KVRI Burbot Committee 2004).

West Arm, Kootenay Lake (BC)

Although estimated at approximately 200,000 fish prior to 1967, no theoretical reference conditions have been proposed for the West Arm. Because of its current status in the West Arm—functionally extirpated—all participants at recent burbot population workshops acknowledged that establishing a West Arm burbot population will require, in the short term, an experimental stocking or transplant program. However, the workshops generated a reasonable amount of skepticism about whether stocking or transplanting burbot would result in a viable, self-sustaining West Arm stock. In particular, there was uncertainty as to whether juvenile burbot could survive given the currently large biomass of northern pikeminnow and largescale sucker occupying former burbot habitat and ecological niches.

LINKS

For a more complete discussion of how Mainstem Columbia River operations affect subbasin fisheries, and how those effects might be minimized see Appendix 18.

Click Here

Kootenai River, Koocanusa Reservoir (MT)

No theoretical reference conditions have been developed for burbot in Montana Subbasin waters.

4.5.4 Out-of-Subbasin Effects and Assumptions

Mainstem Columbia River hydro and flood control operations profoundly influence ecological, biological, and physical habitat conditions in upriver and headwater areas, including the Kootenai River Subbasin. The abundance, productivity, and diversity of fish and wildlife species inhabiting the Kootenai River Subbasin and other headwater areas of the Columbia River Basin depend on the dynamic conditions of their immediate environments. These conditions are profoundly affected by out-of-basin effects (e.g., operation of the Mainstem Columbia River hydropower system). Mainstem and out-of basin operations affect Kootenai Subbasin burbot in the following ways:

- Unnatural water discharge and temperature regimes at any time of the year can negatively affect resident fish and taxa in supporting lower trophic levels. For example, unnaturally high discharge during winter in the Kootenai River is thought to negatively affect or prohibit burbot spawning migrations (Paragamian 2000). However, unnatural, detrimental effects of hydro operations to burbot and other native taxa can be mitigated to varying degrees by releasing flows at more constant rates, and providing smoother shaped water blocks required to meet power production and flood control requirements.

- Summer flow augmentation causes reservoirs in the Kootenai Subbasin to be drafted during the most biologically productive summer months. This loss of productivity reduces forage availability and in-reservoir biomass production of all taxa in the reservoir.

- Drafting reservoirs too deep prior to the January 1 and the potential of subsequent inflow under-forecasts may decrease the probability of reservoir refill.

- Flow fluctuations caused by variable power production needs, flood control, or fish flows create wide varial zones in near-shore river and reservoir habitats. Varial zones are characterized by biological instability, due to frequent inundation and dewatering, and by losses of ecological and biological productivity and function. Burbot use areas of Koocanusa Reservoir that regularly dewater for power production. Although not significantly different statistically, the catch distribution indicated that smaller burbot more frequently occupied the Tobacco-Sophie Bay area of the reservoir (which gets dewatered) compared to the main body of the reservoir (Ostrowski et al. 1997). These authors reported that the lack of a statistically significant difference in burbot habitat use may have been due to unrepresentative (small) sample size (figure 4.20).

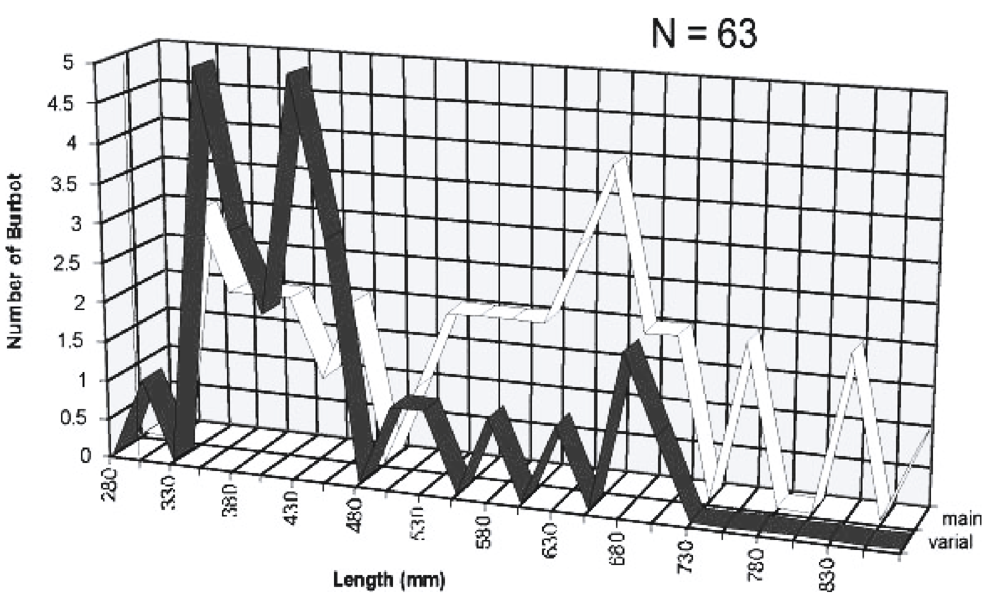

Figure 4.20. Comparison of burbot length frequency distributions between the varial zone and the main areas of Koocanusa Reservoir.

4.5.5 Environment-Population Relationships

Prior to discussing environmental factors of importance to burbot survival (Key Ecological Attributes, KECs) it is important to understand the role of population size in environment-population relationships. Small population size, characteristic of most imperiled populations, may eclipse environmental and ecological concerns otherwise relevant to environmental-population relationships. Specifically, if genetically effective population size (the functional size of a population based on its instantaneous ability to successfully produce a subsequent generation) is too small to provide population viability and persistence, given a reasonable amount of ecological uncertainty, population trajectories may be determined more by stock-limitation than by inferred effects of environment-population relationships (habitat limitation). Furthermore, a positive relation exists between population size and measures of genetic diversity or genetic integrity—a decline in one produces a decline in the other. Finally, even in small, imperiled populations, ecological limitation may further contribute to population decline along with small population size.

Thus, various external and internal drivers contribute to population declines, sometimes independently, sometime collectively, depending on which part of the decline trajectory a particular population represents. Therefore, it is also important to document and understand environmental factors that are important to burbot survival.

Environment s Ability to Provide Key Ecological Correlates

In most waters of the Kootenai River Subbasin, with the possible exception of Duncan and Trout lakes in B.C., and Montana waters, extremely low numbers of remaining burbot appear to currently pose a greater risk to their continued existence than does any combination of key ecological correlates or non-demographic limiting factors. Thus, in these regions of the subbasin, it appears that the current post-development environmental conditions can provide little restorative value to these remnant stocks or populations. Furthermore, it appears that restoration of these native burbot populations to include natural recruitment and stable size and age class structures is unlikely to occur without improvement of current ecological conditions and restoration of ecological functions.

Subbasin burbot managers and researchers recently began experimental alterations of Libby Dam discharge operations in order to restore natural production. However, monitoring of recent experimental discharge reductions during the historical burbot spawning season (December-March) failed to provide evidence of any natural spawning or recruitment in the Idaho portion of the Subbasin (Kootenai Basin Burbot Conservation Committee, pers. comm. 2003). This may be due to extreme stock limitation (i.e., too few burbot may be left to measure a response to experimentally reduced discharge regimes, or to provide observable experimental treatment effects), or to other effects. However, Kozfkay and Paragamian (2002) found drought conditions of the winter of 2000-2001 provided ideal conditions for burbot movement and documented spawning of burbot through weight changes in recaptured fish and a limited number of post-spawn biopsies.

Long-term Viability of Populations Based on Habitat Availability and Condition

Based on natural production and habitat availability and condition, burbot (other than the Duncan Lake, Trout Lake, and Montana populations) long-term viability does not currently appear favorable. To date, no formal population viability or persistence modeling has been undertaken with Kootenai Subbasin burbot. However, extremely low remnant burbot numbers in the riverine portions of the Subbasin in Idaho and B.C. suggest low probabilities of long-term viability for burbot in these areas. Long-term viability of lacustrine populations in BC and in the Kootenai River and Koocanusa Reservoir in Montana appears more favorable, however, no analyses have occurred to support or refute this claim.

4.5.6 Burbot Limiting factors and Conditions[5]

No single factor appears responsible for the collapse of burbot in the Kootenai River Subbasin. Rather, a combination of overharvest, habitat alteration, and ecosystem degradation appears to be the cause (KVRI Burbot Committee 2004). Possible linkages may exist (or have existed) among many of the following interrelated hypotheses of burbot collapse:

- Increased winter water flow
- Increased winter water temperature
- Environmental degradation
- Changes in primary and secondary productivity
- Kootenay lake flood control
- Altered ecological community composition

These factors are outlined and briefly described below, and are based on information from the Kootenai River/Kootenay Lake Burbot Conservation Strategy (KVRI Burbot Committee 2004), Hammond and Anders (2003), Ahrens and Korman (2002), Paragamian (2002), and Anders et al. (2002):

Increased Winter Water Flow

Burbot are known to move extensive distances to spawn (Robins and Deubler 1955; McCrimmon 1959; Percy 1975; Morrow 1980; Johnson 1981; Breeser et al. 1988; Evenson 2000; Paragamian 2000; Schram 2000), and spawn during winter over a relatively confined time period (Arndt and Hutchinson 2000, Evenson 2000, McPhail and Paragamian 2000). Tagging, telemetry, and genetic studies indicated that burbot freely move between Kootenay Lake and Kootenai River during low flow periods (Paragamian et al. 1999). However, Hammond and Anders (2003) could not subsequently substantiate major burbot spawning

LINKS

For the website containing descriptions of surface waters included in the Montana state water quality assessment database go to: http://nris.state.mt.us/wis/environet/2002_305bhome.html.

Click Here

For the website listing 303(d) water-quality impaired streams and lakes for the Idaho portion of the subbasin, go to: http://inside3.uidaho.edu/WebMapping/IDEQ/

Click Here

Holderman and Hardy (2004) discuss potential limiting factors in the Lower Kootenai. Go to Appendix 120.

Click Here

[5] *The following section on limiting factors was largely excerpted from the Kootenai River/Kootenay Lake Burbot Conservation Committee's Conservation Strategy (KVRI Burbot Committee 2004).*

migrations from Kootenay Lake and the lower Kootenay River in British Columbia to upstream historical spawning tributaries in Idaho after reviewing available data. Based on empirical burbot swimming performance data (Jones et al. 1974), Paragamian (2000) suggested that burbot spawning migrations in the Kootenai River may be limited or prohibited by increased post-dam water column velocities in the Kootenai River associated with higher post-dam discharge regimes. Post-Libby Dam Kootenai River winter regimes discharge average 3 to 4 times higher than natural due to power production and flood control operations (Partridge 1983; Paragamian 2000).

Increased Winter Water Temperature

Burbot spawning has been reported in water temperatures between 1 and 4 °C (Morrow 1980; McPhail and Paragamian 2000). Taylor and McPhail (2000) demonstrated that survival from fertilization to hatching was highest at 3 °C, and that all embryos died at water temperature above 6 °C. Since 1974 (post-Libby Dam), winter river temperatures have averaged 3 to 4 °C, compared to pre-dam river temperatures of 1 °C or less (Partridge 1983). The Kootenai River in Idaho commonly froze during winter prior to dam operation, but has remained ice-free every winter since initial dam operation. Thus, if burbot are spawning in the Idaho portion of the Kootenai Subbasin, artificially elevated post-dam water temperatures may be having a negative effect on spawning and incubation success and natural recruitment. Warmer post-dam water temperatures in the Kootenai River and the resulting lack of ice cover may also have negative effects on burbot spawning, especially in the historical spawning tributaries in the Idaho portion of the Subbasin.

Environmental Degradation

Logging and mining operations occurred in the Kootenai River Subbasin as early as the 1880s. Affects of these operations on habitat in the Kootenai River are documented in Northcote (1973), Cloern (1976), Daley et al. (1981), and Partridge (1983). These operations have caused flashy tributary discharge patterns, which have physically altered the streams and caused siltation (Northcote 1973). There is concern with water toxicity because of the release of heavy metals (Partridge 1983). Attempts were made as early as 1892 to dike the lower river to claim land for agricultural use (Northcote 1973). A fertilizer plant operated on the St. Mary River from 1953-1970 which greatly increased nutrient loading (Northcote 1973).

Changes in Primary and Secondary Productivity

During the mid-1960s the Cominco fertilizer plant on the St. Mary River in BC caused eutrophication in the Kootenai River and increased productivity in the river and Kootenay Lake (Northcote 1973). When operations ceased at the plant during the late 1960s, total phosphorus loading to Kootenay Lake was greatly reduced, contributing to current ultraoligotrophic system status (Ahrens and Korman 2002).

Simultaneous pollution abatement practices further reduced nutrient (and contaminant) loading to the system (Daley et al. 1981). Koocanusa Reservoir, the impoundment created by Libby Dam, acted as a nutrient sink, and has reduced productivity of the river and Kootenay Lake downstream (figure 4.21), with sediment trapping efficiencies of over 95 percent (Woods and Falter (1982) report 75 percent phosphorous trapped) (Snyder and Minshall 1996). Resulting reductions in Kootenay Lake productivity are thought to have reduced food available to juvenile burbot (Paragamian 1994) and reduced growth and survival rates (Ahrens and Korman 2002).

Fishery Harvest

The West Arm of Kootenay Lake once supported a significant burbot fishery with an annual harvest of up to 26,000 fish from the late 1960s to the early

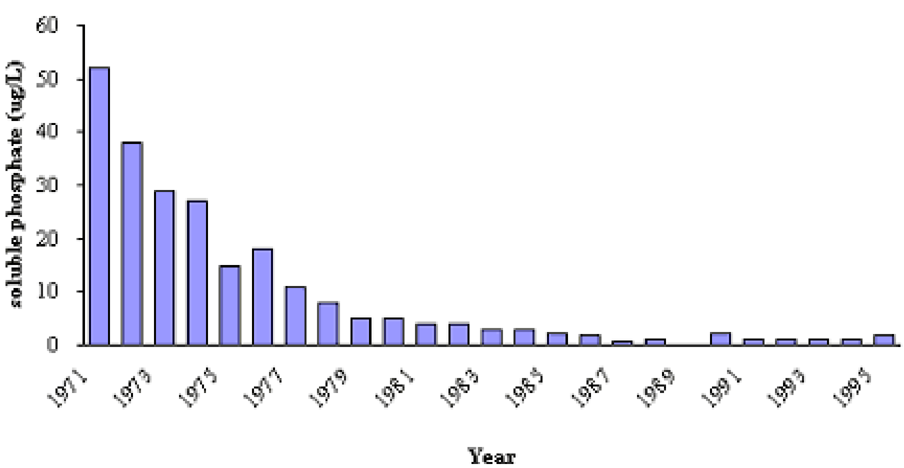

Figure 4.21. Phosphorous loading to Kootenay Lake from the Kootenai River before and after Libby Dam (1974). Data are integrated water-column averages for soluble reactive phosphorous collected at depths of 0-30 m during spring (March 1-July 15) from a mid-lake station. Data collection was changed in 1992. Station 5 was used in place of historic mid-lake station. Source: B.C. MELP 1998).

1970s. Catches declined precipitously beginning in the mid 1970s. and by the mid-1980s annual burbot catches were typically less than 400 fish. This reduction in catch resulted in the fishery being closed to angling in 1997. Martin (1976) estimated the annual allowable harvest for the Kootenay Lake fishery at 12,000 fish, however, estimated annual catch (~26,000) more than doubled the estimated annual allowable harvest. Simultaneous reduction in food availability following decreased productivity from pollution abatement efforts, loss of the Kootenai River floodplain, and impoundment (Duncan (1967) and Libby (1972) dams) likely contributed to the extirpated status of burbot in the West Arm of Kootenay Lake.

In Idaho Subbasin waters, early harvest accounts (1930s-1940s) suggested that the combination of overharvest and habitat alterations decimated Idaho burbot runs before 1950. However, unregulated harvests for another 20 years, with annual estimates exceeding 50,000 lbs (Paragamian and Whitman 1996) likely further contributed to the demise of burbot stocks that spawned in Idaho portions of the Subbasin (KVRI Burbot Committee 2004). Harvest restrictions during the 1970s and the fishery closure during the early 1980s failed to restore Idaho burbot populations, possibly due to the severity of harvest and concurrent habitat loss and degradation (Anders et al. 2002).

It has been subsequently argued that failed recruitment, not harvest, caused the collapse of Idaho burbot stocks in the Kootenai River. Paragamian et al. (2000) suggested that burbot populations, which possess considerable resilience, often respond favorably after harvest is eliminated and cited several published accounts of recovery in Alaska, Wisconsin, and Finland. These authors also reported that because the Idaho burbot population(s) did not rebound after fishery closures, recruitment limitation, not overharvest, caused their demise. However, harvest can exceed a population's level of resiliency (Longhurst 1998). Due partly to their patchy distributions, the Gadid species, Atlantic cod and Kootenai Subbasin burbot, often exhibit catch rate hyperstability, making them prone to unexpected and undetected overharvest, including overharvest beyond a stock's ability to recover. In the case of Kootenai Subbasin burbot, a series of temporally correlated habitat alterations (e.g., diking, impoundments and their subsequent system denutrification) contribute to the difficulty of partitioning or prioritizing causal factors of decline. As was stated for the collapse of the burbot fishery at Balfour, (West Arm Kootenay Lake; Ahrens and Korman 2002), the exact mechanism(s) of collapse of burbot stocks in Idaho can only be speculated.

Kootenay Lake Flood Control

During spring, generally during March, Kootenay Lake is lowered approximately 2m (6 feet) to provide water storage space for flood control. In contrast, prior to the construction of the Cora Linn Dam in the 1930s at the outlet of Kootenay Lake, the lake would rise approximately 3m (9 ft) each spring as a result of runoff from snowmelt. Raising the lake level could potentially decrease current velocity in the Kootenai River and its tributaries, and is thought to "move the upstream edge of flat water upstream".

Due to the lack of gradient in the historic lower river floodplain, lower Kootenay Lake elevation also lowers Kootenai River elevation, causing a potential drafting effect in tributary streams and potentially increasing current velocity in the low gradient reaches of Idaho tributaries. Some have speculated that potential velocity increases could wash rearing larval burbot from their natal streams (KVRI Burbot Committee 2004). However, no empirical observation, measurement, or simulation modeling has occurred to quantify or validate this idea.

Altered Ecological Community Composition

British Columbia

West Arm Kootenay Lake – Based on abundance estimates and catch records, burbot likely dominated the demersal fish community in West Arm of Kootenay Lake during 1960s-70s (Martin 1976; Ahrens and Korman 2002). However, extirpation of West Arm burbot population was followed by increased abundance of other native fishes (northern pikeminnow, largescale sucker) likely due to compensatory population growth from relaxation of interspecific competition. Recent benthic surveys on the historic "ling beds" near the mouth the lake's West Arm recently revealed extremely high densities of largescale suckers in areas historically dominated by burbot. This community composition shift may have also resulted in increased predation on and competition with any remaining YOY and juvenile burbot (Ahrens and Korman 2002).

In addition to documented and hypothesized changes in fish community composition in the West Arm, changes also occurred in the invertebrate community. Reduced transport of non-native *Mysis* shrimp over the shallow sill from the main lake into the West Arm may have occurred due to increased water clarity following impoundment (sediment trapping) by Duncan and Libby dams (Ahrens and Korman 2002). These authors suggested that significant increases in water clarity following impoundment and cultural denutrification (figure 4.21) resulted in deeper distribution of photophobic mysids in the main lake. Thus, reduced transport of mysids over the shallow West Arm sill could have led to reduced growth and survival rate for juvenile burbot (Ahrens and Korman 2002).

Idaho

Paragamian (2002) assessed the changes in the species composition of the fish community in a reach of the Kootenai River known as the Hemlock Bar. Paragamian found a post-dam change in the fish community from one in which insectivores and omnivores were equally represented to one that was dominated by omnivores. Paragamian (2002) also documented changes in the growth rate of mountain whitefish and lower densities.

Timeline of Impacts

- Logging and mining operations beginning in the 1880s,
- Attempts to dike the lower river to claim land for agricultural use in 1892,
- Completion of Cora Linn Dam (former natural Bonnington Falls) in 1930.
- Unregulated harvest beginning with “dust bowlers" during the 1930s.
- Local recognition of burbot collapse by the early 1900s.
- Fertilizer plant operation (nutrient loading) on St. Mary’s River from 1953-1970.
- Substantial sport and commercial fishery harvest from 1950s to 1970s.
- Completion of Duncan Dam in 1967.
- Completion of Libby Dam in 1972.
- Alteration of Kootenai River hydrograph and thermograph beginning in 1974 downstream from Libby Dam.
- Pollution abatement activities throughout watershed.
- Kootenay Lake fertilization beginning in 1992.

Human Impacts

The Kootenai River system has been subjected to many human influences over the course of the past 100 years or more (Northcote 1973). A comprehensive account of anthropogenic changes and resulting ecological responses in the Kootenai Basin is provided by Anders et al. (2002), Paragamian (2002), and other authors. By the mid-1960s, phosphorus concentrations increased 15-fold, and nitrogen doubled from baseline conditions in the Kootenai River due to municipal and industrial development. Pollution abatement beginning in the late 1960s, and subsequent impoundment of the Kootenai River (Libby Dam, 1972) reversed this culturally eutrophic condition. By the mid-1990s the Kootenai River was classified as ultraoligotrophic, as it remains today. Reverberating trophic responses to cultural denutrification were temporally correlated with the collapse of the functional Kootenai River Subbasin downstream from Libby Dam, and its native burbot populations.

The pre-impoundment Kootenai River hydrograph was characterized by annual average discharge peaks of approximately 60,000 cfs during the natural high-runoff period in spring and early summer, with highest discharge during the period of record reaching 160,000 cfs (Scott Bettin, Bonneville Power Administration, personal communication). Post-impoundment river discharge (1973-1989) rarely exceeded 20,000 m^3/sec. Post-impoundment river discharge during the spring and early summer has been reduced by as much as 67 percent, and has increased during the winter by as much as 300 percent relative to pre-impoundment conditions (Partridge 1983). The pre-development Kootenai River ecosystem included a naturally functional floodplain over 5 km wide along the 128 km of the river immediately upstream from Kootenay Lake. Diking of this section of the river eliminated thousands of hectares of natural floodplain, and the associated productivity, diversity of habitats, and ecosystem functions (Duke et al. 1999; Anders et al. 2002).

Post-impoundment winter water temperatures in the Kootenai River downstream from Libby Dam averaged 3 °C warmer than pre-impoundment values (Partridge 1983). Summer water temperatures in the same river reaches during the same years were consistently lower than pre-impoundment values, due to hypolimnetic withdrawal from Libby Dam (Partridge 1983; Snyder and Minshall 1994). Libby Dam and the impounded Koocanusa Reservoir reduced downstream transport of phosphorous and nitrogen by as much as 63 percent and 25 percent respectively (Woods 1982), with sediment trapping efficiencies exceeding 95 percent (Snyder and Minshall 1996).

Diking and channelization altered channel bed conditions by trapping sediments previously deposited over the historic floodplain during periods of high river discharge. Like other large river-floodplain ecosystems, the Kootenai River was historically characterized by seasonal flooding that promoted the exchange of nutrients and organisms among a mosaic of habitats, reported to enhance biological productivity and habitat diversity (Junk et al. 1989; Bayley 1995).

Agricultural activities (farming, channelization, and diking) have restricted the Kootenai River's natural floodplain from Kootenay Lake upstream to Bonners Ferry, Idaho. Forest developments have affected a significant area of the drainage. A fertilizer plant in B.C. (on the St. Mary River near Kimberley) polluted the river and lake. The Cora Linn Dam on the Kootenay River downstream from Nelson, the Duncan Dam at the north end of Kootenay Lake, and the Libby Dam upstream from Kootenai Falls have all dramatically affected movement of water through the system. In addition to these major perturbations, numerous but smaller impacts have also shaped the present integrity of the Kootenai River ecosystem (e.g., road construction, urbanization, introduction of non-native fish and invertebrates).

Impoundment of rivers represents a cataclysmic event for large river-floodplain ecosystems (Ligon 1985). By altering water, sediment, and nutrient flow dynamics, dams interrupt and alter a river's important ecological processes in aquatic, riparian, and surrounding terrestrial environments. These environments, their life-supporting ecological functions, and the persistence of their floral and faunal communities are inexorably linked. Alteration of any component of such highly integrated natural systems generally results in cascading trophic effects throughout the ecosystem. Thus, major system perturbations, such as impounding large rivers, create a myriad of ecological dysfunction, reflected at all trophic levels on an ecosystem scale. The importance of nutrient and energy dynamics during natural pulses of water discharge in rivers has been extensively described in terms of river ecology (e.g., flood pulse, river continuum, nutrient spiraling, and serial discontinuity concepts).

Depressed biological productivity, alteration of spawning and rearing habitats, fish species abundance changes, altered predator-prey dynamics, and consistent white sturgeon recruitment failure constituted biological and ecological responses to Kootenai River Basin development (Ashley et al. 1999; Marcuson 1994; Paragamian 1994; Snyder and Minshall 1994, 1995, 1996; Anders and Richards 1996; Duke et al. 1999; USFWS 1999). Closures of the recreational kokanee (*Oncorhynchus nerka*), burbot (*Lota lota*), and white sturgeon harvest fisheries in Idaho and BC since the mid-1980s were fisheries management responses to ecological perturbations and possible past overharvest (Anders et al. 2002).

4.6 White Sturgeon (*Acipenser transmontanus*)

4.6.1 Background

Worldwide, diversity of sturgeon and paddlefish is currently imperiled, as evident by the extirpation of many North American, European, and Asian forms (Rochard et al. 1999; Birstein 1993; Birstein et al. 1997a, 1997b; 1997c; Findeis 1997; Khodorevskyaya et al. 1997; Kryhtin and Svirskii 1997; Ruban 1997; Wei et al. 1997). With few exceptions (Bruch et al. 2001a), the population abundance of most *Acipenser* species is currently at historically low levels. This includes many North American taxa, such as white sturgeon (*Acipenser transmontanus*) (Rieman and Beamesderfer 1990; Birstein 1993; Waldman 1995; Boreman 1997; Beamesderfer and Farr 1997; Wirgin et al. 1997; Campton et al. 2000; Mayden 2001).

Although sturgeons express many different life histories, all spawn exclusively in freshwater (Kynard 1997). Many require large, river systems with intact functional processes to complete various early life stages. Proceedings from recent international meetings on sturgeon management, research, and conservation share consistent findings that the sturgeon's imperiled status reflects the degree of degradation of large river habitats and ecological functioning of large river-floodplain systems. Four causal factors were cited repeatedly for the demise of sturgeons across geography: harvest, habitat fragmentation, hydropower development, and pollution (4th International Sturgeon Symposium 2001; Van Winkle et al. 2002; 1994 New York). Humans have harnessed the energy of most large river systems, and have modified their hydrographs to prevent flooding and the associated losses of human life and property. These changes have occurred at the expense of native species, such as white sturgeon.

White sturgeon are endemic to the Pacific coast of North America and its tributaries west of the Rocky Mountain continental divide, from central California to the Gulf of Alaska and the Aleutian Islands (Scott and Crossman 1973). White sturgeon are typically an anadromous species. However, the Kootenai River of British Columbia, Montana, and Idaho contains a unique headwater population that has been isolated from the ocean and other downstream Columbia River populations for over 10,000 years (Alden 1953; Northcote 1973). Kootenai River white sturgeon are genetically and behaviorally distinct from other white sturgeon stocks. The Kootenai population is characterized by significantly lower genetic diversity than found in other populations in the downstream Columbia Basin waters (Setter and Brannon 1992; Anders et al 2002; Anders and Powell 2002). Kootenai River sturgeon are also more active at 6 °C, several degrees cooler than the activity threshold for Columbia and Snake River sturgeon (Paragamian and Kruse 2001).

LINKS

White sturgeon information generated by State, federal, and tribal biologists working in Montana is available from 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 fisheries information for the Kootenai 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

LINKS

For summaries of and access to four scientific papers on Kootenai River white sturgeon, including papers on spawning locations, success of hatchery-reared fish, assessment of bioaccumulated metal and organochlorine compounds, and temporal distribution of spawning events, go to Appendix 107.

Click Here

Reasons for Selection as a Focal Species

Due to their dependence on functioning large river-floodplain ecosystems, and their sensitivity to largescale alterations of such systems, white sturgeon serve as a valuable and informative focal species. Furthermore, due to their unusual longevity (> 100 yrs.) temporal correlation of population status with particular ecological perturbations or environmental conditions serves as a valuable indicator, further supporting their role as an important focal species for Subbasin Planning activities.

On September 6, 1994, the U.S. Fish and Wildlife Service listed the Kootenai River population of white sturgeon as an endangered species *(59* FR 45989) under the authority of the Endangered Species Act of 1973, as amended. The global heritage status rank for the Kootenai River white sturgeon is T1 (critically imperiled) because of the fish's limited range in the Kootenai River of British Columbia, Idaho, and Montana; the population is isolated and small; there has been very limited reproduction since 1977 (figures 4.22 and 4.23); and the population has been negatively impacted by river regulation and probably other habitat alterations. The state/province heritage rank for Idaho, Montana, and B.C. is S1 (critically imperiled). The white sturgeon is a culturally significant species to the Kootenai Tribe of Idaho. For these reasons, we have selected the Kootenai River white sturgeon as a focal species.

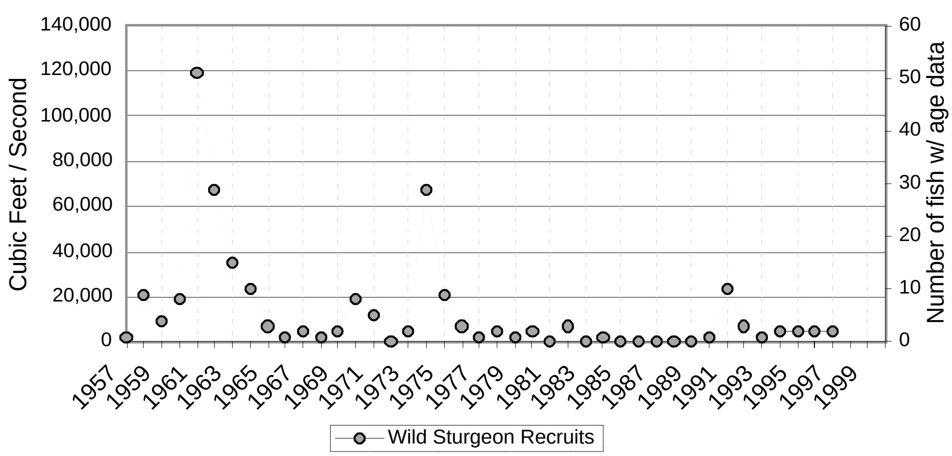

Figure 4.22. Numbers of white sturgeon recruits 1957 to 1999.

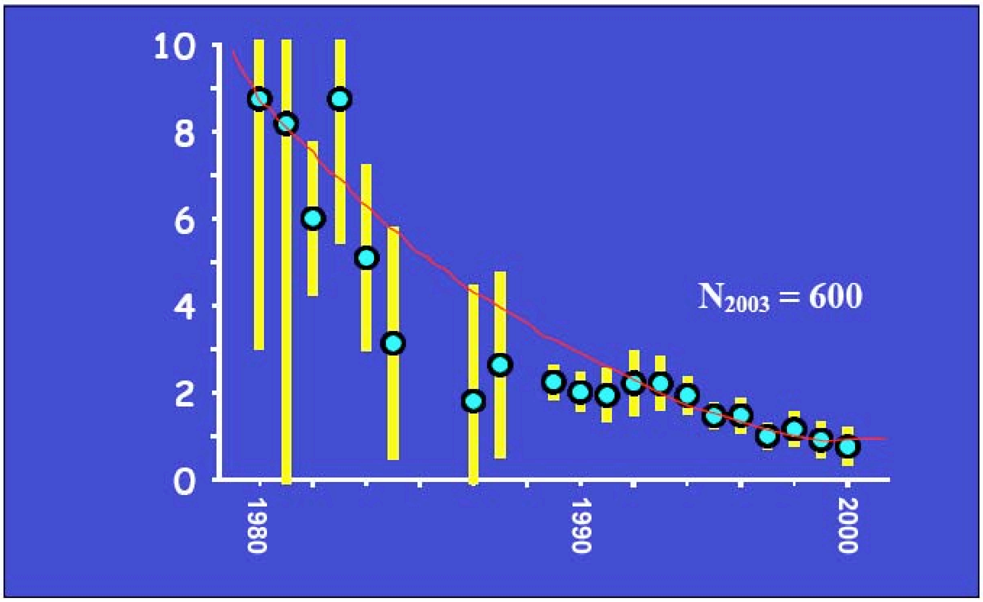

Figure 4.23. Summary of Kootenai River white sturgeon population abundance estimates. Source: Paragamian et al. In Press.

Summary of population data

The abundance of the Kootenai River white sturgeon population was estimated to be 6,800 fish during the early 1980s, before a precipitous population crash resulted in the current (2003) estimate of approximately 600 fish remaining in the population (figure 4.23). However, the accuracy of these early abundance estimates is questionable, as indicated by the large amount of variability associated with them. Empirical demographic modeling during 2002 revealed the increasingly imperiled demographic status of the population. Modeling suggested 90 percent, 75 percent, and 72 percent reductions in population abundance, biomass, and annually available spawners, respectively, over the past 22 years (1980-2002), and a current population "halving time" of 7.4 years (Paragamian et al. In Press).

Because of the near-complete failure of natural recruitment, the modeled sturgeon population declined by nearly 90 percent from 6,800 fish in 1980 to 630 in 2002 (figure 4.23). It is estimated that fewer than 500 adults from the existing wild population will remain by 2005, and fewer than 50 adult fish will be left by 2030 (figure 4.24). Total biomass declined by about 75 percent, from 80 to 20 metric tons between 1980 and 2002. Annual numbers of female spawners declined from 270 per year in 1980 to about 77 in 2002. It is estimated that fewer than 30 females will be spawning during any year after 2015.

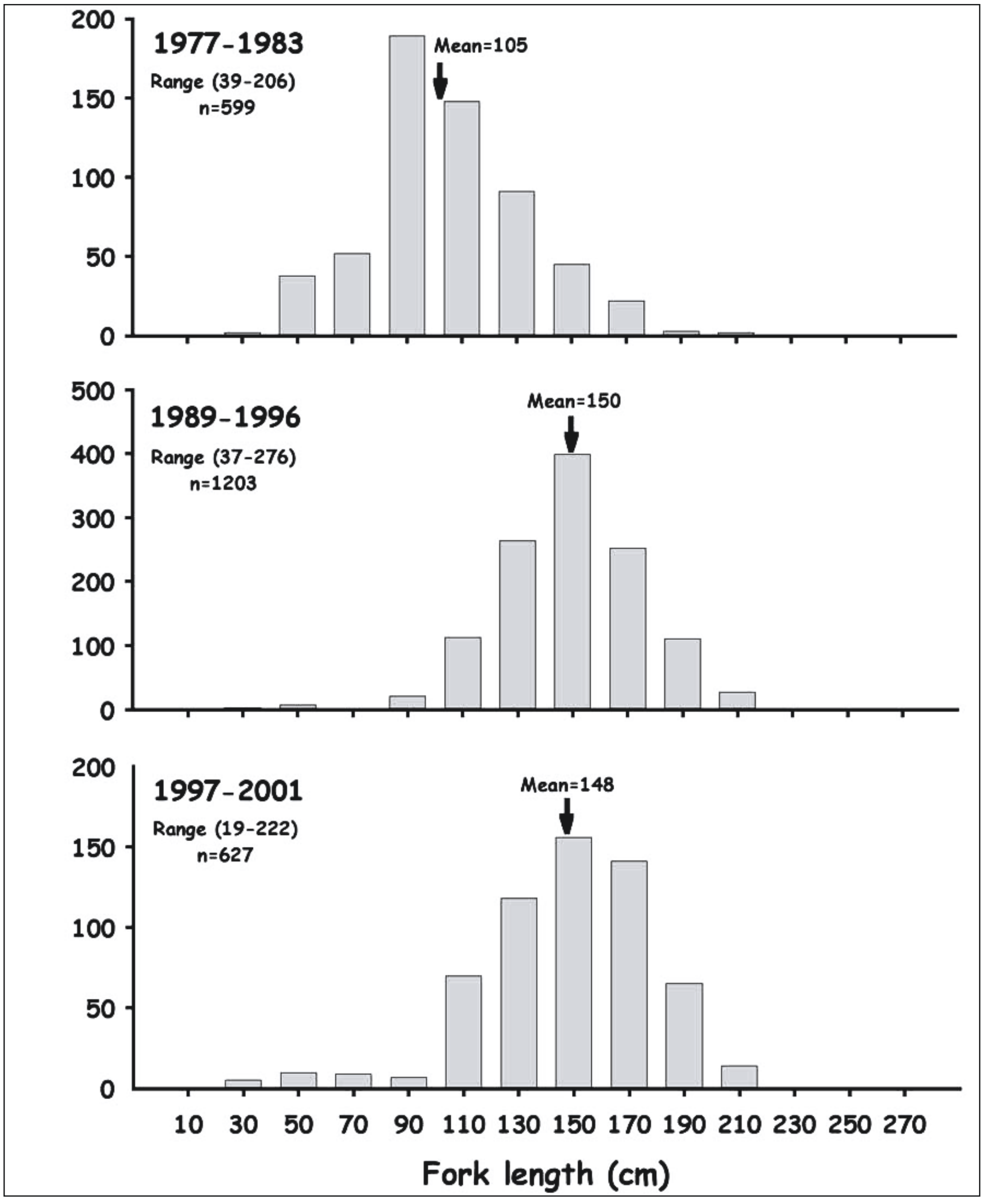

Figure 4.24 Changes in size composition of the Kootenai River white sturgeon population from 1977 to 2001 (Paragamian et al. In Press).

In the absence of natural recruitment, the Kootenai white sturgeon population is threatened by demographic and genetic bottlenecks, as indicated by the right-shifting size composition of the population (figure 4.24).

Historic and Current Distribution

Within the Kootenai River Subbasin, white sturgeon historically occupied an approximately 300 km (186.5 mile) reach, from Kootenai Falls (km 380.5) downstream to the north end of Kootenay Lake (km 17), and upstream into what is now Duncan Reservoir, as well all of the lake's West Arm (approx. 50 km or 31 miles) (figure 4.25). This population was thought to have been post-glacially recolonized and subsequently trapped in this area between upstream (Kootenai Falls) and downstream (Bonnington Falls) migration barriers. The population's current range is similar to its historic range, although population abundance is now greatly diminished, and very few fish appear to inhabit waters upstream from Bonners Ferry.

Status of White Sturgeon Introductions, Artificial Production and Captive Breeding Programs

No introductions of white sturgeon from outside the Kootenai River Subbasin have ever occurred. To date (2004), no captive breeding (captively rearing juveniles in a hatchery to broodstock age for future spawning in captivity) has occurred within the Subbasin. However, conservation aquaculture techniques using exclusively wild, native broodstock were first applied to wild white sturgeon populations in 1990 on the Kootenai River in northern Idaho following concerns that missing year classes, failed recruitment, and skewed age-class structure were threatening this population. Subsequent concerns regarding duration, breadth, and magnitude of ecosystem degradation in Montana, Idaho, and B.C. portions of the Kootenai River suggested that a conservation hatchery program may be warranted to preclude extinction. The Kootenai River white sturgeon population was listed as endangered under the Endangered Species Act (ESA) in 1994 (USFWS 1994). A Recovery Plan was completed in 1999, which incorporated the conservation aquaculture program (Duke et al. 1999; USFWS 1999; Kincaid 1993). The Hatchery Genetics and Management Plan prepared for the Northwest Power and Conservation Council (Ireland 2000) and the Adaptive Multidisciplinary Conservation Aquaculture Plan prepared for the USFWS White Sturgeon Recovery Team (KTOI 2004) provide the guidance for the conservation aquaculture program.

The Kootenai River Conservation Aquaculture Program has greatly expanded since 1990, and has: (1) provided frequent year classes of captively reared progeny from wild, native brood stock; (2) preserved within-population genetic diversity; (3) minimized disease introduction and transmission; and (4) substantially

LINKS

For the Kootenai River White Sturgeon Conservation Aquaculture HGMP, go to Appendix 77.

Click Here

For the Recovery Plan for the Kootenai River Population of the White Sturgeon, go to Appendix 78.

Click Here

For An Adaptive Multidisciplinary Conservation Aquaculture Plan for Endangered Kootenai River White Sturgeon, go to Appendix 103

Click Here

For the NPCC's Artificial Production Review Evaluation of the Kootenai Tribe of Idaho's white sturgeon hatchery, go to: http://www.apre.info/APRE/apre_report/ShowAPREReport?Section=Landing

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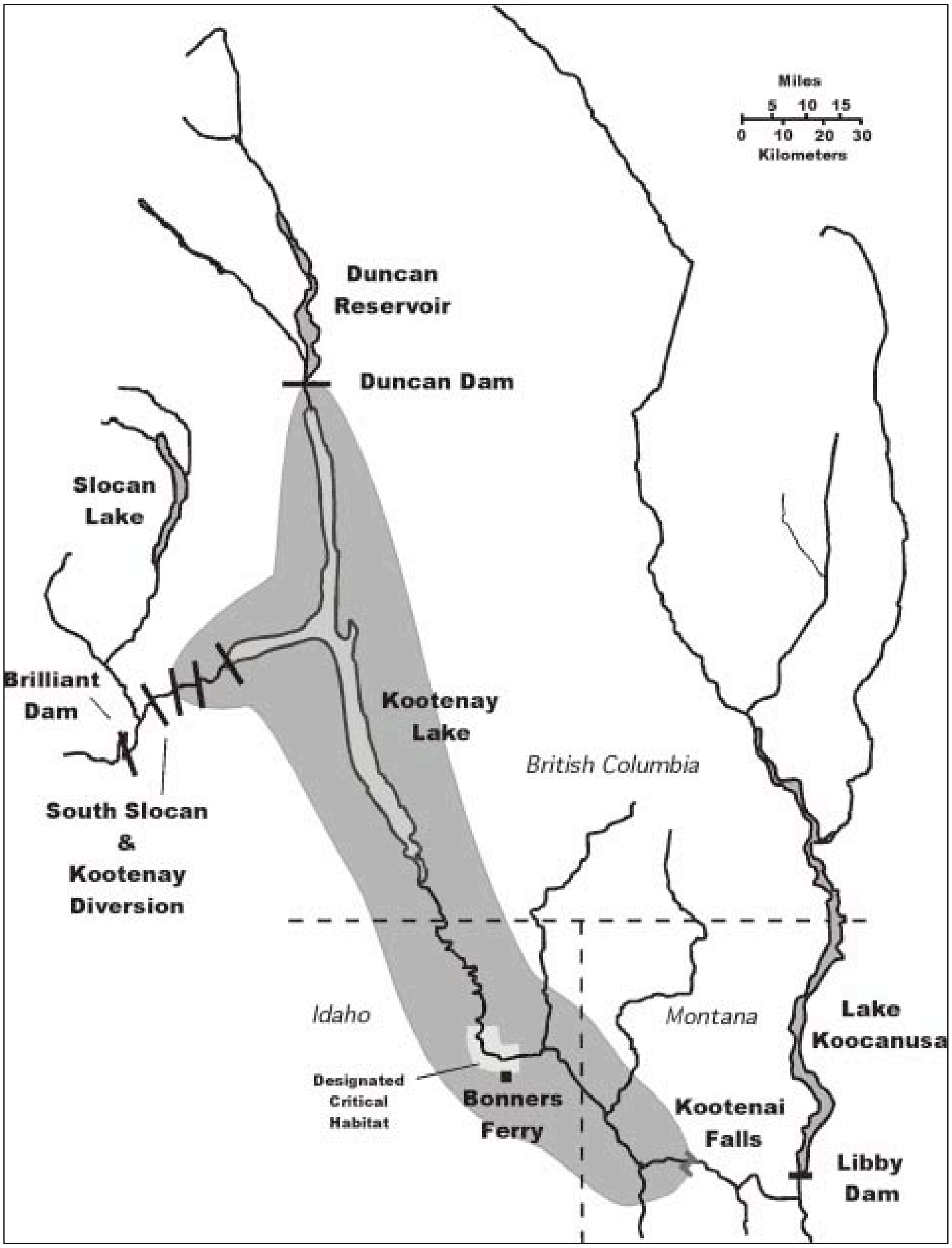

Figure 4.25. Historic distribution of Kootenai River white sturgeon (shaded area). Currently, the population generally inhabits the meandering reach from Bonners Ferry downstream into and including Kootenay Lake. Adult fish are rarely captured between Bonners Ferry and Kootenai Falls. White sturgeon have been recently isolated in Duncan Reservoir (1967), upstream from Duncan Dam. Critical habitat designated by the USFWS following the listing of the population as endangered under the ESA in 1994 is indicated just downstream from Bonners Ferry, Idaho (Figure from Paragamian et al. In Press)

contributed to the developing field of white sturgeon conservation aquaculture (Ireland et al. 2002a, 2002b; LaPatra et al. 1999). This program is also developing, implementing, and evaluating relatively rigorous fish health, population biology, and population genetic research components. In 1999, the Program expanded to include the use of a "fail-safe" facility in British Columbia (expansion of the existing Kootenay Trout Hatchery near Fort Steele, B.C. to hatch and rear white sturgeon; spelled "Kootenay" in Canada) to guard against catastrophic loss due to facility failure or a possible disease outbreak at one location. Program arrangements with the Province of B.C. facilitate annual hatching and rearing of various progeny groups at one or both locations, and provide an efficient mechanism for demographic restoration stocking in Canadian waters of the Kootenay system.

During the first 12 years of the Program (1990-2002), with the exception of 1994, mature wild fish were captured annually and bred to produce 4 to 12 separate families, and 4 to 10 adults per family at breeding age (~20 yrs) (figure 4.26). Annual egg-to-larval survival rates ranged from 1.8 to 86 percent from 1990 though 2002, and up to 12 families (including half-sib families with a shared female parent) were produced (figure 4.27). A total of slightly over 40,000 fish have been released since the early 1990s, with the majority of those releases occurring since the late 1990s.

Inter-annual variation in survival and production rates was affected by differential gamete viability among brood stock and improved by facility upgrades. Facility improvements were temporally correlated with increased survival and

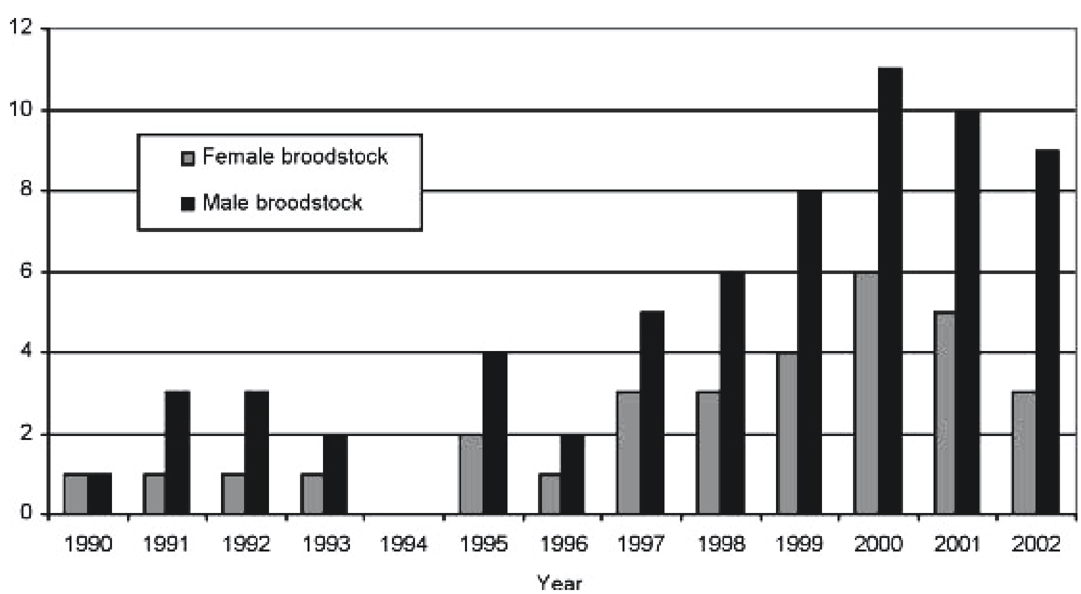

Figure 4.26. Male and female white sturgeon brood stock spawned in the Kootenai River Hatchery from 1990 through 2002. No fish were spawned during 1994.

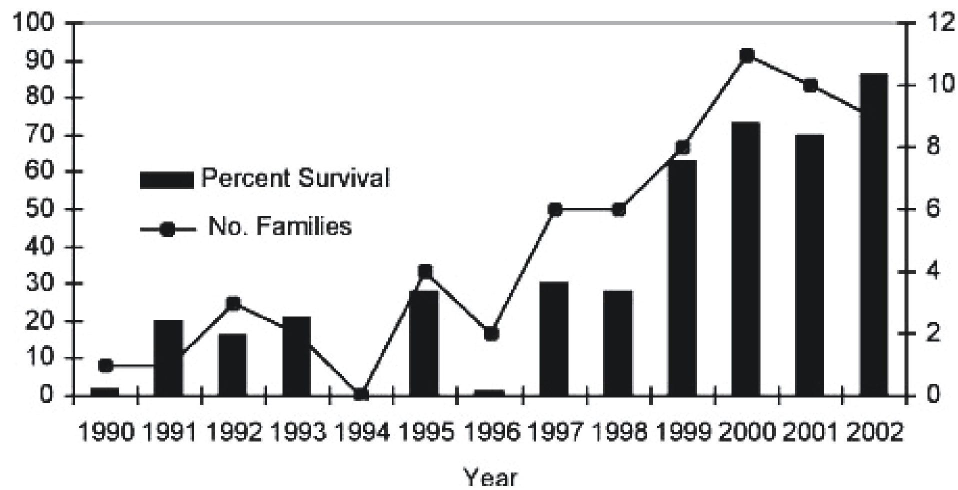

Figure 4.27. Mean annual white sturgeon egg to larval survival rates and numbers of families produced in the Kootenai Hatchery from 1990 through 2002. No fish were spawned during 1994; poor brood stock egg quality during 1996 resulted in extremely low egg to larval survival rates. Facility upgrades at the Kootenai Hatchery were completed in 1999.

production rates and performance measures. Most performance measures have increased substantially during the first 10 years of the program (figures 4.26 and 4.27).

Recapture and survival rates of juvenile white sturgeon produced in the Conservation Aquaculture Program exceeded initial expectations. Average annual post-release juvenile survival rates also exceeded initial expectations at approximately 60 percent within the release year, and 90 percent during all subsequent years (Ireland et al. 2002b). These estimates are currently being updated to include recapture and survival rates during 2003 (Ray Beamesderfer, S.P. Cramer and Associates, pers. comm. 2003).

Genetic brood stock management

Length variation arises in the D-loop of white sturgeon as a consequence of a gain or loss of 1-5 repeated tandem 78-82 base-pair nucleotide sequences (Brown et al. 1992, 1996; Buroker et al. 1990). Length variation or length polymorphism in the D-loop has been previously examined in a phylogenetic context in white sturgeon of the Columbia Basin (Brown et al. 1992, 1993). This marker system was applied to Kootenai River white sturgeon by Anders et al. (2002). Five different mtDNA length variants were observed among the 54 brood stock samples (Anders et al. 2000). The same five length variants were also observed among the 112 samples from the wild population (figure 4.28). Based on results of Chi-square (X^2) analysis, haplotype (length variant) frequency distributions of the wild population and brood stock sample groups were not significantly different ($P \leq .05$; df=4, X^2 matrix value = 0.87; X^2 critical = 11.41, Appendix A; Anders et al. 2000). Therefore, brood stock selection to date appeared sufficiently representative such that statistical differences in haplotype frequencies of wild population and brood stock sample groups were nonsignificant (i.e., the brood stock sample group provided a robust, random sample of the wild population, based on our analysis).

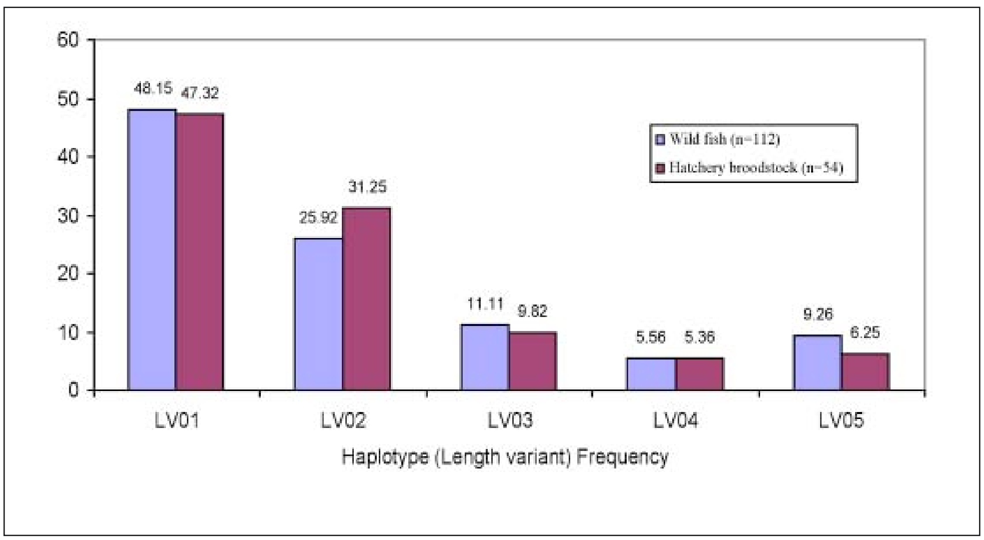

Figure 4.28. Comparison of haplotype (length variant, LV) frequencies between the wild population and the subset of Kootenai Hatchery brood stock, (1997 through 2000).

Future population trajectories with hatchery intervention

Hatchery-reared fish released since 1990 can be expected to begin recruiting to the adult population after year 2020 (figures 4.29 and 4.30). The adult population will rapidly increase from 2020 to 2030, after which it is projected to stabilize to about 3,000 sturgeon, which is 5 times the current adult population size and just under half the total number estimated in 1980. Population projections describe a significant near-term bottleneck in spawner numbers as the wild population fades but hatchery fish have not yet matured. A total of 113 to 203 females are projected to contribute to hatchery brood stock over the expected life span of the current wild population depending in catachability in out-years when abundance

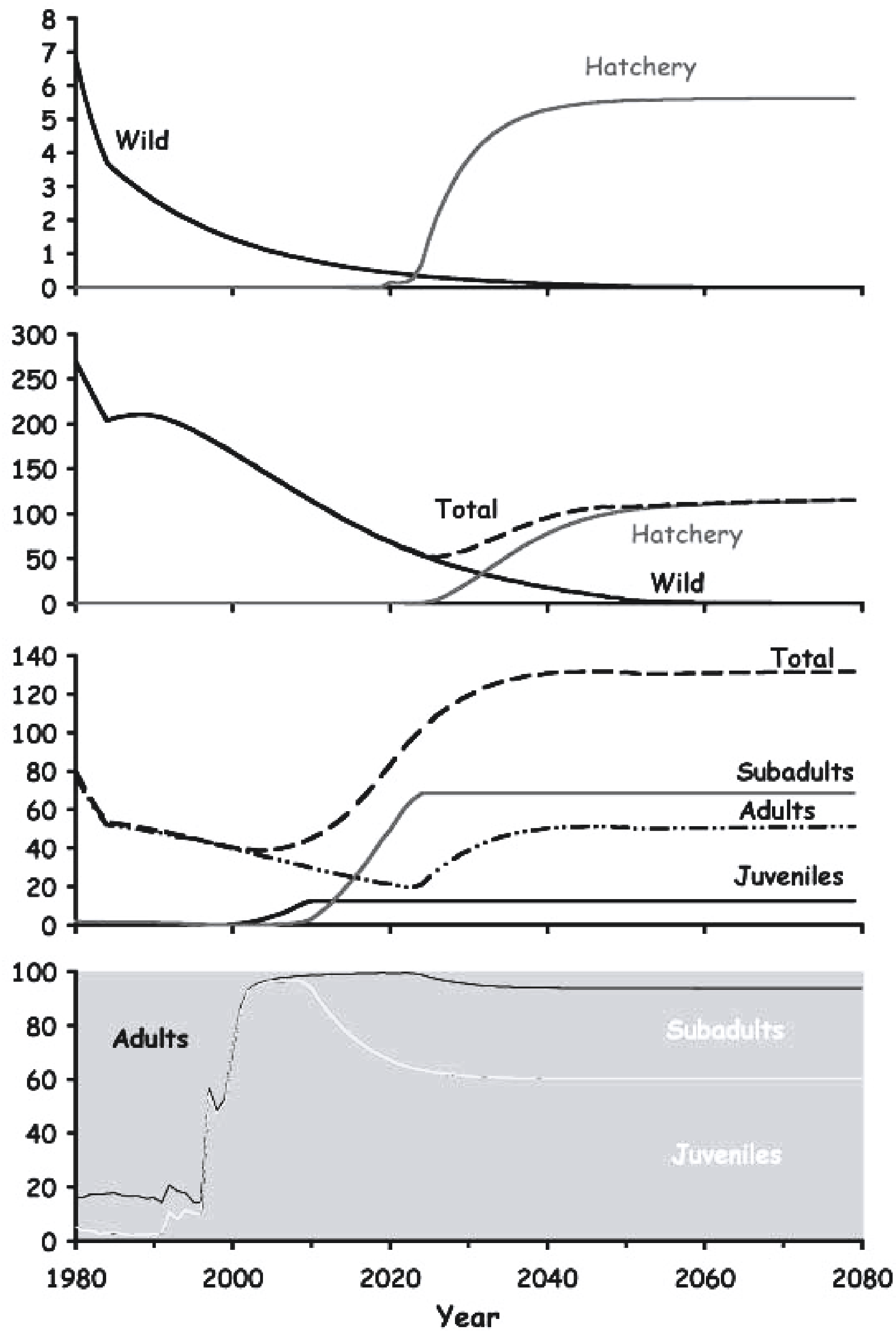

Figure 4.29. Simulated population size, female spawner number, biomass, and size composition (From Paragamian et al. In Press).

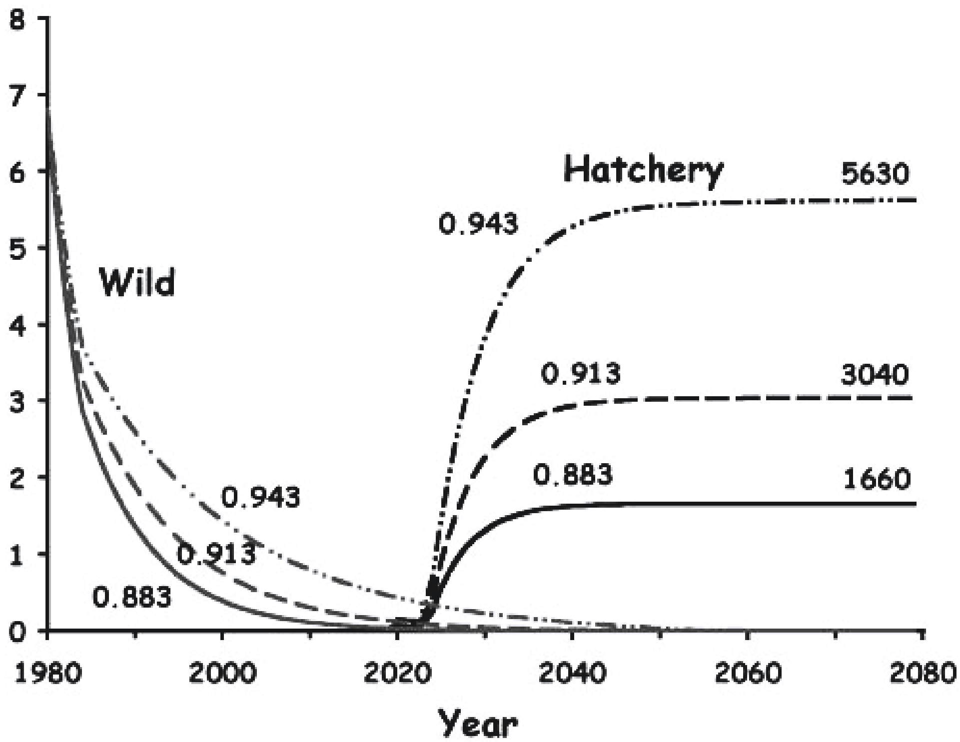

Figure 4.30. Sensitivity to annual mortality rate in model projections of hatchery-origin adult number (From Paragamian et al. In Press).

is low. Projections also indicate that equilibrium populations established over the long term (if hatchery production can be sustained through this bottleneck) will be dominated by juveniles (by numbers) and subadults (by biomass) (figure 4.29). Numbers predicted by these simple population simulations are extremely sensitive to estimates of annual survival rate but predicted patterns do not change. Figure 4.30 illustrates the profound effect of a +/- 3 percent change in survival rate on resulting population demographics.

Historic and Current Harvest

Historic harvest of white sturgeon in the Kootenai River Subbasin was typically undocumented. Although past quantitative records of white sturgeon harvest from the Kootenai River were unavailable, commercially harvested white sturgeon were locally marketed in the earlier part of this century (Partridge 1983). Up until 1984 there was a limited sport fishery for white sturgeon in the Idaho reach of the Kootenai River. From 1984 through 1994 fishing was catch and release only (Apperson and Wakkinen 1993). Currently, fishing for white sturgeon is not allowed in the Kootenai River. For a description of past fishing regulations for white sturgeon in Idaho, Montana, and British Columbia, see the USFWS White Sturgeon Recovery Plan (1999) (Appendix 78).

4.6.2 Population Delineation and Characterization

Population Units

With the exception of the artificial separation of white sturgeon in Duncan Reservoir from the rest of the Kootenai River Subbasin, which was caused by completion of Duncan Dam in 1967, all empirical demographic, telemetry, and genetic analyses (Anders 1991; Apperson and Anders 1991; Duke et al. 1999; USFWS 1999; Paragamian and Kruse 2001) indicate the presence of a single white sturgeon population in the Kootenai River Subbasin. The only known reproduction areas for this population exist in the Idaho section of the Kootenai River, and have been designated as critical habitat by the USFWS after the agency listed the species as endangered. In the Kootenai River, in a river reach several hundred kilometers in length, upstream spawning and subsequent downstream migrations of white sturgeon have been consistently observed during the past 10 years (Anders 1991; Apperson and Anders 1991; Marcuson 1994; USFWS 1999; Duke et al 1999; Paragamian et al. 1999, 2001). Thus, white sturgeon in the Kootenai River Subbasin appear to possess no geographic population structure or population units.

Life History[1]

Sturgeons exhibit several life history forms including diadromy (migrating between fresh and saltwater), anadromy (spawn in fresh water, spend nonreproductive periods in marine environment), amphidromy (bidirectional, nonreproductive migration between fresh and saltwater), and potadromy (all feeding and reproductive migrations within a freshwater river system). Poorly understood, but accounting for most white sturgeon in impounded reaches of the Columbia River system in the U.S. and Canada, is facultative potadromy, which occurs when dams prohibit expression of historically anadromous or amphidromous life history strategies (Kynard 1997). Based on expressed life histories, white sturgeon appear to be best described as facultatively anadromous, where not dam-locked. Regardless of life history strategies expressed, all sturgeons spawn

[1] *This section on white sturgeon life history characteristics was largely excerpted from Anders (2002). General life history characteristics of Acipenserids were recently summarized by Bemis and Kynard (1997) and Kynard (1997).*

exclusively in large freshwater river systems, often following upstream migrations of considerable distance (Bemis and Kynard 1997).

White sturgeon are characterized by delayed onset of first reproduction. First maturation generally occurs from 10 to 20 years of age for males, and from 15 to 30 for females (Scott and Crossman 1973; Semakula and Larkin 1968; Conte et al. 1988; Paragamian et al. In Press). This trait, coupled with empirically confirmed migratory and dispersal ability, are theorized to contribute to gene flow in white sturgeon (Brown et al. 1992, 1993). Furthermore, individual longevity ($\leq$ 82 years of age, Simpson and Wallace 1982), infrequently exceeding 100 years of age (Smith et al. 2001) may also contribute to observed migration, dispersal, and gene flow (Brown et al. 1993, 1996).

White sturgeon are iteroparous spawners that broadcast gametes into the water column. Fertilization occurs before the demersal, adhesive embryos settle to the substrate (Wang et al. 1985; Conte et al. 1998; Paragamian et al. 2001, and references therein). In demographically viable white sturgeon populations, iteroparity provides the opportunity for within-year reproduction by numerous generations of fish. Reproductive periodicities vary between sexes; males may reproduce every 2 to 4 years, while females may reproduce at no less than 5-year intervals (Conte et al. 1988; Chapman et al. 1996; Paragamian et al. In Press). Simpson and Wallace (1982) reported 4 to 11 year spawning periodicity for white sturgeon, but made no mention of gender. Little is known regarding reproductive senescence in *A. transmontanus*, although a recent review of the literature and datasets for sturgeon suggested that the Kootenai River white sturgeon population will remain reproductive throughout their lifespan (Webb 2003). One perspective suggests that natural selection would not favor the persistence of this life history trait because longevity beyond reproductive age would serve no advantageous purpose to the population (E. Brannon, University of Idaho, pers. comm.). Mature adults are thought to spawn numerous times over a 30-40 year period, and possibly longer (S. Doroshov, University of California, Davis, pers. comm.). If an individual female initially reproduced at age 25 and successfully spawned in subsequent 5-year intervals until age 65, it theoretically could contribute gametes to subsequent generations up to nine times. Finally, communal spawning, along with the above reproductive mechanisms, likely contributes to increased gene flow and maintenance of genetic diversity in white sturgeon relative to that of paired, semelparous fishes (e.g., Salmonidae), especially in the absence of confirmed homing fidelity.

Genetic Integrity

Geographic isolation, potential postglacial population founding effects, subsequent demographic bottlenecks, and past harvest may have all contributed to the relatively low genetic diversity currently observed for the Kootenai River white sturgeon population (Setter and Brannon 1990; Anders et al. 2002). Genetic studies of white sturgeon involving allozyme analysis began during the mid 1980s (Bartley et al 1985; Setter 1988; Setter and Brannon 1992). Two subsequent studies (Anders and Powell 2002; Anders et al. 2002) evaluated population genetics of Kootenai River white sturgeon using two mitochondrial DNA (mtDNA) marker systems: control region length polymorphism, and sequencing of a non-repetitive, hypervariable 453 bp. segment of mitochondrial control region. Both these studies involved white sturgeon from over approximately 18 locations in the Columbia, Snake, Kootenai, Fraser, and Sacramento River Basins (Anders and Powell 2002; Anders et al. 2002).

Results of the two independent genetic analyses (protein electrophoresis) (Bartley et al. 1985; Setter and Brannon 1992) suggested that white sturgeon from the Kootenai River population had lower heterozygosities (H= 0.014) than conspecifics from the Columbia, Fraser, and Sacramento river systems (H= 0.049-0.069). The mean percentage of 29 polymorphic loci surveyed was lowest in the Kootenai River population (27.6 percent) compared with white sturgeon from the Snake (31.0 percent) and the mid-Columbia (44.8 percent) rivers, and Lake Roosevelt (55.2 percent, Setter and Brannon 1992). Kootenai River white sturgeon are believed to be a post-glacially isolated population of ancestral Columbia River stock; no unique alleles were found in Kootenai River fish relative to downstream populations (Setter and Brannon 1992). Setter and Brannon (1992) suggested that due to lower diversity and genetic distance estimates separating white sturgeon in Kootenai system from other areas, the Kootenai River population constituted a stock within a species.

In the third genetic study involving Kootenai Subbasin sturgeon (mtDNA), length variants revealed reduced haplotype diversity in Kootenai Subbasin sturgeon compared to those in downriver areas in the Columbia Basin, and in the Fraser and Sacramento basins (Anders and Powell 2002). Samples from the Kootenai River Basin locations each shared five haplotypes (figure 4.28). Frequencies of each haplotype were similar between populations in Kootenay Lake (KL) and the Kootenai River (KR). However, the frequency of LV-01 in Kootenay Lake (53.4 percent) was slightly higher than in the Kootenai River (43.9 percent).

In the final genetic analysis involving Kootenai Subbasin white sturgeon to date, sequence analysis of a 453 base-pair non-repetitive section of the mtDNA control region from 40 fish from the Kootenai system (20 from Kootenai River, 20 from Kootenay Lake) revealed that 37 fish (92.5 percent) shared one haplotype (Anders and Powell 2002). (This haplotype was also the most common among 20 samples at each of the 11 other sites in WA, OR, ID, CA, and BC). Three haplotypes existed in both the Kootenai River and Kootenay Lake, compared to 4 to 11 (mean = 7) from a sample of 20 fish in 11 other areas of western North America (Anders et al. 2001). These and earlier genetic research findings (Bartley et al. 1985; Setter and Brannon 1992) support the postglacial isolation hypothesis, and consideration of Kootenai River white sturgeon as a separate population.

Genetic relationships of white sturgeon throughout their geographic range remain unclear. Contemporary gene flow between and among populations or locations has not been well characterized (Brown et al. 1993). However, Anders and Powell (2002) provided empirical evidence of population structure at large geographic scales on the west coast of North America.

In addition, appropriate biological and ecological data needed to accurately define white sturgeon populations and putative population structure remain inadequate. Previous examinations of genetic variation among white sturgeon from several locations using protein electrophoresis reported a reduced level of genetic variation in the Kootenai River population relative to downstream Columbia River Basin locations (Bartley et al. 1985; Setter and Brannon 1992). However, the level of genetic variation or the degree to which conspecifics in the Columbia, Snake, and other rivers form genetically distinct populations, distinct population segments (DPS; Federal Register, 1973, Endangered Species Act, Section 15.3, No. 3-16; Waples 1991), or evolutionary significant units (ESU; Ryder 1986; Moritz et al. 1987; Waples 1991; Moritz 1994) remains unknown.

The Kootenai Tribe of Idaho and the Genomic Variation Lab at the University of California, Davis have partnered to begin a more rigorous genetic evaluation of the wild population and the hatchery program using a suite of nine polymorphic microsatellite loci (Rodzen and May 2002; Rodzen et al. 2004).

4.6.3 Population Status

Current Status[2]

Empirical demographic modeling during 2002 revealed increasingly imperiled demographic status for the endangered Kootenai River white sturgeon population. Modeling suggested 90, 75, and 72 percent reductions in population abundance, biomass, and annually available spawners, respectively, during the past 22 years (1980-2002), and a current population "halving time" of 7.4 years. Recruitment failures continue to drive the decline of the Kootenai sturgeon population. No significant recruitment of juvenile sturgeon has occurred since at least 1974 and

[2] *This section on the current status of Kootenai River Subbasin white sturgeon was taken largely from Paragamian et al. (In review).*

consistent recruitment has not occurred since at least 1965. A few wild juveniles are periodically captured (0-11 annually). Of 659 recently captured juveniles, 620 were hatchery-reared and 39 (~6 percent) were wild, confirming very low natural recruitment. Managed (augmented) flows have not stimulated recruitment to date as hoped. Thus, prospects for restoring natural production remain uncertain. Furthermore, this population may be currently or intermittently stock-limited (Anders et al. 2002).

Current population abundance and dynamics confirm that time has not yet run out for the Kootenai sturgeon, but opportunities for effective intervention are rapidly dwindling. The long life span of sturgeon provides an extended period in which to identify and implement effective but contentious recovery measures. However, 35 and possibly 50 years of this window of opportunity have now passed for Kootenai white sturgeon. Consistent recruitment collapsed 15 to 30 years prior to the first systematic population surveys around 1980. Another 20 years have passed, during which the species was listed under the U.S. Endangered Species Act, a recovery plan was completed (Duke et al. 1999; USFWS 1999), a conservation hatchery program was developed (Ireland et al. 2002a; Ireland et al. 2002b), and spring spawning flow measures have been implemented (Paragamian et al. 2001a, 2001b).

The next 5 to 20 years will be a critical period in the preservation of Kootenai River white sturgeon. A bottleneck in spawner numbers will occur as the wild population dwindles and hatchery-reared fish released beginning in 1992 are not yet recruited to the spawning population. Critically low fish numbers cannot be avoided by any action that has not yet been implemented (Paragamian et al. In Press).

Historic Status

Little is known of the historical status of white sturgeon in the Kootenai River Subbasin. Kootenai Falls, Montana, and Bonnington Falls, B.C. were reported to be migration barriers that isolated white sturgeon in a ~300 km reach of the Kootenai River in Montana, Idaho, and B.C. after recolonization following the most recent Pleistocene glacial period (Wisconsin), approximately 12,000 years BP (Alden 1953; Northcote 1973; Partridge 1983). During this glacial period, the outlet of the West Arm of Kootenay Lake was blocked by ice. This blockage formed glacial Lake Kootenai, which extended south into the area currently occupied by the Lake Pend Oreille system. It is believed that this connection with the large glacial lakes to the south permitted recolonization of the Kootenai region by fish species whose subsequent migration was blocked by Kootenai and Bonnington Falls (Alden 1953).

Historically, the Lower Kootenai River produced approximately ten different species of fish utilized as food by the Kootenai Indians (Scholz 1985). Some of these species included the Kootenai River white sturgeon (*Acipenser transmontanus*), bull trout (*Salvelinus confluentus*), whitefish (*Prosopium williamsoni*) and burbot (*Lota lota*). For the Kootenai Tribe of Idaho, the Kootenai white sturgeon held a cultural and religious significance. Even their canoes took the shape and name (sturgeon-nosed canoes) of this large native fish (figure 4.31).

Historically, natural production of white sturgeon in the Kootenai River supported commercial and recreational fisheries (Partridge 1983), as well as a subsistence fishery for the native Kootenai Indians (Schaeffer 1940; Johnson 1969; Turney-High 1969; Scholz et al. 1985). Currently, white sturgeon occupy the meandering reach, from Bonners Ferry, Idaho, downstream to the river delta at the south end of Kootenay Lake. White sturgeon are also found throughout Kootenay Lake (Duke et al. 1999; USFWS 1999). Accurate estimates of historical population size are unknown. The first calculated estimate of Kootenai River white sturgeon population size was 1,194 individuals (95 percent CI: 907-1,503; Partridge 1983). At that time, natural recruitment appeared to be lacking (Partridge 1983). Population size was subsequently estimated in 1990, (880 individuals, 95 percent CI: 639-1,211; Apperson and Anders 1991), and 1996 (1,469 individuals, 95 percent CI: 720-2,197; Paragamian et al. 1996). During the mid-1990s, approximately 90 percent of the individuals in this population were estimated to be ≥ 21 years of age (Paragamian et al. 1995; BPA 1997). During the late 1990s, natural recruits since 1974 comprised approximately 1 percent of the current population (Bonneville Power Administration 1997). For comparison, immature fish accounted for over 95 percent of the white sturgeon population downstream from Bonneville Dam, the furthest downstream impoundment on the Columbia River (DeVore et al. 1999). This unimpounded lower Columbia River population is considered the most productive of any white sturgeon population in the Columbia River Basin (DeVore et al. 1999), and also has access to food resources in estuarine and marine habitats unavailable to upstream impounded populations.

Figure 4.31. Photograph of a Kutenai sturgeon-nosed canoe.

Theoretical Reference Condition[3]

The short-term recovery objectives of the Kootenai River White Sturgeon Recovery Plan are to reestablish successful natural recruitment and prevent extinction through the use of conservation aquaculture. The long-term objective is to downlist and then delist the fish when the population becomes self-sustaining and can provide at least a catch and release fishery.

Criteria for reclassification or downlisting to threatened status for Kootenai River white sturgeon include:

1. Natural production of white sturgeon occurs in at least 3 different years of a 10-year period. A naturally produced year class is demonstrated through detection by standard recapture methods of at least 20 juveniles from that class reaching more than 1 year of age, and;

2. The estimated white sturgeon population is stable or increasing and juveniles reared through a conservation aquaculture program are available to be added to the wild population each year for a 10-year period. For this purpose, a year class will be represented by the equivalent of 1,000 one year old fish from each of 6 to 12 families, i.e., 3 to 6 female parents. Each of these year classes must be large enough to produce 24 to 120 white sturgeon surviving to sexual maturity. Over the next 10 years, the number of hatchery reared juvenile

[3] *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."*

fish released annually will be adjusted depending upon the mortality rate of previously released fish and the level of natural production detected. Additionally, if measures to restore natural recruitment are successful, the conservation aquaculture program may be modified. Conversely, the U.S. Fish and Wildlife Service may recommend that the conservation aquaculture program be extended beyond 10 years if adequate natural recruitment to support full protection of the existing Kootenai River white sturgeon gene pool is not clearly demonstrated, and;

3. A long-term Kootenai River Flow Strategy is developed in consultation of interested State, Federal, and Canadian agencies and the Kootenai Tribe at the end of the 10-year period based on results of ongoing conservation actions, habitat research, and fish productivity studies. This strategy should describe the environmental conditions that resulted in natural production, i.e., recruitment (as described in criterion No. 1) with emphasis on those conditions necessary to repeatedly produce recruits in future years.

Recovery or delisting will be based on providing suitable habitat conditions and restoring an effective population size and age structure capable of establishing a self-sustaining Kootenai River population of white sturgeon.

4.6.4 Out-of-Subbasin Effects and Assumptions

Mainstem Columbia River hydro and flood control operations influence ecological, biological, and physical habitat conditions in upriver and headwater areas, including the Kootenai River Subbasin. The abundance, productivity, and diversity of fish and wildlife species inhabiting the Kootenai River Subbasin, and other headwater areas of the Columbia River Basin, depend on the dynamic conditions of their immediate environments. These conditions are profoundly affected by out-of-basin effects (e.g., operation of the Mainstem Columbia River hydropower system). Mainstem and out-of-basin operations affect Kootenai Subbasin white sturgeon in the following ways:

- Unnatural water discharge and temperature regimes at any time of the year can negatively affect resident fish and supporting lower trophic level taxa. However, unnatural, detrimental effects of hydro operations to white sturgeon and other native taxa can be mitigated to varying degrees by releasing flows at more constant rates and providing smoother shaped water blocks required to address power production and flood control requirements.

- Summer flow augmentation causes reservoirs in the Kootenai Subbasin to be drafted artificially during the most biologically productive summer months. This loss of productivity reduces forage availability and in-reservoir biomass production of all taxa in the reservoir.

- Drafting reservoirs too hard (deep) prior to the January 1 and subsequent inflow forecasts decreases the probability of reservoir refill.

- Flow fluctuations caused by variable power production needs, flood control, or fish flows create wide varial zones in near-shore river and reservoir habitats. Varial zones are characterized by biological instability, due to frequent inundation and dewatering, and by losses of ecological and biological productivity and function.

4.6.5 Environment-Population Relationships

In addition to demographic and genetic requirements, suitable physical habitat (abiotic) and ecological (biotic) conditions are required for viability and persistence of fish populations (table 4.63). In particular, key ecological correlates for Kootenai River white sturgeon include, but are not limited to: suitable water quality, hydraulic and thermal conditions, and predation and competition within ranges that collectively allow life cycle completion. Abiotic and biotic factors must be collectively suitable for completion of each specific life stage in the life cycle continuum, including: spawning, incubation, recruitment, juvenile and subadult rearing, sexual maturation and reproduction.

Long-term Viability of Populations Based on Habitat Availability and Condition

Based on empirical research during the past 20 years, and on current habitat availability and condition, the Kootenai River white sturgeon population appears to possess no long-term viability without intervention (figure 4.32). Without intervention, continued recruitment failure and population extinction are certain during the next 20-40 years (Paragamian et al. In Press). To compensate for: (1) limited or failed natural recruitment since at least the 1960s, (2) the need to preclude extinction, and (3) the failure to reestablish natural recruitment during the 1990s with limited altered hydrograph experiments, a more rigorous

LINKS

For the USGS report summarizing lower Kootenai River channel conditions and changes in suspended-sediment transport and geometery in white sturgeon habitat, go to: http://id.water.usgs.gov/PDF/wri034324/index.html

Click Here

For the USGS surveys of lower Kootenai River cross sections, go to: http://id.water.usgs.gov/PDF/ofr041045/index.html

Click Here

Table 4.63. Description of environment/population relationships by life stage for Kootenai River white sturgeon. Key environmental correlates are presented as a series of abiotic and biotic factors.

Life Stage:	**Spawning**
Life stage status	**Limiting**
	Population appears to be stock limited (too few spawners to compensate for collective early life mortality due to biotic and abiotic factors; Anders et al. 2002)
Abiotic factors	
Hydrograph	Post-impoundment thermograph reversed Higher discharge during winter, much lower during summer; absence of natural spring freshet. Absence of historical hydrograph may be responsible for lack of upstream migration to suitable spawning habitat (in canyon reach)(Partridge 1983; Anders 1991; Duke et al 1999; USFWS 1994, 1999; Bob Hallock, USFWS pers, comm.)
Thermograph	Post-impoundment thermograph cooler in spring, summer, warmer in winter, unnatural thermal changes may negatively affect spawning migrations, success (Duke et al. 1999; USFWS 1994, 1999; Paragamian and Kruse 2001).
Water Quality	Although contamination may be a chronic and possibly sub-lethal stressor in the Kootenai River (Kruse and Scarnecchia 2002) observations of embryo mortality rates does not indicate water quality *per se* is limiting spawning. However, bioaccumlated toxins could negatively affect gamete viability, and therefore spawning success.
Physical habitat	Habitat conditions where spawning is occurring appear to limit or preclude successful embryo incubation (post-dam depositional areas lacking interstitial space) (Duke et al. 1999; USFWS 1994, 1999; Paragamian and Kruse 2001; Anders et al 2002).
Biotic factors	
Food Availability	Food availability is not directly applicable to spawning success. Nutrient limitation in wild sturgeon diets could negatively affect spawning success through reduced gamete viability or fecundity. However, empirical relative weight estimates provided an index of condition factor and has declined from a robust average of 150% in 1977-1983 to 90% in 1989-2001. (Ray Beamesderfer, S.P. Cramer and Associates, personal communication; Paragamian et al. In Press).
Predation	Confirmed predation on white sturgeon eggs and embryos by native omnivorous fishes in the Kootenai River (Anders 1994, 1996), and confirmed ingestion rates of white sturgeon eggs and embryos by native omnivorous fishes in Columbia River impoundments (Miler and Beckman 1996) suggest that white sturgeon recruitment in the Kootenai River may be negatively affected by predation. This potentially limiting effect to recruitment may be exacerbated by additional post-dam habitat and ecological community changes downstream from Libby Dam (Korman and Walters 1999; Anders et al. 2002; Paragamian 2002). During 1994 and 1995, 632 stomach content samples from predatory fishes collected from the Kootenai River (northern pikeminnow (*Ptychocheilus oregonensis*), peamouth chub (*Mylocheilus caurinus*), and suckers (*Catotomus spp*.) were analyzed (Anders, 1994, 1996). Of 428 naturally spawned white sturgeon eggs collected from the Kootenai River during 1994 and 1995, 12.2% (n=52) were recovered from stomach content samples of these predatory fishes; 662 stomach samples were processed (Anders 1994, 1996).
Competition	Interspecific competition is irrelevant to spawning success (with the exception of predation on eggs and embryos). Due to reduced effective population size of Kootenai River white sturgeon population (numbers of breeders each year) interspecific competition does not appear to limit spawning.
Growth	NA
Survival	NA
Recruitment	Over generations, recruitment failure has negatively affected spawning by reducing the number of breeders spawning in the Kootenai River.

Table 4.63. (cont.). Description of environment/population relationships by life stage for Kootenai River white sturgeon. Key environmental correlates are presented as a series of abiotic and biotic factors.

Life Stage:	**Embryo**
Life stage status	**Limiting**
Abiotic factors	
Hydrograph	May have indirect negative effects on embryo incubation if altered hydrograph contributes to spawning over unsuitable incubation habitat.
Thermograph	No apparent negative effects on incubation. However, if unnaturally cold hypolimnetic water from Libby Reservoir results in spawning reduction or limitation, that limitation to spawning would be reflected in an equal or greater limitation at the embryo life stage.
Water Quality	In terms of contaminants, no empirically confirmed direct negative effects of Kootenai River water quality on embryo incubation in the wild. However, Kruse and Scarnecchia (2002) reported that copper and Aloclor 120 in experimental rearing medium may have decreased survival of experimentally incubating embryos in situ. Furthermore, tens of thousands of progeny from over 100 brood stock have hatched and reared on river water, and have survived well after release from the Kootenai Hatchery. However, these early life stages were incubated and reared with no contact to river sediments.
Physical habitat	Habitat conditions where spawning is occurring appear to limit or preclude successful embryo incubation (post-dam depositional areas lacking interstitial space) (Duke et al. 1999; USFWS 1994, 1999; Paragamian and Kruse 2001; Anders et al. 2002).
Biotic factors	
Food Availability	NA-Embryos are endogenously supplied with nutrients.
Predation	Current incubation habitat appears to be limiting or prohibiting completion of embryo incubation in the Kootenai River. This is based on empirical observation, lab tests of effects of fine material deposition (embryo suffocation), and theory (Korman and Walters 1999; Anders et al. 2002; Koch 2003), and on predation. Empirical evidence of predation on sturgeon embryos (Anders 1994,1996), and ingestion rates of omnivorous fish consuming sturgeon embryos (Miler and Beckman 1996) suggest spawning may be overwhelmed by post-development predation pressure, facilitated by additional post-dam habitat and community changes (Korman and Walters 1999; Anders et al. 2002).
Competition	NA
Growth	NA
Survival	Embryo survival appears compromised or negated by predation and suffocation in current incubation habitat (USFWS 1999; Duke et al 1999; Korman and Walters 1999; Anders et al. 2002).
Recruitment	Significant embryo mortality can result in partial or total recruitment failure, depending on the magnitude of the mortality.

Table 4.63. (cont.). Description of environment/population relationships by life stage for Kootenai River white sturgeon. Key environmental correlates are presented as a series of abiotic and biotic factors.

Life Stage:	**Larvae**
Life stage status	**Limiting**
Abiotic factors	
Hydrograph	May have indirect negative effects on embryo incubation if altered hydrograph contributes to spawning over unsuitable incubation habitat.
Thermograph	No apparent negative effects on incubation. However, if unnaturally cold hypolimnetic water from Libby Reservoir results in spawning reduction or limitation, that limitation to spawning would be reflected in an equal or greater limitation at the larval life stage.
Water Quality	No larvae have been captured from the Kootenai River to determine whether water quality parameters are limiting larval production and survival.
Physical habitat	Habitat conditions where larval rearing is occurring appear to limit or preclude successful embryo incubation (post-dam depositional areas lacking interstitial space) (Duke et al. 1999; USFWS 1994, 1999; Paragamian and Kruse 2001; Anders et al 2002).
Biotic factors	
Food Availability	It is currently unknown whether food availability limits larval production. Anders et al. (2002) speculated that food limitation could have negative effects on larvae, given the current ultraoligotrophic status of the Kootenai River (Snyder and Minshall 1996; Hoyle 2003; Anders et al. 2002, 2003).
Predation	Current larval rearing habitat appears to be limiting or prohibiting completion of this life stage in the Kootenai River. Alternatively, the absence of larvae could result from near total embryo mortality due to mechanisms explained above. Larval suffocation and predation may also be limiting completion in the larval life stage for Kootenai River white sturgeon (Brannon et al. 1985; Korman and Walters 1999; Anders et al. 2002).
Competition	NA
Growth	NA
Survival	No known surviving larvae from natural production have been collected from the Kootenai River. Therefore, no estimates of survival rate are available.
Recruitment	Significant larval mortality could result in partial or total recruitment failure, depending on the magnitude of the mortality.

Table 4.63. (cont.). Description of environment/population relationships by life stage for Kootenai River white sturgeon. Key environmental correlates are presented as a series of abiotic and biotic factors.

Life Stage:	**Juvenile Rearing**
Life stage status:	**Non-limiting**
Abiotic factors	
Hydrograph Thermograph Water Quality Physical habitat	The post-development thermograph, hydrograph, water quality, and physical habitat features do not appear to be limiting juvenile rearing. Most juvenile rearing in the Kootenai River currently involves hatchery-produced fish, which survived and grew better than expected after release. Annual survival rates averages 60% for the year of release, and 91% during all subsequent post-release years (Paragamian et al. In Review).
Biotic factors	
Food Availability Predation Competition Growth Survival Recruitment	Based on empirical survival and growth estimates, biotic factors of food availability, predation, competition, growth and survival do not appear to be limiting or prohibiting completion of the juvenile life stage. However, as with all post-development systems, large-scale system perturbations have effects on the aquatic communities that may not be detected due to the lack of a previous reference pre-dam condition. The importance of nutrient and energy dynamics during natural pulses of water discharge in rivers has been extensively described in terms of river ecology (e.g., flood pulse, river continuum, nutrient spiraling, and serial discontinuity concepts. (Vannote et al. 1980; Daley et al. 1981; Woods et al 1982; Ward et al. 1983; Junk et al. 1989. Bayley 1995; Ligon 1995; Snyder and Minshall 1996, and others). Post-development environmental and ecological conditions may have non-lethal negative effects on this life stage.
Life Stage:	**Sub-Adult Rearing to Sexual Maturity**
Life stage status	**Non-limiting**
Abiotic factors	
Hydrograph Thermograph Water Quality Physical habitat	The hydrograph, thermograph, water quality, and physical habitat do not appear to be limiting or prohibiting the completion of the sub-adult life stage for Kootenai River white sturgeon. However, as with all post-development systems, large-scale system perturbations have effects on the aquatic communities that may not be detected due to the lack of a previous reference pre-dam condition.
Biotic factors	
Food Availability Predation Competition Growth Survival Recruitment	Based on current food availability, predation, competition, growth and survival do not appear to be limiting the Kootenai River white surgeon population, or the completion of the sub-adult life stage. However, recruitment failures on decadal scales are seriously limiting the population, with a projected persistence estimate of less than 30 years without intervention (Ray Beamesderfer, S. P Cramer and Associates, pers. comm.; Paragamian et al. In Review). However, as with all post-development systems, large-scale system perturbations have effects on the aquatic communities that may not be detected due to the lack of a previous reference pre-dam condition. The importance of nutrient and energy dynamics during natural pulses of water discharge in rivers has been extensively described in terms of river ecology (e.g., flood pulse, river continuum, nutrient spiraling, and serial discontinuity concepts) (Vannote et al. 1980; Daley et al. 1981; Woods et al. 1982; Ward et al. 1983; Junk et al. 1989. Bayley 1995; Ligon 1995; Snyder and Minshall 1996, and others). Post-development environmental and ecological conditions may have non-lethal negative effects on this life stage.

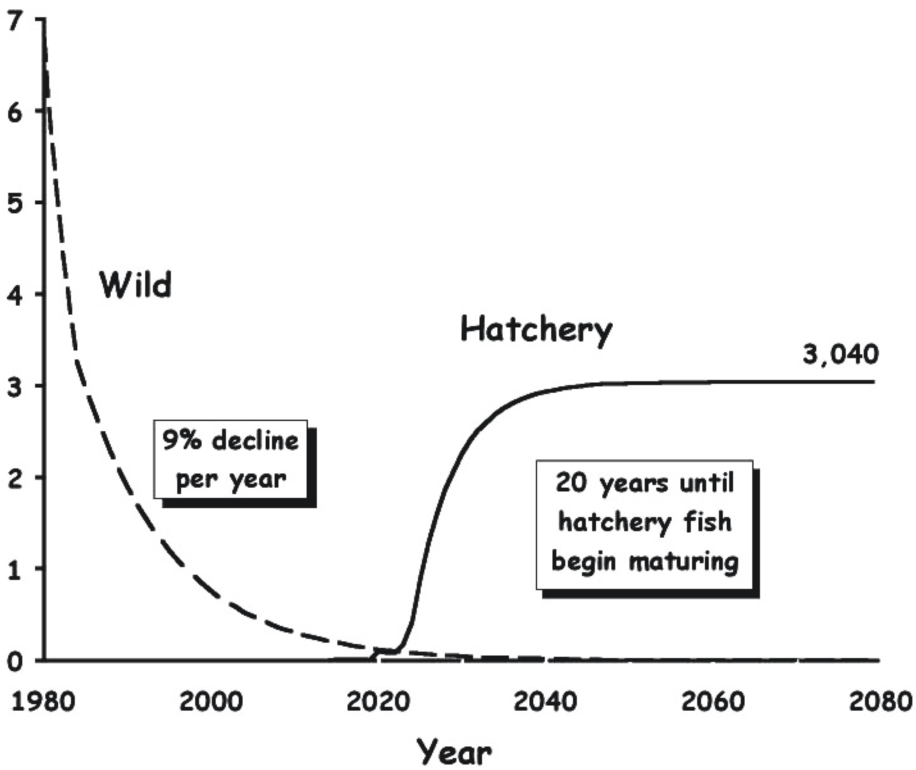

Figure 4.32. Empirically modeled trajectory of Kootenai River white sturgeon with and without hatchery intervention (Paragamian et al. In Press).

conservation program has been implemented to preclude extinction while factors limiting or prohibiting natural recruitment are being addressed and resolved (KTOI 2004).

4.6.6 White Sturgeon Limiting Factors and Conditions[4]

A series of factors appear to be limiting natural recruitment in the Kootenai River white sturgeon population (figure 4.33). These factors fall into two general categories: demographic stock limitation and post-spawning early life mortality factors.

[4] *This section on limiting factors and conditions of Kootenai River white sturgeon were largely excerpted from Anders et al. 2002.*

Demographic stock limitation

An important initial question regarding natural recruitment failure in the Kootenai River white sturgeon population was whether this population is stock limited. Because males in this system are believed to spawn every 2 to 3 years, and females at least every 5 years (USFWS 1999), natural production in this population should be initially limited by reduced annual numbers of female spawners. Severe limitation of female spawners in a given year could render post-spawning early life mortality factors obsolete during that year.

Early-life mortality factors

During years lacking female stock limitation, given natural spawning and failed natural recruitment, post-spawning early-life mortality factors (figure 4.33, shaded boxes) could explain failed recruitment. These potential early-life mortality factors may have affected egg, larval, fingerling, and young-of-the-year (YOY) stages of white sturgeon. Spawning location may be the most significant issue to post-ESA listing of white sturgeon (Paragamian et al. 2001, 2002). While spawning has been documented each year since listing in 1994 (as evidenced by the capture of over 1,000 eggs (Paragamian et al. 2001, 2002)) only one larval fish was captured, while the capture of hatchery fish (released at about 15 to 20 cm) totals 200 to 400 each year. Survival of hatchery fish stocked at age 1+ to 2 is about 65 percent for the first year and 90 percent thereafter (Ireland et al. 2002b). These data suggest a survival bottleneck at the egg-to-hatch-out stage, and habitat appears to be the most limiting factor.

A major contribution to the debates about white sturgeon recruitment failure and habitat requirements associated with successful natural recruitment was provided in a recent paper that presented a riparian habitat hypothesis to explain successful white sturgeon recruitment (Coutant 2004). Based on an extensive review of available literature and studies, this paper proposed that submerged riparian habitat during seasonal high water is needed for early development. Where recruitment is successful, channels are complex and floodable riparian vegetation or rocky substrate is abundant. There—spawning occurs in turbulent zones upstream (1–5 km) of seasonally submerged riparian habitat—eggs can disperse into inundated habitat and adhere to newly wetted surfaces for incubation; yolk-sac larvae can move to riparian crevices for pre-feeding development; feeding larvae have food-rich flooded habitat for early growth; and larvae can transition to juveniles as water recedes to permanent channels. Such habitat is lacking where recruitment is low and present only in high-flow years where recruitment is sporadic. These observations suggest that management should

LINKS

For a riparian habitat hypothesis for successful reproduction of white sturgeon (Coutant 2004), go to Appendix 118.

Click Here

Holderman and Hardy (2004) discuss potential limiting factors in the Lower Kootenai.

Click Here

In her MS Thesis, Hoyle (2003) discusses the responses of periphyton, benthic macroinvertebrates, and juvenile white sturgeon to experimental additions of nitrogen and phosphorous in the Kootenai River, Idaho.

Click Here

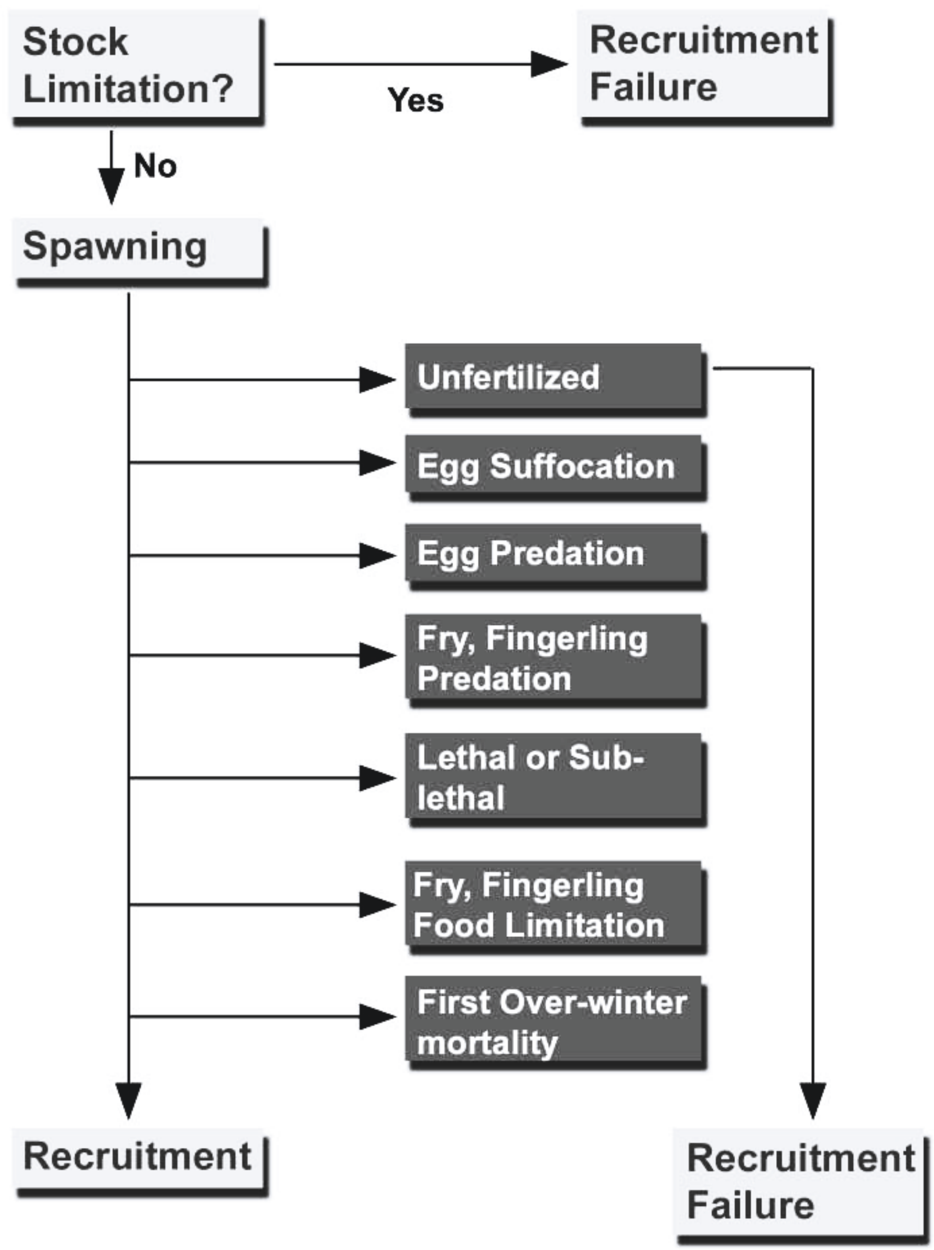

Figure 4.33. Hypothesized causes of natural recruitment failure in the Kootenai River white sturgeon population. Although post-spawning mortality factors (shaded boxes) operate in natural, unaltered ecosystems, post-development alterations in the Kootenai River may have increased their relative contributions to recruitment failure in this population. (See text for discussion of mortality mechanisms). Figure from Anders et al. 2002.

LINKS

The declining population of Kootenai River white sturgeon has prompted an assessment of the feasibility of various habitat enhancement scenarios to reestablish white sturgeon populations. For the first phase in this assessment, go to Appendix 95.

Click Here

rehabilitate riparian zones and provide high river flows during spawning to stimulate natural recruitment.

Additional empirical evidence for the use of riparian and side channel habitat for successful completion of early life stages was also recently reported from the lower Fraser River in British Columbia (Perrin et al. 2003). Six spawning sites were reported by the authors, five of which were in side channels. Multiple lines of evidence, including radio tracking of pre-spawning adults and visual observations, substantiated the use of side channels by white sturgeon for spawning. These observations are consistent with observations supporting the riparian habitat hypothesis (Coutant 2004).

LINKS

For T.J. Kock's MS thesis entitled: Effects of Sedimentation nnd WaterVelocity on White Sturgeon Embryo Survival, go to Appendix 119:

Click Here

Eggs

Based on empirical evidence, egg suffocation and predation were suspected egg mortality factors for Kootenai River white sturgeon (Paragamian et al. 2001, 2002). Paragamian and Kruse (1999) experimented with egg sampling mats by placing drift nets on seven experimental mats. Of 484 eggs collected in 1998, 91 were collected by the experimental mats, of which 81 were on the mat and 10 were mixed with sand in the drift nets. Over 96 percent (428 of 444) of the naturally produced white sturgeon eggs collected from the Kootenai River between 1991 and 1995 were collected from habitat that appeared to be suboptimal for incubation (Paragamian et al. 2001, 2002). River velocity and substrate characteristics of documented white sturgeon egg collection areas (near assumed spawning habitat) in the Kootenai River were atypical of white sturgeon spawning habitat in other parts of the Columbia River Basin (Parsley et al. 1993; Hildebrand and McKenzie 1994; Paragamian et al. 2001, 2002). In the three farthest downstream Columbia River reservoirs, the free-flowing reach downstream from Columbia River dams in the U.S., and the Columbia River in B.C., white sturgeon spawned in higher water-velocity areas with substrate particle size larger than those observed in the Kootenai River (table 4.64). These differences in spawning habitat use by Kootenai River and Columbia River white sturgeon may have contributed to recruitment failure. White sturgeon also spawned in considerably colder water in the Kootenai River than in all lower and upper Columbia River locations (table 4.64). Spawning in colder water would subject white sturgeon eggs in the Kootenai River to a longer incubation period. Longer incubation periods could result in increased egg mortality by increasing the duration of exposure to predation and suffocation.

Additionally, white sturgeon spawning and incubation microhabitat characteristics may have limited or prohibited successful incubation and hatching of white sturgeon eggs in the Kootenai River. Egg incubation and collection areas in the Kootenai River lacked interstitial space (Paragamian et al. 2001,

Table 4.64. Physical habitat conditions at sites where white sturgeon (Acipenser transmontanus) eggs were collected in the Columbia River in the United States and Canada, and from the Kootenai River in the United States. (From Anders et al. 2002 b).

Location	Years	Water Temp (°C)	Mean water column velocity (m/s)	Velocity near substrate	Substrate type	References
Lower Columbia River	1987-1991	18-Oct	1.0-2.8	0.06-2.4	Boulder	Parsley et al. 1993
Columbia River Impoundments	1987-1991	18-Dec	0.81-2.10	0.52-1.62	Cobble	Parsley et al. 1993
Kootenai River	1994	7.8-11.2	0.03-0.27	-	Fine sediment and sand	Anders 1994
	1995	8.4-12.9	0.68	0.93	Fine sediment and sand	Anders and Westerhof 1996
	1991-1998	8.5-12.0	0.19-0.83	-	Fine sediment and sand	Paragamian et al. 2001
Columbia River, BC.	1993	15.5-17.0	-	-	Clean small boulder, large cobble	Hildebrand and McKenzie 1994
	1995	15.5-21.6	0.5-1.8	-	Bedrock, boulder, cobble	RL&L 1996
Fraser River, BC	1998	15.1	-	-	Bedrock	RL &L 1998; Perrin et al. 1999
Sacramento River, CA.	1970	14-22	-	-	Gravel	Stevens and Miller 1970
	1973	-	-	-	Mud and sand	Kohlhorst 1976

2002; USFWS 1999). These habitats occurred predominantly in the historical alluvial floodplain, currently characterized by low gradient, low water velocity, and the deposition of fine sands, silts, and sediments (Anders and Richards 1996).

Spawning location of Kootenai River white sturgeon appears to be a contradiction to white sturgeon life history (Paragamian et al. 2001, 2002). The depositional characteristics of white sturgeon egg incubation habitats are relevant to egg survival in the Kootenai River due to the eggs' demersal and adhesive qualities. An adhesive jelly layer surrounds white sturgeon eggs throughout early development. The adhesiveness of the jelly layer is important for anchoring eggs to the substrate at the vegetal pole during natural spawning (Conte et al. 1988). Attachment to the substrate in this fashion orients the micropyle upward prior to fertilization. Contact with freshwater causes the jelly layer to hydrate and the egg becomes adhesive within 5 minutes (Conte et al. 1988). The observation that no confirmed viable white sturgeon eggs collected from the Kootenai River from 1991 through 1995 had developed beyond approximately 60 hours after estimated spawning and fertilization suggested that egg suffocation might have been a substantial early life mortality factor for this population. However, during 1996, many of the naturally spawned eggs collected were within a day of hatching (V. Paragamian, IDFG, pers. comm.).

During 1994 and 1995, 632 stomach content samples from predatory fishes collected from the Kootenai River (northern pikeminnow (formerly northern squawfish), (*Ptychocheilus oregonensis*), peamouth chub, (*Mylocheilus caurinus*), and suckers (*Catotomus* spp.) were analyzed (Anders 1994, 1996). Of 428 naturally spawned white sturgeon eggs collected from the Kootenai River during 1994 and 1995, 12.2 percent (52) were recovered from stomach content samples of these predatory fishes (Anders 1994, 1996). Although observed predation accounted for only 12 percent of all eggs collected during these 2 years, identification of ingested eggs in stomach content samples was likely for a presumably short period of time. Thus, documented consumption of white sturgeon eggs likely represented an extremely conservative estimate of predation.

Miller and Beckman (1996) reported the occurrence of 1 to 70 white sturgeon eggs in guts of four omnivorous fish species in the Columbia River (northern pikeminnow, largescale sucker *(Catostomus macrocheilus)*, prickly sculpin *(Cottus asper)*, and common carp, *(Cyprinus carpio)*)). Empirical confirmation of one largescale sucker in the Columbia River consuming 70 white sturgeon eggs (Miller and Beckman 1996) suggested that predation may account for considerable egg mortality in the Columbia River. Given the inefficiency of collecting consumed white sturgeon eggs from stomach content samples, and the presence of these predatory species, predation may have been an important, underestimated mortality factor for white sturgeon eggs in the Kootenai River. Furthermore, this predation scenario may have been exacerbated by reduced predator search times and volumes due to reduced river discharge (volume) during white sturgeon spawning and incubation seasons in the post-impoundment Kootenai River, relative to pre-impoundment water volumes (Risk-Ratio hypothesis; Korman and Walters 1999). In addition, reduced turbidity in the post-impoundment system may have also increased efficiency of visual predation (Korman and Walters 1999). However, predation is a natural phenomenon and there is very little empirical data for the Kootenai River to substantiate predation as the leading mortality factor.

Larvae

If naturally spawned and fertilized eggs hatched in the post-development Kootenai River, mortality of larval white sturgeon may have occurred due to post-impoundment rearing habitat losses or degradation, suffocation, predation, sublethal exposure to contaminants, or larval starvation (figure 4.33, shaded boxes). Over a 5-year period (1991-1995), no larval white sturgeon were collected from the Kootenai River (USFWS 1999; Paragamian et al. 2001, 2002) despite extensive sampling with gear and techniques proven to efficiently capture larval white sturgeon in other river systems (Palmer et al. 1988; Parsley et al. 1993; Anders and Beckman 1993; McCabe and Tracy 1993). No white sturgeon larvae were subsequently collected from the Kootenai River from 1995 through 1998 (USFWS 1999). Only one larval white sturgeon has been caught to date. However, the same gear has been used to successfully recapture hatchery reared larval white sturgeon shortly after their release (Paragamian et al. 2003).

Brannon et al. (1985) conducted laboratory studies to characterize distribution behaviors of Columbia River white sturgeon larvae and fry. These authors concluded that "substrate composition in a river may influence both the emergence and settling response of white sturgeon larvae and could affect whether they remain in an area once they become bottom oriented. Upon hatching, larvae enter the water column and are subject to the influences of current. Larvae then seek the substrate for places that provide cover. Larvae remained in the substrate until the yolk is absorbed and feeding initiated. Larvae were noted to enter just about every conceivable space where they could hide their head. Beneath rocks, gravel interstices, amongst plants, and under detrital material were the places harboring the larvae during the "hiding" phase".

Larval white sturgeon were observed in aquaria to burrow into fine sediments, resulting in mortality by suffocation in some observed cases (E. Brannon, University of Idaho, pers. comm.). Based on habitat sampling and underwater observation, larval rearing habitat in the post-impoundment Kootenai River was characterized by deposition of fine sediments and appeared devoid of interstitial space. If undetected white sturgeon larvae were produced in the Kootenai River, and if laboratory results (Brannon et al. 1985) represent behaviors of larval white sturgeon in the wild, altered larval habitat, predation, or suffocation may have contributed to larval mortality factor in the post-development Kootenai River.

Effects of water- or sediment-borne contaminants have been reported as potential limiting factors for various life stages of Kootenai River white sturgeon

(Apperson and Anders 1991; Kruse and Scarnecchia 2002). However, despite the fact that increased sensitivity to contamination may occur with the earliest life stages, little conclusive empirical evidence suggests this to be a significant factor in the Kootenai River. Kruse and Scarnecchia (2002) reported significant effects of copper and Aroclor exposure on Kootenai River egg mortality in laboratory experiments, however, extrapolation of these findings to the Kootenai River ecosystem remains tenuous. These authors also reported from laboratory studies that contact with Kootenai River sediments can potentially increase exposure of embryos to metals. Unfortunately, no definitive laboratory studies to date have established any threshold levels of contamination relative to empirical damage to any life stages of white sturgeon caused by exposure to contaminants.

Young-of-the-year

If young-of-the-year (YOY) white sturgeon were naturally produced in the Kootenai River, food limitation and subsequent first overwintering mortality may have contributed to recruitment failure at this life stage (figure 4.33). Scott and Crossman (1973) reported that age-0 white sturgeon diets consisted primarily of Chironomid larvae. Amphipods (*Corophium* spp.) accounted for 98 percent of diet items from 149 age-0 white sturgeon (20-267 mm TL) collected from Bonneville and The Dalles pools in the Columbia River from 1988 through 1991 (Sprague et al. 1993). Wydowski and Whitney (1979) reported that the stomachs of small white sturgeon in California contained primarily *Mysis* shrimp (M. relicta) and amphipods. Age-0 lake sturgeon (*Acipenser fulvescens*) in the Lake Winnebago system in Wisconsin were observed in close contact with the substrate, oriented upstream, apparently feeding on drifting benthic organisms (Kempinger 1996). Kempinger (1996) also reported that species of Baetidae nymphs and dipteran larvae were the two principal organisms consumed by lake sturgeon during their first summer of life. No YOY white sturgeon have been collected from the Kootenai River to infer food limitation from gut content analyses. However, low zooplankton (mean < 0.1/L, Paragamian 1994) and low invertebrate densities (Hopkins and Lester 1995) could suggest the possibility of YOY food limitation.

No diet analyses have been reported for YOY white sturgeon in the Kootenai River. The Kootenai River supported low to moderate macroinvertebrate densities (overall mean density of benthic macroinvertebrates was 344.4/m^2, Hopkins and Lester 1995), consistent with reported low nutrient levels (Snyder and Minshall 1996). Hopkins and Lester (1995) also reported that invertebrate densities in Lower Granite Reservoir of the Snake River, Idaho, which has a naturally spawning and recruiting white sturgeon population, averaged 940.5/m^2, nearly threefold greater than in the Kootenai River. Because individual female white sturgeon may be very fecund (at Columbia basin latitudes hundreds of thousands of eggs per fish), consistently failing recruitment during the past few decades suggests considerable system alteration to explain this natural recruitment failure.

Energy requirements and food availability requirements for first overwinter survival of YOY white sturgeon in the Kootenai River are currently unknown. However, cultural denutrification, low density and diversity of invertebrate food items, and possible deficits in first overwintering energy budgets for YOY white sturgeon could contribute to natural recruitment failure or limitation in the Kootenai River.

Human Impacts

The Kootenai River system has been subjected to many human influences over the course of the past 100 years or more (Northcote 1973). A comprehensive account of anthropogenic changes and resulting ecological responses in the Kootenai Basin is provided by Anders et al. (2002), Paragamian (2002), and other authors. By the mid-1960s, phosphorus concentrations increased 15-fold, and nitrogen doubled from baseline conditions in the Kootenai River due to municipal and industrial development. Pollution abatement beginning in the late 1960s, and subsequent impoundment of the Kootenai River (Libby Dam, 1972) reversed this culturally eutrophic condition. By the mid-1990s the Kootenai River was classified as ultraoligotrophic, as it remains today. Reverberating trophic responses to cultural denutrification were temporally correlated with the collapse of the functional Kootenai River Subbasin downstream from Libby Dam.

The pre-impoundment Kootenai River hydrograph was characterized by annual average discharge peaks of approximately 60,000 cfs, during the natural high-runoff period in spring and early summer, with highest discharge during the period of record reaching 160,000 cfs (Scott Bettin, Bonneville Power Administration, pers. comm.). Post-impoundment river discharge (1973-1989) rarely exceeded 20,000 m^3/sec. Post-impoundment river discharge during the spring and early summer has been reduced by as much as 67 percent, and has increased during the winter by as much as 300 percent relative to pre-impoundment conditions (Partridge 1983). The pre-development Kootenai River ecosystem included a naturally functional floodplain over 5 km wide along the 128 km of the river immediately upstream from Kootenay Lake. Diking of this section of the river eliminated thousands of hectares of natural floodplain, and the associated productivity, diversity of habitats, and ecosystem functions (Duke et al. 1999; Anders et al. 2002).

LINKS

For an assessment of Kootenai River dike vegetation, go to Appendix 102.

Click Here

LINKS

A brief summary of white sturgeon contaminant studies can be found in Appendix 101.

Click Here

Post-impoundment winter water temperatures in the Kootenai River downstream from Libby Dam averaged 3 °C warmer than pre-impoundment values (Partridge 1983). Summer water temperatures in the same river reaches during the same years were consistently lower than pre-impoundment values, due to hypolimnetic withdrawal from Libby Dam (Partridge 1983; Snyder and Minshall 1994). Libby Dam and the impounded Koocanusa Reservoir reduced downstream transport of phosphorous and nitrogen by as much as 63 percent and 25 percent respectively (Woods 1982), with sediment trapping efficiencies exceeding 95 percent (Snyder and Minshall 1996).

Diking and channelization altered channel bed conditions by trapping sediments previously deposited over the historic floodplain during periods of high river discharge. Like other large river-floodplain ecosystems, the Kootenai River was historically characterized by seasonal flooding that promoted the exchange of nutrients and organisms among a mosaic of habitats, reported to enhance biological productivity and habitat diversity (Junk et al. 1989; Bayley 1995).

Agricultural activities (farming, channelization, and diking) have restricted the Kootenai River's natural floodplain from Kootenay Lake upstream to Bonners Ferry, Idaho. Forest developments have affected a significant area of the drainage. A fertilizer plant on the St. Mary River near Kimberley, B.C. polluted the river and lake. The Cora Linn Dam on the Kootenay River downstream from Nelson, the Duncan Dam at the north end of Kootenay Lake, and the Libby Dam upstream from Kootenai Falls have all dramatically affected movement of water through the system. In addition to these major perturbations, numerous but smaller impacts have also shaped the present integrity of the Kootenai River ecosystem (e.g., road construction, urbanization, and introduction of non-native fish and invertebrates).

Impoundment of rivers represents a cataclysmic event for large river-floodplain ecosystems (Ligon 1985). By altering water, sediment, and nutrient flow dynamics, dams interrupt and alter a river's important ecological processes in aquatic, riparian, and surrounding terrestrial environments. These environments, their life-supporting ecological functions, and the persistence of their floral and faunal communities are inexorably linked. Alteration of any component of such highly integrated natural systems generally results in cascading trophic effects throughout the ecosystem. Thus, major system perturbations, such as impounding large rivers, create a myriad of ecological dysfunction, reflected at all trophic levels on an ecosystem scale. The importance of nutrient and energy dynamics during natural pulses of water discharge in rivers has been extensively described in terms of river ecology (e.g., flood pulse, river continuum, nutrient spiraling, and serial discontinuity concepts).

The Kootenai River also has indications of contamination by PCBs, organochlorine pesticides, dioxins, and certain metals. Georgi (1993) noted that the chronic effects on wild sturgeon spawning in "chemically polluted" water and rearing over contaminated sediments, in combination with bioaccumulation of contaminants in the food chain, could possibly be reducing the successful reproduction and early-age recruitment to the Kootenai River white sturgeon population. Contaminants that are bioaccumulated and passed to progeny through ova or sperm can impact viability, survival, and development of naturally spawned sturgeon eggs (Adams 1990; Heath 1995). Recent research indicates that Kootenai River water concentrations of total iron, zinc, manganese, and the PCB Arochlor 1260 exceeded suggested environmental background levels (Kruse and Scarnecchia 2001a; Kruse and Scarnecchia 2001b). Zinc and PCB levels exceeded EPA freshwater quality criteria. Several metals, organochlorinepesticides, and the PCB Arochlor 1260 were found above laboratory detection limits in ova from adult female white sturgeon in the Kootenai River. Plasma steroid levels in adult female sturgeon showed a significant positive correlation with ovarian tissue concentrations of the PCB Arochlor 1260, zinc, DDT, and all organochlorine compounds combined, suggesting potential disruption of reproductive processes. In an experiment designed to assess the effects of aquatic contaminants on sturgeon embryos, results suggest that contact with river-bottom sediment increases the exposure of incubating embryos to metal and organochlorine compounds. Increased exposure to copper and Arochlor 1260 significantly decreased survival and incubation time of white sturgeon embryos and could be a potentially significant additional stressor to the white sturgeon population.

Although pollution abatement has taken place at several sources throughout the basin, the effects on sturgeon may be long term. Pollution effects are usually compounded generationally and often require generations before they dissipate.

Depressed biological productivity, alteration of spawning and rearing habitats, fish species abundance changes, altered predator-prey dynamics, and consistent white sturgeon recruitment failure constituted biological and ecological responses to Kootenai River Basin development (Ashley et al. 1999; Marcuson 1994; Paragamian 1994; Snyder and Minshall 1994, 1995, 1996; Anders and Richards 1996; Duke et al. 1999; USFWS 1999). Closures of the recreational kokanee (*Oncorhynchus nerka*), burbot (*Lota lota*), and white sturgeon harvest fisheries in Idaho and B.C. since the mid-1980s were fisheries management responses to ecological perturbations and possible past overharvest (Anders et al. 2002).

LINKS

For the USGS report summarizing lower Kootenai River channel conditions and changes in suspended-sediment transport and geometery in white sturgeon habitat, go to: http://id.water.usgs.gov/PDF/wri034324/index.html

Click Here

For the USGS surveys of lower Kootenai River cross sections, go to: http://id.water.usgs.gov/PDF/ofr041045/index.html

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4.7 Target Species

The Kootenai Subbasin 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 364 terrestrial vertebrate species[1] occur in the subbasin (IBIS 2003). (Appendix 79 gives the predicted distributions of terrestrial vertebrate species in Montana and Idaho 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 Kootenai, 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 4.65). These target species were selected because they:

1. Have been designated as a Federal endangered or threatened species or have been otherwise designated a priority species for conservation action,

2. Play an important ecological role in the subbasin such as a functional specialist or a critical functional link species,

3. Possess economic or cultural significance to the people of the Kootenai 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 the 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 94. Most of the links summarize what is known about the species across its entire range or at least its range in Idaho and Montana. For most target species detailed, subbasin-scale information simply does not exist.

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 79 gives the predicted distributions of terrestrial vertebrate species in Montana and Idaho in acres and by percent distribution by land stewardship.

Click Here

[1] *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.*

Table 4.65. Terrestrial target species.

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

[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 49 for a list of key ecological functions.

Click Here

While Appendix 94 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 80. 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). 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.

4.7.1 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 4.66 lists the impacts in each of those categories that biologists identified most often in the regulated mainstem and across the rest of the subunits. Because of the nature of the assessment, certain impacts—chiefly impoundments and reductions in nutrients/productivity—are under-represented in the riparian and wetland biomes with respect to the degree that they are currently inhibiting populations of target species and ecological processes and functions. These "under-represented impacts" are shown in column 5 of Table 4.66.

LINKS

Appendix 94 provides more information and links for each of target species.

Click Here

For the results of the Terrestrial Biome Assessment (TBA), go to Appendix 80.

Click Here

Table 4.66. 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)	Major Impacts Under-Represented in this Analysis
Regulated Mainstem				
Riparian	Altered Hydrograph (6)	Diking (2)		
Wetland	Altered Hydrograph (5)	Diking (2)		
Rest of the Subbasin				
Mesic Forest	Forest Management (23) Fire Exclusion and Forest Management (4)	Non-native Species (7) Insects and Disease (4)	Fire Exclusion (6) Roads (4)	
Grassland	Forest Encroachment (27) Fire Exclusion (4) Land Conversion (4)	Overgrazing (10) Human Development (7)	Non-native Species (8)	
Riparian	Forest Management (9) Land Conversion (8)	Forest Management (7) Non-native Species (5)	Human/wildlife Conflicts (6) Land Conversion (3)	Impoundment Reductions in Nutrients/Productivity
Wetland	Roads (9) Land Conversion (5) Overgrazing (4)	Land Conversion (10)	Forest Management (8)	Impoundment Reductions in Nutrients/Productivity
Xeric Forest	Fire Exclusion (9) Forest Management (5)	Non-native Species (8)	Fire Exclusion (4) Forest Management (4)	

[1] Roads and associated logging practices in watersheds can affect the hydrography and ecology of wetlands even though those impacts do not occur directly in wetlands (Jones and Hendricks 2000). See Appendix 37.

Forest management impacts in the context of TBA 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, the level of habitat fragmentation, and hydrologic processes. Changes to any one of these parameters may have negative or postive affects, depending on the wildlife species at issue.

5 HUC/Unit Classification

5.1 Aquatic Systems

5.1.1 Methods

To help us classify 6th field 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 Kootenai and Flathead 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 our case 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 (table 5.1) within the subbasin (lakes that the Technical Team could foresee doing BPA-related management actions on in 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.

LINKS

For a more detailed description of QHA and how it works, go to Appendix 85.

Click Here

QHA habitat attribute scores are in Appendices 32 and 33.

Click Here

Appendix 7 is an electronic map of the HUCs used in QHA.

Click Here

Table 5.1. Lakes assessed in the Kootenai Subbasin using the Lacustrine QHA (LQHA) spreadsheet tool.

Lake	Location
Kootenay Lake	Canada
Moyie Lakes	Canada
Duncan Lake	Canada
Trout Lake	Canada
Koocanusa Reservoir	U.S./Canada
Kilbrennan	U.S.
Loon Lake	U.S.
Bull Lake	U.S.
Sophie Lake	U.S.
Boulder Lake	U.S.
Granite Lake	U.S.
Leigh Lake	U.S.
Therriault Lake	U.S.
McArthur Lake	U.S.

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 and judgement 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 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 substantially 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 Kootenai Subbasin held a four-day meeting in Whitefish, Montana to conduct our HUC6-by-HUC6 aquatic assessment using QHA. Fisheries biologists, hydrologists, data managers and GIS professionals from Kootenai Tribe of Idaho, Montana Fish, Wildlife & Parks, Idaho Fish and Game, US Army Corps of Engineers, US Fish and Wildlife Service, the Kootenai National Forest, the Idaho Panhandle National Forests, Idaho Department of Environmental Quality, the B.C. Ministry of Sustainable Resource Management, the B.C. Ministry of Water, Land, and Air Protection, and a private consulting firm evaluated habitat parameters (tables 4.12 and 4.13) on all the sixth code HUCs in the Kootenai Subbasin, including those within the Canadian portion[1]. Later, other non-habitat modifiers—genetic purity, presence of nonnatives, pathogens—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 from *Upstream* (National Research Council

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[1] *In the U.S. portion of the subbasin, some valley HUCs were lumped. In the Canadian portions of the subbasin, time limitations prevented the use of 6th-code HUCs. Instead, the Canadian members of the team used analogous watershed units developed during a previous watershed restoration planning exercise in B.C.*

Table 5.2 Protection/restoration aquatic classification system used to classify streams in the Kootenai Subbasin (adapted from the system 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 Kootenai Subbasin (adapted Upstream by the 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.

1996) (tables 5.2 and 5.3). The technical team then reviewed the resulting classification using professional knowledge and judgment 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 (the expert system) and expert opinion gave us our final stream and lake classification.

An important advantage 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 habitat cannot be improved much, and limited at the high-impact

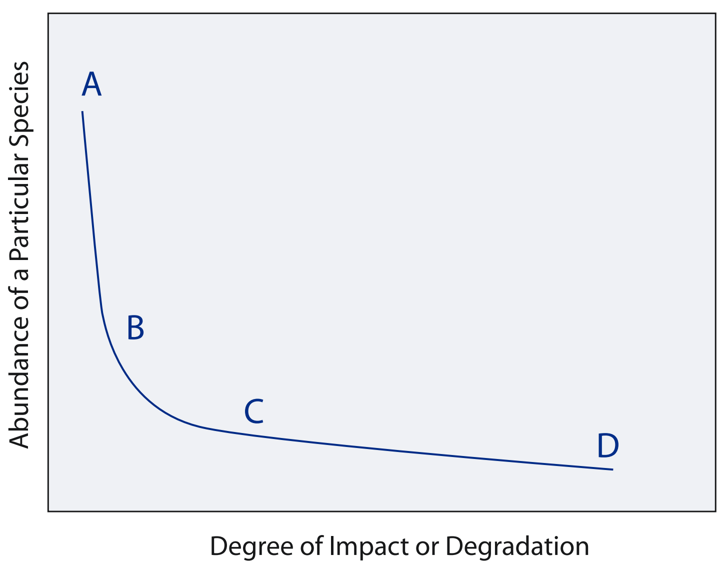

Figure 5.1. Relationship between degree of degradation and productivity.

end by intractable ecological complications and irreversible constraints (such as introduced species) that cap what can be regained through restoration action (Dr. Chris Frissell, pers. comm. 2003). In other words, going from D to B or A in figure 5.1, if it is 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 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). Within Class 2 waters, streams and lakes with ESA-listed species will have a higher priority for restoration than those without ESA-listed species. 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.

5.1.2 HUC Classifications

LINKS

For a 6th-field HUC interactive hydrologic map of the Kootenai Subbasin go to Appendix 7.

Click Here

Tables 5.5 to 5.22 list the Kootenai Subbasin HUC-6s in each of the five restoration/protection classes by salmonid focal species. Tables 5.23 to 5.26 list the selected lakes in each of the classes for the salmonid focal species. Tables 5.27 and 5.28 list the mainstem river reaches and selected lakes in each of the classes for burbot and white sturgeon. It should be noted that the Technical Team views this classification or ranking as dynamic, and if conditions change for any given HUC-6 in the future (for example, if a major forest fire should occur that changes aquatic habitat conditions), that HUC may be re-scored and reclassified. Also, the Technical Team only scored the lakes in the subbasin that they could foresee doing BPA-related mitigation activities on in the future. As additional information becomes available or as circumstances change, other lakes may be added to the various classes.

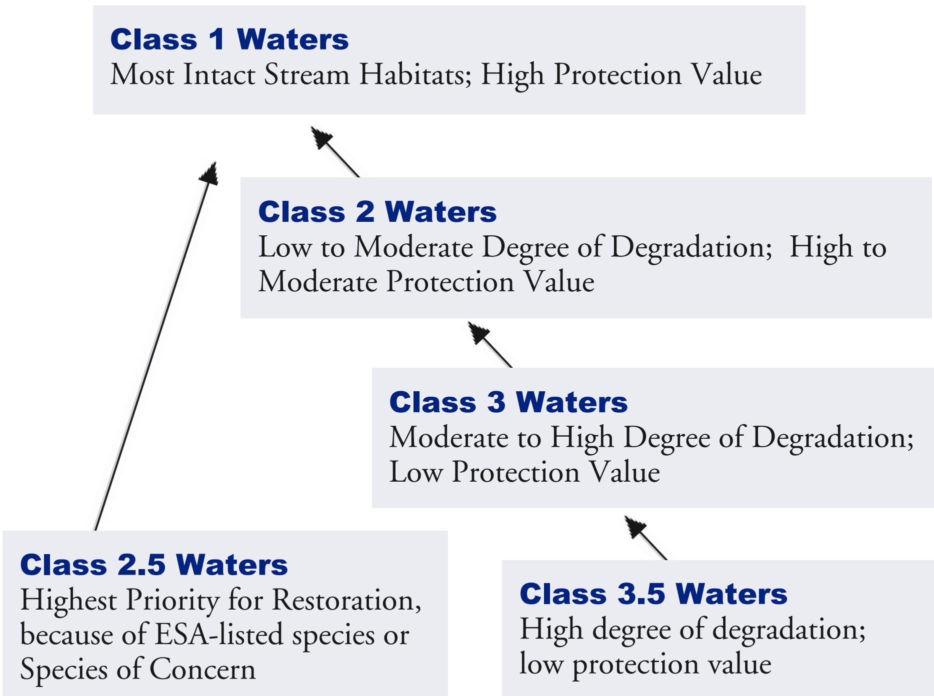

Figure 5.2. The desired path of reaches within each class with regard to restoration and protection. Class 3.5 waters have low protection value and a high degree of degradation, but with passive restoration and improved management, they may improve enough to become Class 3 waters.

Table 5.4. Class 1 waters for bull trout.

Class 1 Bull Trout Streams	
Upper Kootenai	
Kootenai River 1 / Koocanusa	Kootenai River 5
Kootenai River 2 / Koocanusa	Lake Koocanusa Valley
Kootenai River 3 / Koocanusa	Ross Creek
Kootenai River 4 / Koocanusa	
Lower Kootenai	
Long Canyon Creek	Trout Creek
Parker Creek	
Bull River	
Kikomun Creek	
Duncan Lake	
Cooper and Meadow Creeks	Lardeau Creek
East Creek	Mobbs and Tenderfoot Creeks
Glacier Creek	Poplar and Cascade Creeks
Hamill Creek	Rapid Creek
Healy Creek	Westfall River
Houston Creek	Wilkie Creek
Lake Creek	
Elk	
Brule Creek	Sparwood
Cummings Creek	Upper East Elk
Grave Greek	Upper West Elk
Lizard Creek	Wigwam River
Morrissey Creek	
Kootenay Lake	
Crawford and Gray Creeks	Kokanee and Redfish Creeks
Cultus and Next Creeks	Lasca and Five Mile Creeks
Fry Creek	Midge Creek
Grohman, Duhamel, Sitkum and Sproule Creeks	La France, Lockhart, Akokli and Sanca Creeks
Harrop Creek	Powder and Cambell Creek
Kaslo River	Summit and Corn Creeks
Kootenay River	
Elk Creek	Simpson River
Meadow Creek	Tokumm Creek
Ochre Creek	Upper Kootenay River
Slocan	
Bonanza Creek	Seaton and Carpenter Creeks
Hoder Creek	Wilson Creek
Koch Creek	
St. Mary	
Dewar Creek	Norbury Creek
Findlay Creek	Redding and Meachen Creeks

Table 5.5. Class 2 waters for bull trout.

Class 2 Bull Trout Streams	
Upper Kootenai	
Big Cherry Creek 1	Lake Creek 1
Big Creek	Lake Creek 2
Big Creek South Fork	Libby Creek 1
Big Creek South Fork East Branch	Libby Creek 2
Callahan Creek	North Callahan Creek
Fortine Creek 3	OBrien Creek
Granite Creek	Phillips Creek
Grave Creek 1	Pipe Creek
Grave Creek 2	Pipe Creek 1
Keeler Creek	Pipe Creek 2
Kootenai River 5 Valley	Quartz Creek
Kootenai River 6	South Callahan Creek
Kootenai River 7	Therriault Creek
Kootenai River 8	Wigwam River
Fisher	
Fisher River 1	Silver Butte Fisher River
Fisher River 2	West Fisher Creek
Fisher River 3	
Lower Kootenai	
Ball Creek	Grass Creek
Boulder Creek 2	Kootenai River 10
Boundary Creek	Kootenai River 9
Caribou Creek	Myrtle Creek
Cow Creek	Snow Creek
Fall Creek	
Moyie	
Deer Creek	Moyie Tributaries
Lower Moyie River Tributaries	Round Prairie
Moyie River Valley 1	Round Prairie Tributaries
Moyie River Valley 2	
Bull River	
Bull Below Dam	Phillipps Creek
Gold Creek	Sand Creek
Linklater Creek	
Elk	
Coal Creek	Michel Creek
Fording River	
Kootenay Lake	
Woodbury and Coffee Creeks	
Kootenay River	
Cochran Creek	
Slocan	
Silverton, Enterprise and Lemon Creeks	
St. Mary	
Hellroaring and Perry Creeks	Mather and Lost Dog Creeks
Joseph Creek	Matthew Creek
Lussier River	Wild Horse River

Table 5.6. Class 2.5 waters for bull trout.

Class 2.5 Bull Trout Streams	
Upper Kootenai	
Libby Creek 2 Valley	
Fisher	
Mainstem Fisher River Valley	
Lower Kootenai	
Blue Joe Creek	Kootenai River 10 Valley
Kootenai River 9 Valley	
Elk	
Wigwam River	
Kootenay Lake	
Moyie River	
Kootenay River	
Blackfoot, Thunder and East White	North White River
Middle Fork White River	
St. Mary	
Skookumchuck Creek	Upper St. Mary River

Table 5.7. Class 3 waters for bull trout.

Class 3 Bull Trout Streams	
Lower Kootenai	
Curley Creek	Twentymile Creek
Deep Creek 2	Deep Creek 3 Valley
Kootenay Lake	
Boundary Creek and Creston	Upper Moyie River and Lamb Creek

Table 5.8. Class 3.5 waters for bull trout.

Class 3.5 Bull Trout Streams	
Lower Kootenai	
Deep Creek 1	
Duncan Lake	
Lower Lardeau River	Upper Duncan River
Lower Trout	Upper Trout
Elk	
East Fernie	Hosmer East
East Fernie	Hosmer West
Grave Greek	West Fernie
Kootenay Lake	
West Moyie	
Kootenay River	
Daer Creek	Nine Mile Creek
Lower East White River	Nixon Creek
Lower West White River	West Upper Kootenay River
Mid Vermillion	
Slocan	
Slocan	Slocan River
St. Mary River	
East Canal Flats	Wasa
St. Mary River	West Canal Flats

Table 5.9. Class 1 waters for westslope cutthroat trout.

Class 1 Westslope Cutthroat Trout Streams	
Upper Kootenai	
Kootenai River 1 / Koocanusa	Kootenai River 4 / Koocanusa
Kootenai River 2 / Koocanusa	Kootenai River 5
Kootenai River 3 / Koocanusa	Ross Creek
Lower Kootenai	
Long Canyon Creek	Trout Creek
Parker Creek	
Moyie	
American Creek Headwaters	
Bull River	
Quinn Creek	Upper West Bull
Upper East Bull	
Elk	
Brule Creek	Lizard Creek
Cummings Creek	Mid East Elk
East Fernie	Upper East Elk
East Fernie	Upper West Elk
Grave Greek	West Fernie
Kootenay Lake	
Arrow/Duck	Moyie River
Kamma and Leadville Creeks	Sullivan Creek
Kianuka Creek	Sunrise and Sundown Creeks
Kid Creek	West Moyie
Kokanee and Redfish Creeks	Woodbury and Coffee Creeks
Lasca and Five Mile Creeks	
Kootenay River	
Daer Creek	North White River
Fenwick Creek	Ochre Creek
Lower West White River	Simpson River
Meadow Creek	Tokumm Creek
Mid Vermillion	Upper Kootenay River
Nixon Creek	Whiteswan
St. Mary	
Dewar Creek	St. Mary River
East Canal Flats	Upper St. Mary River
Skookumchuck Creek	West Canal Flats

Table 5.10. Class 2 waters for westslope cutthroat trout.

Class 2 Westslope Cutthroat Trout Streams	
Upper Kootenai	
Barron Creek	Kootenai River 8
Big Cherry Creek 1	Lake Creek 1
Big Creek	Lake Creek 2
Big Creek South Fork	Libby Creek 2
Big Creek South Fork East Branch	Libby Creek 2 Valley
Bobtail Creek	McGuire Creek
Boulder Creek	Meadow Creek
Bristow Creek	Middle Fork Parsnip Creek
Deep Creek	OBrien Creek
Dodge Creek	Paramenter Creek
Dunn Creek	Phillips Creek
Fivemile Creek	Pipe Creek
Flower Creek	Pipe Creek 1
Fortine Creek 1	Pipe Creek 2
Fortine Creek 2	Quartz Creek
Fortine Creek 3	Ruby Creek
Granite Creek	Sinclair Creek
Grave Creek 1	Star Creek
Grave Creek 2	Sullivan Creek
Indian Creek	Sutton Creek
Jackson Creek	Therriault Creek
Keeler Creek	Tobacco River
Kootenai River 5 Valley	Tobacco River Valley
Kootenai River 6	Wigwam River
Kootenai River 7	Young Creek
Fisher	
East Fisher Creek	McKillop Creek
Elk Creek	Silver Butte Fisher River
Fisher River 1	West Fisher Creek
Fisher River 2	Wolf Creek 1
Yaak	
Burnt Creek	Yaak River 3
Pete Creek	Yaak River 4
Seventeenmile Creek 1	Yaak River 5
Seventeenmile Creek 2	Yaak River East Fork
South Fork Yaak River	Yaak River Upper West Fork
Spread Creek	Yaak Rvr. 2 Valley
Yaak River 2	

Table 5.10 (cont.). Class 2 waters for westslope cutthroat trout.

Class 2 Westslope Cutthroat Trout Streams (cont.)	
Lower Kootenai	
Ball Creek	Fall Creek
Boulder Creek 1	Grass Creek
Boulder Creek 2	Kootenai River 10
Boundary Creek	Kootenai River 9
Caribou Creek	Mission Creek
Cow Creek	Smith Creek 1
Deep Creek 1	Smith Creek 2
Deep Creek 3	Snow Creek
Bull River	
Bull Below Dam	Mid Bull
Galbraith Creek	Phillipps Creek
Gold Creek	Plumbob and Chipka Creeks
Ha Ha Creek	Sulphur Creek
Kikomun Creek	West Bull (above dam)
Elk	
Hosmer East	Sparwood
Hosmer West	Wigwam River
Morrissey Creek	
Kootenay Lake	
Boundary Creek and Creston	Hawkins Creek
Goat River	
Kootenay River	
Albert River	Lower East White River
White	Middle Fork White River
Cross River	Nine Mile Creek
Elk Creek	Palliser River
Grave Greek	West Upper Kootenay River
St. Mary	
Findlay Creek	Norbury Creek
Mark Creek	Redding and Meachen Creeks
Mather and Lost Dog Creeks	Wasa
Matthew Creek	

Table 5.11. Class 2.5 waters for westslope cutthroat trout.

Class 2.5 Westslope Cutthroat Trout Streams	
Fisher	
Fisher River 3	Mainstem Fisher River Valley
Lower Kootenai	
Blue Joe Creek	Kootenai River 10 Valley
East Fork Boulder Creek	Myrtle Creek
Kootenai River 9 Valley	
Moyie	
Canuck Creek	Moyie River Valley 2
Deer Creek	Moyie Tributaries
Lower Moyie River Tributaries	Round Prairie Tributaries
Moyie River Valley 1	

Table 5.12. Class 3 waters for westslope cutthroat trout.

Class 3 Westslope Cutthroat Trout Streams	
Upper Kootenai	
Canyon Creek	Rainy Creek
Cripple Horse Creek	Swamp Creek
Edna Creek	Warland Creek
Fisher	
Bear Springs Creek	MCGinnis Creek
Lower Kootenai	
Curley Creek	Deep Creek 3 Valley
Deep Creek 2	Twentymile Creek
Bull River	
Englishman Creek	Linklater Creek
Iron Creek	Sand Creek
Elk	
Coal Creek	Lower Elk
Fording River	Michel Creek
Kootenay Lake	
Creek	Yahk and Gilnockie
Kootenay River	
Cochran Creek	
St. Mary River	
Hellroaring and Perry Creeks	Lussier River
Joseph Creek	Wild Horse River

Table 5.13. Class 3.5 waters for westslope cutthroat trout.

Class 3.5 Westslope Cutthroat Trout Streams	
Upper Kootenai	
Pinkham Creek 2	Tenmile Creek
Fisher	
Cow Creek	
Yaak	
Pine Creek	
Moyie	
Round Prairie	

Table 5.14. Class 1 waters for Columbia River redband trout.

Class 1 Redband Trout Streams	
Lower Kootenai	
Long Canyon Creek	Trout Creek
Parker Creek	
Duncan Lake	
Asher Creek	Lower Lardeau River
Cooper and Meadow Creeks	Lower Trout
Duncan Lake Tribs.	Mobbs and Tenderfoot Creeks
East Creek	Poplar and Cascade Creeks
Ferguson Creek	Rapid Creek
Glacier Creek	Stevens and Hall Creeks
Hamill Creek	Upper Duncan River
Healy Creek	Upper Trout
Houston Creek	Westfall River
Howser Creek	Wilkie Creek
Lardeau Creek	
Kootenay Lake	
Arrow/Duck	Moyie River
Cultus and Next Creeks	North Kootenay Lake
Fletcher and Bjerkness Creeks	Powder and Cambell Creek
Fry Creek	South Arm Kootenay Lake
Grohman, Duhamel, Sitkum and Sproule Creeks	La France, Lockhart, Akokli and Sanca Creeks
Harrop Creek	Sullivan Creek
Kokanee and Redfish Creeks	Summit and Corn Creeks
Lasca and Five Mile Creeks	Upper Moyie River and Lamb Creek
Midge Creek	West Moyie
Kootenay River	
Fenwick Creek	Palliser River
Middle Fork White River	West Upper Kootenay River
Slocan	
Bonanza Creek	Seaton and Carpenter Creeks
Hoder Creek	Slocan
Koch Creek	Winlaw Creek
Nemo, Beatrice, Evans and Gwillim Creeks	

Table 5.15. Class 2 waters for Columbia River redband trout.

Class 2 Redband Trout Streams	
Upper Kootenai	
Big Cherry Creek 1	Kootenai River 8
Callahan Creek	Libby Creek 2
Granite Creek	Libby Creek 2 Valley
Kootenai River 5 Valley	North Callahan Creek
Kootenai River 6	South Callahan Creek
Kootenai River 7	
Fisher	
Bear Springs Creek	Pleasant Valley Creek
Cow Creek	Pleasant Valley Fisher River
East Fisher Creek	Pleasant Valley Fisher River 1
Elk Creek	Pleasant Valley Fisher River 2
Fisher River 1	Silver Butte Fisher River
Fisher River 2	West Fisher Creek
Fisher River 2 Valley	Wolf Creek 1
Island Creek	Wolf Creek 2
Little Wolf Creek	Wolf Creek 2 Valley
MCGinnis Creek	Wolf Creek 3
McKillop Creek	
Yaak	
Basin Creek	Yaak River 2
Hellroaring Creek	Yaak River 3
Pete Creek	Yaak River 4
Seventeenmile Creek 2	Yaak River 5
Spread Creek	Yaak River East Fork
Yaak River 1	Yaak Rvr. 2 Valley
Lower Kootenai	
Boulder Creek 1	Fall Creek
Boulder Creek 2	Grass Creek
Boundary Creek	Kootenai River 10
Deep Creek 1	Kootenai River 10 Valley
Deep Creek 2	Kootenai River 9 Valley
Deep Creek 3 Valley	Kootenai River 9
Deep Creek 3	Twentymile Creek
East Fork Boulder Creek	
Kootenay Lake	
Boundary Creek and Creston	Kaslo River
Cottonwood Creek	Lower West Arm below Brilliant Dam
Crawford and Gray Creeks	Woodbury and Coffee Creeks
Slocan	
Goose Creek	Slocan River
Silverton, Enterprise and Lemon Creeks	Wilson Creek

Table 5.16. Class 2.5 waters for Columbia River redband trout.

Class 2.5 RedbandTrout Streams	
Fisher	
Fisher River 3	Pleasant Valley / Fisher River
Mainstem Fisher River Valley	Weigel Creek
Lower Kootenai	
Ball Creek	Twentymile Creek
Blue Joe Creek	

Table 5.17. Class 3 waters for Columbia River redband trout.

Class 3 Redband Trout Streams
None

Table 5.18. Class 3.5 waters for Columbia River redband trout.

Class 3.5 Redband Trout Streams
Yaak
Pine Creek

Table 5.19. Class 1 waters for kokanee.

Class 1 Kokanee Streams	
Duncan Lake	
Cooper and Meadow Creeks	Lower Lardeau River
Glacier Creek	Rapid Creek
Healy Creek	Upper Duncan River
Lake Creek	Wilkie Creek
Kootenay Lake	
Fletcher and Bjerkness Creeks	Midge Creek
Fry Creek	North Kootenay Lake
Sproule Creeks	Sanca Creeks
Kokanee and Redfish Creeks	Powder and Cambell Creek
Lasca and Five Mile Creeks	South Arm Kootenay Lake

Table 5.20. Class 2 waters for kokanee.

Class 2 Kokanee Streams	
Lower Kootenai	
Boulder Creek 2	
Moyie	
Moyie River Valley 2	
Duncan Lake	
Lardeau Creek	Mobbs and Tenderfoot Creeks
Lower Trout	Poplar and Cascade Creeks
Kootenay Lake	
Crawford and Gray Creeks	Kaslo River
Harrop Creek	Woodbury and Coffee Creeks

Table 5.21. Class 2.5 waters for kokanee.

Class 2.5 Kokanee Streams	
Lower Kootenai	
Kootenai River 9	Kootenai River 10
Kootenai River 9 Valley	Kootenai River 10 Valley

Table 5.22. Class 3 waters for kokanee.

Class 3 Kokanee Streams	
Lower Kootenai	
Deep Creek 3 Valley	
Kootenay Lake	
Arrow/Duck	Cultus and Next Creeks
Boundary Creek and Creston	Summit and Corn Creeks
Cottonwood Creek	

Table 5.23. Bull trout classification for lakes.

Class 1 Bull Trout Lakes	
Trout Lake	Moyie Lakes
Class 2 Bull Trout Lakes	
Bull Lake	Koocanusa Reservoir
Kootenay Lake	Duncan
Class 2.5 Bull Trout Lakes	
Sophie Lake	

Table 5.24. Westslope cutthroat trout classification for lakes.

Class 2 Westslope Cutthroat Trout Lakes	
Bull Lake	Leigh Lake
Boulder Lake	Moyie Lakes
Granite Lake	Therriault Lake
Koocanusa Reservoir	
Class 3 Westslope Cutthroat Trout Lakes	
Sophie Lake	
Class 3.5 Westslope Cutthroat Trout Lakes	
Loon	

Table 5.25. Columbia River redband trout classification for lakes.

Class 1 Redband Trout Lakes	
Trout Lake	
Class 2 Redband Trout Lakes	
Kootenay Lake	Duncan
Class 3 Redband Trout Lakes	
McArther	
Class 3.5 Redband Trout Lakes	
Kilbrennan	Loon

Table 5.26. Kokanee classification for lakes.

Class 1 Kokanee Lakes: Protection Priorities	
Trout Lake	
Class 2 Kokanee Lakes: Restoration Priorities	
Kootenay Lake	Duncan

Table 5.27. Burbot classification for streams and lakes.

Class 2 Burbot River Reaches	
Canyon (Idaho, MT Upstream to Kootenai Falls) & tributaries up to first barrier	Straight Reach (Highway 95 Bridge to Deep Creek) & tributaries up to first barrier
Meander Reach (Deep Creek to Kootenay Lake) & Tribs up to first barrier	
Class 1 Burbot Lakes	
Trout Lake	
Class 2 Burbot Lakes	
Duncan Lake	Koocanusa Reservoir
Kootenay Lake	

Table 5.28. White Sturgeon classification for streams and lakes.

Class 2.5 White Sturgeon River Reaches	
Braided Reach (Moyie River to Highway 95 Bridge)	Meander Reach (Deep Creek to Kootenay Lake)
Canyon (Idaho, MT Upstream to Kootenai Falls)	Straight Reach (Highway 95 Bridge to Deep Creek)
Class 2 White Sturgeon Lakes	
Duncan Lake	Kootenay Lake

5.2 Terrestrial Systems

5.2.1 Methods

To help us classify terrestrial subunits according to the degree to which each has been modified and each subunit's 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.

LINKS

For the results of the Terrestrial Biome Assessment (TBA), go to Appendix 80.

Click Here

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.

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 the degree of impact or percent of optimum (table 5.29).

5.2.2 Subunit Classifications

Tables 5.30 through 5.34 list the subunits in each of the three groups in the Kootenai Subbasin.

[2] *Technical Team members included wildlife biologists and GIS professionals from the states of Montana and Idaho, Forest Service, Canada, Kootenai Tribe of Idaho, Salish and Kootenai Tribes, and US Fish and Wildlife Service.*

Table 5.29. Protection/restoration classification of terrestrial biome subunits in the Kootenai 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 5.30. Riparian Biome subunit classification.

Riparian Biome		**Percent of Optimum**
Unit	**Subunit**	
Class 1: 60 to 85 Percent of Optimum		
UPELK-for	All Upper Elk River	**69%**
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness	**68%**
UPKOOT-np	All Upper Kootenai River-National Parks	**68%**
BULL-for	All Bull River	**66%**
KTLK-val	Other S half Kootenay Lk to US border	**66%**
KTLK-wild	All NE side of Kootenay Lk/Purcell Mtns	**65%**
Wigwam-for	All Wigwam Ck trib of Elk River	**64%**
WTRVR-for	All White River watershed-CFS	**62%**
KTLK-for	All NW side Kootenay Lk/Slocan	**62%**
Wigwam-bdr	All Wigwam Ck to CAN border	**62%**
YAAK-for	All riparian in Yaak River watershed	**61%**
MDLELK-for	All Middle Elk River	**61%**
MOYIE-bdr	All Upper Moyie River to US border	**61%**
Class 2: 40 to 60 Percent of Optimum		
YAHK-bdr	All Upper Yahk(Yaak) River to US border	**59%**
Bvrft-for	All Beaverfoot Range-CFS	**58%**
Fernie-val	All Fernie area on lower Elk River	**58%**
TP-for	All Teepee Ck watershed	**58%**
CABMTN-for	All riparian in Lake Ck watershed-USFS	**56%**
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS	**56%**
KTLKWA-for	All West Arm Kootenay Lk/Nelson	**56%**
Trench-val	All riparian St Marys Trench	**55%**
CABMTN-wild	All riparian in Libby Ck watershed-Wilderness	**54%**
MOYIE-for	All riparian in lower Moyie River watershed	**53%**
KTLK-val	CVWMA (Creston Valley Waterfowl Mgmt Area)	**51%**
KOCNUSA-for	All riparian West of Koocanusa Res.-USFS	**50%**
BNFRY-val	Deep Ck valley riparian wetlands	**48%**
UPFSHR-for	All Upper Fisher River/Paradise Valley	**45%**
TBCO-val	All Tobacco River watershed	**44%**
KOCNUSA-cval	All Canadian Koocanusa Res. unit	**42%**
BNFRY-val	Other riparian in Deep Ck/Bonners Ferry unit	**41%**
Class 2.5: Restoration Priority because of ESA Concerns		
LOKOOT-val	All Lower Kootenai River valley and bench	**28%**
Class 3: Less than 40 Percent of Optimum		
LOFSHR-for	All Lower Fisher River/Wolf Ck	**39%**
KOCNUSA-val	All Koocanusa Res. east	**32%**

Table 5.31. Wetland Biome subunit classification.

Wetland Biome Unit	Subunit	Percent of Optimum
Class 2: 40 to 60 Percent of Optimum		
Wigwam-bdr	All Wigwam Ck to CAN border	**59%**
CABMTN-for	Alpine wetlands in Lake Ck unit	**59%**
UPKOOT-np	All Upper Kootenai River-National Parks	**55%**
Bvrft-for	All Beaverfoot Range-CFS	**55%**
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness	**54%**
BULL-for	All Bull River	**54%**
MDLELK-for	All Middle Elk River	**54%**
UPELK-for	All Upper Elk River	**53%**
WTRVR-for	All White River watershed-CFS	**53%**
KTLK-for	All NW side Kootenay Lk/Slocan	**53%**
BNFRY-val	Curley Ck watershed forested wetlands	**52%**
KTLK-wild	All NE side of Kootenay Lk/Purcell Mtns	**52%**
Fernie-val	All Fernie area on lower Elk River	**51%**
YAHK-bdr	All Upper Yahk(Yaak) River to US border	**51%**
MOYIE-for	Round Prairie wetland complex	**51%**
Wigwam-for	All Wigwam Ck trib of Elk River	**51%**
MOYIE-for	Other wetlands in lower Moyie River watershed	**50%**
YAAK-for	All wetlands in Yaak River watershed	**50%**
Stmry-np	All wetlands St Marys Trench	**50%**
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS	**49%**
KTLK-val	Other S half Kootenay Lk to US border	**49%**
CABMTN-for	Other wetlands in Lake Creek watershed-USFS	**48%**
KTLKWA-for	All West Arm Kootenay Lk/Nelson	**47%**
TP-for	All Teepee Ck watershed	**47%**
CABMTN-wild	All wetlands in Libby Ck watershed-Wilderness	**47%**
KOCNUSA-cval	All Canadian Koocanusa Res. unit	**47%**
UPFSHR-for	All Upper Fisher River/Paradise Valley	**46%**
MOYIE-bdr	All Upper Moyie River to US border	**45%**
KOCNUSA-for	West of Koocanusa Res.-USFS	**45%**
KTLK-val	CVWMA (Creston Valley Waterfowl Mgmt Area??)	**45%**
BNFRY-val	Other wetlands in Deep Ck/Bonners Ferry unit	**42%**
TBCO-val	All Tobacco River watershed	**42%**
LOFSHR-for	All Lower Fisher River/Wolf Ck	**40%**
Class 2.5: Restoration Priority because of ESA Concerns		
LOKOOT-val	All Lower Kootenai River valley and bench	**21%**
Class 3: Less than 40 Percent of Optimum		
KOCNUSA-val	All Koocanusa Res. east	**39%**

Table 5.32. Grassland/Shrub Biome subunit classification.

Grassland/Shrub Biome Unit	Subunit	Percent of Optimum
Class 1: 60 to 85 Percent of Optimum		
Trench-val	Old Kimberly Airport grasslands	**65%**
Wigwam-for	Wigwam Flats grassland	**64%**
Class 2: 40 to 60 Percent of Optimum		
Trench-val	Premier Ridge grasslands	**59%**
YAAK-for	Yaak River watershed S of CAN border	**56%**
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS	**53%**
CABMTN-for	Lake Ck watershed-USFS	**53%**
MOYIE-for	Lower Moyie River S of CAN border	**51%**
KOCNUSA-for	West of Koocanusa Res.-USFS	**51%**
UPFSHR-for	Upper Fisher River/Paradise Valley	**50%**
CABMTN-wild	Libby Ck watershed-Wilderness +	**49%**
KOCNUSA-val	Koocanusa Res. east/US border portion Tobacco Plains	**48%**
KOCNUSA-cval	Other Koocanusa Res. CAN grassland/shrub	**48%**
BNFRY-val	Deep Ck/Bonners Ferry south	**48%**
TBCO-val	Other Tobacco River grass/shrub	48%
Trench-val	Skookumchuck grasslands	47%
LOKOOT-val	Lower Kootenai River valley and bench	46%
KOCNUSA-cval	Tobacco Plains in Koocanusa Res. CAN unit	46%
LOFSHR-for	Lower Fisher River/Wolf Ck	45%
TBCO-val	Tabacco Plains in the Tobacco River unit	45%
Trench-val	Other St Marys Trench grassland/shrub	42%
Class 3: Less than 40 Percent of Optimum		
Fernie-val	All Fernie area on lower Elk River	**39%**
Trench-val	Wycliffe Prairie (in St. Marys Unit)	**34%**

Table 5.33. Xeric Forest Biome subunit classification.

Xeric Forest Biome Unit	Subunit	Percent of Optimum
Class 1: 60 to 85 Percent of Optimum		
WTRVR-for	White River watershed-CFS	**64%**
BULL-for	Bull River unit	**64%**
KTLK-val	S half Kootenay Lk to US border	**63%**
Wigwam-for	Wigwam Ck trib of Elk River	**62%**
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness	**60%**
Class 2: 40 to 60 Percent of Optimum		
Wigwam-bdr	Wigwam Ck to CAN border	**59%**
LOKOOT-for	All Selkirks west of lower Kootenai River valley-USFS	**58%**
BNFRY-val	Deep Ck/Bonners Ferry south	**56%**
MOYIE-for	Lower Moyie River S of CAN border	**53%**
LOKOOT-val	Other Lower Kootenai River valley and E non-bench	**53%**
YAAK-for	Yaak River watershed S of CAN border	**52%**
KOCNUSA-cval	Koocanusa Res. CAN unit/CAN portion Tobacco Plains	**51%**
CABMTN-wild	Libby Ck watershed-Wilderness +	**51%**
KOCNUSA-val	Koocanusa Res. east/US border portion Tabacco Plains	**51%**
CABMTN-for	Lake Ck watershed-USFS	**51%**
Trench-val	St Marys Trench	**51%**
TBCO-val	Tobacco River watershed	**50%**
LOKOOT-val	Lower Kootenai River bench between valley and E mtns	**49%**
KOCNUSA-for	West of Koocanusa Res.-USFS	**48%**
UPFSHR-for	Upper Fisher River/Paradise Valley	**48%**
LOFSHR-for	Lower Fisher River/Wolf Ck	**46%**

Table 5.34. Mesic Mixed Forest Biome subunit classification.

Mesic Mixed Conifer Biome Unit	 Subunit	Percent of Optimum
Class 1: 60 to 85 Percent of Optimum		
UPELK-for	Upper Elk River unit	**78%**
UPKOOT-np	Upper Kootenay River-National Parks	**76%**
BULL-for	Bull River	**76%**
Wigwam-for	Wigwam Ck trib of Elk River-border	**75%**
KTLK-wild	NE side of Kootenay Lk/Purcell Mtns	**75%**
KTLK-for	NW side Kootenay Lk/Slocan	**71%**
Wigwam-bdr	Wigwam Ck to CAN border	**71%**
WTRVR-for	White River watershed-CFS	**70%**
KTLK-val	S half Kootenay Lk to US border	**70%**
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness	**70%**
KTLKWA-for	West Arm Kootenay Lk/Nelson	**69%**
MDLELK-for	Middle region Elk River	**67%**
KOCNUSA-val	Koocanusa Res. east	**67%**
YAHK-bdr	Upper Yahk(Yaak) River to US border	**67%**
Fernie-val	Fernie area on lower Elk River	**66%**
TBCO-val	Tobacco River watershed	**66%**
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS	**66%**
KOCNUSA-for	West of Koocanusa Res.-USFS	**65%**
YAAK-for	Yaak River watershed S of CAN border	**65%**
MOYIE-bdr	Upper Moyie River to US border	64%
CABMTN-for	Lake Ck watershed-USFS	62%
CABMTN-wild	Libby Ck watershed-Wilderness +	62%
UPFSHR-for	Upper Fisher River/Paradise Valley	62%
Trench-val	St Marys Trench	61%
BNFRY-val	Deep Ck/Bonners Ferry south	61%
LOFSHR-for	Lower Fisher River/Wolf Ck	61%
TP-for	Teepee Ck watershed	60%
Class 2: 40 to 60 Percent of Optimum		
Bvrft-for	Beaverfoot Range-CFS	59%
KOCNUSA-cval	Koocanusa Res. CAN unit	58%
MOYIE-for	Lower Moyie River S of CAN border	57%
LOKOOT-val	Lower Kootenai River valley and bench	55%

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6 Interpretation and Synthesis

6.1 Key Findings

The findings from the HUC-6 and HUC-4 evaluations and the biome, community, and single-species assessments are brought together in this section 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 that had 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). High levels of ecological integrity indicated that evolutionary and ecological processes were being maintained, as were 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 of the ecological integrity rating included the forest, range, aquatic, and hydrologic systems. Table 6.1 shows the results of this assessment for the seven watersheds within the Kootenai Subbasin. With respect to the main ecosystem components, forest and aquatic ranked lowest (low) followed by hydrology (moderate). With respect to HUC-4 watersheds, the Fisher and Lower Kootenai watersheds ranked lowest (low) followed by the Upper Kootenai, Moyie, and Yaak (moderate). The composite rank for the Kootenai Subbasin was 1.6, which is just below moderate and 53 percent of optimum. These assessment scores provided a general but valuable indication of how the integrity of various ecological components of the Kootenai Subbasin compared to those of other subbasins in the Columbia River Basin.

Resident Salmonids

Aquatic System QHA Scores

As part of this assessment, the Kootenai Subbasin Aquatic Technical Team used

Table 6.1. Interior Columbia Basin Ecosystem Management Project (ICBEMP) Integrity ratings for watersheds within the Kootenai Subbasin

Watershed	Forest	Aquatic	Hydrology	Watershed Composite
Upper Kootenai	Low (1)	Moderate (2)	Moderate (2)	**Moderate (1.6)**
Fisher	Low (1)	Low (1)	Moderate (2)	**Low (1.3)**
Yaak	Low (1)	Moderate (2)	High (3)	**Moderate (2)**
Moyie	Low (1)	Low (1)	High (3)	**Moderate (1.6)**
Lower Kootenai	Low (1)	Low (1)	Moderate (2)	**Low (1.3)**
Biome Composite	**Low (1)**	**Low (1.4)**	**Moderate (2.4)**	**Moderate (1.6)**

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 include elements like: (1) disturbance to water flow; (2) bare soil & disturbances to soil structure; (3) riparian vegetation; (4) sensitivity of stream banks and hill slopes to disturbance; (5) cycling of nutrients, energy, & chemicals; (6) surface & sub-surface flows; (7) stream-specific measurements such as gradient, stream bed substrate, full bank width, and depth; &, (8) recovery potential following disturbance.*

QHA to evaluate all the sixth-code HUCs in the Montana and Canadian portions of the Kootenai Subbasin on the basis of eleven habitat attributes for streams and thirteen habitat attributes for lakes. The attributes used in QHA are assumed to be the main habitat drivers of resident salmonid production and sustainability in streams (Parkin and McConnaha 2003). Tables 6.2 and 6.3 present the average subbasin-wide scores and ranks for all eleven stream attributes in the U.S. and Canadian portions of the subbasin respectively. Table 6.4 presents the scores and ranks for the thirteen lake attributes. 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 represent the current condition of the habitat relative to the normative or reference condition on a scale of 0 to 4 (where 0 = 0 percent of normative; 1 = 25 percent of normative; 2 = 50 percent of normative; 3 = 75 percent of normative; and 4 = 100 percent of normative). Normative 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.

For tributaries in the U.S. portion of the subbasin, the average of the eleven habitat attribute scores gives an overall score for subbasin aquatic stream habitat of 3.11, 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 78 percent of optimum. For the regulated mainstem, the average score is 2.2, or 55 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 in the U.S. portion of the subbasin are riparian condition, fine sediment, channel stability, and habitat diversity. In the regulated mainstem, the attributes functioning at the lowest levels are flows (the hydrograph), riparian condition, temperature, and fine sediment.

For streams in the Canadian or B.C. portion of the subbasin, the average of the eleven habitat attribute scores gives an overall score for subbasin aquatic stream habitat of 3.43, 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 86 percent of optimum. Again, QHA looks only at habitat conditions and does not consider impacts from non-native species. The habitat attributes currently functioning at the lowest levels are riparian condition, habitat diversity, channel stability, and fine sediment. Low temperature, oxygen, and high temperature are currently functioning at nearest to 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 for subbasin

Table 6.2. Average scores in the U.S. portion of the subbasin for eleven habitat attributes[1] important to resident salmonids.

	Tributaries		Regulated Mainstem	
Habitat Attribute	**Score**	**Rank**	**Score**	**Rank**
Channel stability	2.81	8	2.50	5
Fine sediment	2.33	9	2.33	6
Habitat Diversity	2.91	7	2.83	3
High Flow	3.10	5	0.67	10
High Temperature	2.81	8	2.17	7
Low Flow	3.26	4	0.67	10
Low Temperature	3.96	2	1.67	8
Obstructions	3.00	6	2.75	4
Oxygen	3.97	1	4.00	1
Pollutants	3.86	3	3.50	2
Riparian Condition	2.21	10	1.17	9
Average Score	3.11		2.20	
% of Optimum	78%		55%	

[1] *Attribute definitions are given in table 4.12.*

Table 6.3. Average scores in the B.C. portion of the subbasin for eleven habitat attributes important to resident salmonids.

Habitat Attribute	Score	Rank
Low Temperature	4.00	1
Oxygen	3.98	2
High Temperature	3.97	3
Pollutants	3.93	4
Low Flow	3.54	5
Obstructions	3.53	6
High Flow	3.49	7
Fine sediment	2.89	8
Channel stability	2.84	9
Habitat Diversity	2.83	10
Riparian Condition	2.74	11
Average Score	3.43	
% of Optimum	86%	

Table 6.4. Average scores for thirteen habitat attributes[1] in selected subbasin lakes and reservoirs.

	Lakes		Reservoirs	
Habitat Attribute	Score	Rank	Score	Rank
Volumetric turnover rates	3.95	2	2.00	7
Trophic status	3.70	6	2.75	4
Temperature	3.80	4	3.00	3
Substrate condition	3.65	7	2.13	6
Shoreline condition	3.45	9	1.75	9
Pollutants	3.70	6	3.25	2
Oxygen	4.00	1	3.25	2
Migratory obstruction	3.55	8	1.88	8
Macrophytes	3.85	3	2.50	5
Hydaulic regime	3.75	5	1.50	10
Habitat diversity	3.70	6	3.00	3
Gas saturation	4.00	1	4.00	1
Entrainment	4.00	1	2.75	4
Average Score	3.78		2.60	
% of Optimum	94%		65%	

[1] *Attribute definitions are given in table 4.13*

aquatic habitat of 3.78, which means that based on the QHA assessment, overall the subbasin aquatic habitat is currently operating at about 94 percent of optimum. Reservoirs had an average score of 2.6, which means they are operating at 65 percent of optimum. Again, QHA looks only at habitat. Based on the QHA scoring, the habitat attributes currently functioning at the lowest levels are hydraulic regime, shoreline condition, migratory obstructions, and volumetric turnover rates. In lakes, all of the habitat attributes scored relatively high.

By averaging the attribute scores for HUC-6 watersheds within each HUC-4 watershed, we can get an indication of how each HUC-4 watershed is operating (tables 6.5 and 6.6). In the U.S., scores range from 71 percent (Fisher) to 79 percent

Table 6.5. Average attribute scores for each HUC-4 watershed in the U.S. portion of the subbasin.

Habitat Attribute	Regulated Mainstem		Upper Kootenai		Fisher		Yaak		Lower Kootenai		Moyie	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Channel stability	2.50	5	2.93	8	2.56	5	3.12	4	2.44	11	2.82	6
Fine sediment	2.33	6	2.57	10	0.96	8	2.59	6	2.56	9	2.91	5
Habitat Diversity	2.83	3	2.97	7	2.56	5	3.35	2	2.76	6	2.91	5
High Flow	0.67	10	2.92	9	2.86	4	3.06	5	3.16	5	3.27	4
High Temperature	2.17	7	2.98	6	2.04	6	3.12	4	2.72	7	2.82	6
Low Flow	0.67	10	3.03	5	3.04	3	3.15	3	3.52	3	3.27	4
Low Temperature	1.67	8	3.86	3	4.00	1	4.00	1	3.72	2	3.73	2
Obstructions	2.75	4	3.15	4	3.50	2	2.38	7	2.52	10	2.73	7
Oxygen	4.00	1	4.00	1	4.00	1	4.00	1	3.84	1	4.00	1
Pollutants	3.50	2	3.97	2	4.00	1	4.00	1	3.36	4	3.45	3
Riparian Condition	1.17	9	2.21	11	1.88	7	1.59	8	2.60	8	2.45	8
Average Score	2.20		**3.15**		**2.85**		**3.12**		**3.02**		**3.12**	
Percent of Optimum	55%		**79%**		**71%**		**78%**		**75%**		**78%**	

Table 6.6. Average attribute scores for each HUC-4 watershed in the B.C. portion of the subbasin.

Habitat Attribute	Bull River		Duncan Lake		Elk		Kootenay Lake		Kootenay River		Slocan		St. Mary	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Channel stability	2.42	5	3.14	7	2.80	7	2.95	8	3.02	7	3.05	7	2.44	6
Fine sediment	2.19	7	3.36	4	2.75	8	2.97	7	3.20	5	2.82	9	2.76	4
Habitat Diversity	2.25	6	3.25	6	2.73	9	2.81	9	3.09	6	2.91	8	2.74	5
High Flow	2.78	4	3.95	2	3.45	4	3.45	6	3.74	3	3.64	5	3.35	2
High Temperature	3.94	2	4.00	1	4.00	1	4.00	1	4.00	1	3.73	4	4.00	1
Low Flow	2.78	4	4.00	1	3.40	5	3.58	5	3.78	2	3.82	3	3.35	2
Low Temperature	4.00	1	4.00	1	4.00	1	4.00	1	4.00	1	4.00	1	4.00	1
Obstructions	3.67	3	3.48	3	3.90	2	3.63	4	3.30	4	3.27	6	3.26	3
Oxygen	4.00	1	4.00	1	4.00	1	3.94	3	4.00	1	3.95	2	4.00	1
Pollutants	4.00	1	4.00	1	3.65	3	3.97	2	4.00	1	3.82	3	4.00	1
Riparian Condition	2.19	7	3.30	5	2.83	6	2.65	10	2.96	8	2.73	10	2.41	7
Average Score	**3.11**		**3.68**		**3.41**		**3.45**		**3.55**		**3.43**		**3.30**	
Percent of Optimum	**78%**		**92%**		**85%**		**86%**		**89%**		**86%**		**83%**	

(Upper Kootenai) of optimum. In B.C., scores range from 78 percent (Bull River) to 92 percent (Duncan Lake) of optimum. Note that U.S. and Canadian HUCs were rated by separate teams of biologists, each familiar with the waters on their side fo the border. Readers are urged to use caution in making relative comparisons of the percent of optimum function between U.S. and Canadian waters.

Burbot

More normative river conditions may be needed for restoration of natural burbot production in the Kootenai River subbasin's imperiled riverine or migratory burbot stocks. However, it is unclear whether these stocks, including the remnant populations in the lower Kootenai River in Idaho retain adequate demographic or genetic vigor to serve as founding sources of population recovery (Hammond and Anders 2002; KVRI Burbot Committee 2004). Habitat conditions used by successfully reproducing burbot stocks within the Subbasin, especially those with high protection scores should be protected.

White Sturgeon

White sturgeon in the Kootenai River subbasin may be recruitment habitat limited, stock limited, or both, with a potential array of operating pre-zygotic and post-zygotic limiting factors (Anders et al. 2002.) Post-zygotic limiting factors may include embryo suffocation and predation on early life stages, contributed to by post-development habitat attributes and hydro operations. Limiting habitat conditions may be physical, thermal, and ecological, resulting from a long history of directly and indirectly altered habitats and habitat conditions.

USFS Watershed Ratings

The Kootenai and Panhandle National Forests (USFS KIPNF 2003) have estimated the expected or apparent watershed condition of the 166 sub-watersheds (HUC-6 scale) in the Kootenai River Subbasin. In the Idaho portion, 69 percent were functioning at risk or not properly functioning; in Montana the number was 83 percent. By this assessment, watersheds in the subbasin are operating at 66 percent of optimum.

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. Our analysis showed the threat to bull trout is high in 26 of the 94 bull trout watersheds in the U.S., moderate in 42, and low in 26. So with respect to non-native species, our QHA analysis showed that watersheds at the HUC-6 scale in the U.S. portion of the subbasin are functioning at about 66 percent of optimum for bull trout[1] (table 6.7). In the Canadian portion, the threat was high in 22 of 99 watersheds and low in 77, which indicates that bull trout watersheds there are operating at

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[1] *Based on February 13, 2004 revisions made by Jim Dunnigan and Mike Hensler (MFWP) and Greg Hoffman (USACOE) to the bull trout QHA file. 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 66 percent of optimum for bull trout with respect to the threat posed by non-native species.*

about 85 percent of optimum with respect to non-natives. In the 7 lakes with bull trout that we assessed using LQHA, we found that the known threat from non-native species is high in 6 lakes and low in 1. Hence, with respect to non-native species, the lakes assessed are functioning at about 43 percent of optimum for bull trout. Table 6.7 shows the results of a similar analysis for the other salmonid focal species in the Kootenai Subbasin.

Shepard and others (2003) report that 14 percent of historically occupied westslope cutthroat trout habitat in the Kootenai Subbasin and 15 percent currently occupied habitat has genetically unaltered stocks, stocks that are less than 10 percent introgressed, or are suspected to contains stocks that are genetically unaltered. Another 56 percent of historically occupied habitat and 59 percent of currently occupied habitat contains stocks that are potentially unaltered (table 6.8). Based on these numbers, our technical team concludes that from a purely genetics standpoint, westslope cutthroat trout are, at best, operating at between 14 to 70 percent of optimum.

Table 6.7. Threat from non-natives to focal species calculated as percent of optimum condition.

	Bull Trout	Westslope Cutthroat Trout	Redband Trout	Kokanee
HUC-6 Watersheds U.S.	66%	55%	48%	62%
HUC-6 Watersheds B.C.	85%	74%	93%	97%
Lakes	43%	55%	50%	56%

Table 6.8. Genetic Status of Westslope Cutthroat Trout by percent of historically and currently occupied habitat (in stream miles) in the Kootenai Subbasin. Source: Shepard et al. 2003.

Status	% Historic Distribution (stream miles)	% Current Distribution (stream miles)
Genetically Unaltered	5%	6%
<10% introgressed	1%	1%
Suspected Unaltered	7%	8%
Total (Genetically Unaltered + < 10% introgressed + Suspected Unaltered)	**14%**	**15%**
Potentially Unaltered	56%	59%
Grand Total (Genetically Unaltered + < 10% introgressed + Suspected Unaltered + Potentially Unaltered)	**70%**	**74%**

Terrestrial System TBA Scores

As part of our assessment, the Kootenai Subbasin Terrestrial Technical Team used a spreadsheet tool to evaluate units and subunits within target biomes in the Montana and Canadian portions of the Kootenai 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 6.9 gives the average, subbasin-wide scores (as percentage of a optimum condition) for each biome. Table 6.10 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 6.10 also shows the biomes that occur in each subunit. 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.

Table 6.9. The TBA scores (as percentage of an optimum condition) for each biome.

Biome	Percent of Optimum
Mesic Coniferous Forest	66%
Riparian	55%
Xeric Forest	54%
Grassland/Shrub	50%
Wetland	49%

Table 6.10. TBA scores as a percent of optimum for Kootenai Subunits.

Unit/Subunit	Biome	Percent of Optimum
BNFRY-val		
Deep Ck/Bonners Ferry south	Mesic mixed conifer	61%
Deep Ck/Bonners Ferry south	Xeric	56%
Curley Ck watershed forested wetlands	Wetlands	52%
Other wetlands in Deep Ck/Bonners Ferry unit	Wetlands	42%
Deep Ck/Bonners Ferry south	Grassland/shrub	48%
Deep Ck valley riparian wetlands	Riparian	48%
Other riparian in Deep Ck/Bonners Ferry unit	Riparian	41%
Average for Unit		**50%**
BULL-for		
Bull River unit	Xeric	64%
Bull River	Mesic mixed conifer	76%
All Bull River	Wetlands	54%
All Bull River	Riparian	66%
Average for Unit		**65%**
Bvrft-for		
Beaverfoot Range-CFS	Mesic mixed conifer	59%
All Beaverfoot Range-CFS	Wetlands	55%
All Beaverfoot Range-CFS	Riparian	58%
Average for Unit		**57%**
CABMTN-for		
Lake Ck watershed-USFS	Mesic mixed conifer	62%
Lake Ck watershed-USFS	Xeric	51%
Lake Ck watershed-USFS	Grassland/shrub	53%
Alpine wetlands in Lake Ck unit	Wetlands	59%
Other wetlands in Lake Creek watershed-USFS	Wetlands	48%
All riparian in Lake Ck watershed-USFS	Riparian	56%
Average for Unit		**55%**
CABMTN-wild		
Libby Ck watershed-Wilderness +	Mesic mixed conifer	62%
Libby Ck watershed-Wilderness +	Xeric	51%
Libby Ck watershed-Wilderness +	Grassland/shrub	49%
All wetlands in Libby Ck watershed-Wilderness	Wetlands	47%
All riparian in Libby Ck watershed-Wilderness	Riparian	54%
Average for Unit		**52%**
Fernie-val		
Fernie area on lower Elk River	Mesic mixed conifer	66%
All Fernie area on lower Elk River	Grassland/shrub	39%
All Fernie area on lower Elk River	Wetlands	51%
All Fernie area on lower Elk River	Riparian	58%
Average for Unit		**54%**

Table 6.10 (cont.). TBA scores as a percent of optimum for Kootenai Subunits.

Unit/Subunit	Biome	Percent of Optimum
KOCNUSA-cval		
Koocanusa Res. CAN unit/CAN portion Tobacco Plains	Xeric	51%
Koocanusa Res. CAN unit	Mesic mixed conifer	58%
All Canadian Koocanusa Res. unit	Wetlands	47%
Tobacco Plains in Koocanusa Res. CAN unit	Grassland/shrub	46%
Other Koocanusa Res. CAN grassland/shrub	Grassland/shrub	48%
All Canadian Koocanusa Res. unit	Riparian	42%
Average for Unit		**49%**
KOCNUSA-for		
West of Koocanusa Res.-USFS	Mesic mixed conifer	65%
West of Koocanusa Res.-USFS	Xeric	48%
West of Koocanusa Res.-USFS	Grassland/shrub	51%
West of Koocanusa Res.-USFS	Wetlands	45%
All riparian West of Koocanusa Res.-USFS	Riparian	50%
Average for Unit		**52%**
KOCNUSA-val		
Koocanusa Res. east	Mesic mixed conifer	67%
Koocanusa Res. east/US border portion Tabacco Plains	Xeric	51%
Koocanusa Res. east/US border portion Tobacco Plains	Grassland/shrub	48%
All Koocanusa Res. east	Wetlands	39%
All Koocanusa Res. east	Riparian	32%
Average for Unit		**47%**
KTLK-for		
NW side Kootenay Lk/Slocan	Mesic mixed conifer	71%
All NW side Kootenay Lk/Slocan	Wetlands	53%
All NW side Kootenay Lk/Slocan	Riparian	62%
Average for Unit		**62%**
KTLK-val		
S half Kootenay Lk to US border	Xeric	63%
S half Kootenay Lk to US border	Mesic mixed conifer	70%
Other S half Kootenay Lk to US border	Wetlands	49%
CVWMA (Creston Valley Waterfowl Mgmt Area)	Wetlands	45%
Other S half Kootenay Lk to US border	Riparian	66%
CVWMA (Creston Valley Waterfowl Mgmt Area)	Riparian	51%
Average for Unit		**57%**
KTLKWA-for		
West Arm Kootenay Lk/Nelson	Mesic mixed conifer	69%
All West Arm Kootenay Lk/Nelson	Wetlands	47%
All West Arm Kootenay Lk/Nelson	Riparian	56%
Average for Unit		**58%**
KTLK-wild		
NE side of Kootenay Lk/Purcell Mtns	Mesic mixed conifer	75%
All NE side of Kootenay Lk/Purcell Mtns	Wetlands	52%
All NE side of Kootenay Lk/Purcell Mtns	Riparian	65%
Average for Unit		**64%**

Table 6.10 (cont.). TBA scores as a percent of optimum for Kootenai Subunits.

Unit/Subunit	Biome	Percent of Optimum
LOFSHR-for		
Lower Fisher River/Wolf Ck	Mesic mixed conifer	61%
Lower Fisher River/Wolf Ck	Xeric	46%
All Lower Fisher River/Wolf Ck	Wetlands	40%
Lower Fisher River/Wolf Ck	Grassland/shrub	45%
All Lower Fisher River/Wolf Ck	Riparian	39%
Average for Unit		**46%**
LOKOOT-for		
All Selkirks west of lower Kootenai River valley-	Xeric	58%
Selkirks west of lower Kootenai River valley-USFS	Mesic mixed conifer	66%
Selkirks west of lower Kootenai River valley-USFS	Wetlands	49%
Selkirks west of lower Kootenai River valley-USFS	Grassland/shrub	53%
Selkirks west of lower Kootenai River valley-USFS	Riparian	56%
Average for Unit		**56%**
LOKOOT-val		
Lower Kootenai River bench between valley and E mtns	Xeric	49%
Lower Kootenai River valley and bench	Mesic mixed conifer	55%
Other Lower Kootenai River valley and E non-bench	Xeric	53%
All Lower Kootenai River valley and bench	Wetlands	21%
Lower Kootenai River valley and bench	Grassland/shrub	46%
All Lower Kootenai River valley and bench	Riparian	28%
Average for Unit		**42%**
MDLELK-for		
Middle region Elk River	Mesic mixed conifer	67%
All Middle Elk River	Wetlands	54%
All Middle Elk River	Riparian	61%
Average for Unit		**60%**
MOYIE-bdr		
Upper Moyie River to US border	Mesic mixed conifer	64%
All Upper Moyie River to US border	Wetlands	45%
All Upper Moyie River to US border	Riparian	61%
Average for Unit		**57%**
MOYIE-for		
Lower Moyie River S of CAN border	Mesic mixed conifer	57%
Lower Moyie River S of CAN border	Xeric	53%
Round Prairie wetland complex	Wetlands	51%
Other wetlands in lower Moyie River watershed	Wetlands	50%
Lower Moyie River S of CAN border	Grassland/shrub	51%
All riparian in lower Moyie River watershed	Riparian	53%
Average for Unit		**53%**
PRCL-wild		
Purcell Mtns in St Marys unit-Wilderness	Xeric	60%
Purcell Mtns in St Marys unit-Wilderness	Mesic mixed conifer	70%
Purcell Mtns in St Marys unit-Wilderness	Wetlands	54%
Purcell Mtns in St Marys unit-Wilderness	Riparian	68%
Average for Unit		**63%**

Table 6.10 (cont.). TBA scores as a percent of optimum for Kootenai Subunits.

Unit/Subunit	Biome	Percent of Optimum
Stmry-np		
All wetlands St Marys Trench	Wetlands	50%
Average for Unit		**50%**
TBCO-val		
Tobacco River watershed	Mesic mixed conifer	66%
Tobacco River watershed	Xeric	50%
Tabacco Plains in the Tobacco River unit	Grassland/shrub	45%
All Tobacco River watershed	Wetlands	42%
Other Tobacco River grass/shrub	Grassland/shrub	48%
All Tobacco River watershed	Riparian	44%
Average for Unit		**49%**
TP-for		
Teepee Ck watershed	Mesic mixed conifer	60%
All Teepee Ck watershed	Wetlands	47%
All Teepee Ck watershed	Riparian	58%
Average for Unit		**55%**
Trench-val		
St Marys Trench	Xeric	51%
St Marys Trench	Mesic mixed conifer	61%
Other St Marys Trench grassland/shrub	Grassland/shrub	42%
Old Kimberly Airport grasslands	Grassland/shrub	65%
Premier Ridge grasslands	Grassland/shrub	59%
Wycliffe Prairie (in St. Marys Unit)	Grassland/shrub	34%
Skookumchuck grasslands	Grassland/shrub	47%
All riparian St Marys Trench	Riparian	55%
Average for Unit		**52%**
UPELK-for		
Upper Elk River unit	Mesic mixed conifer	78%
All Upper Elk River	Wetlands	53%
All Upper Elk River	Riparian	69%
Average for Unit		**67%**
UPFSHR-for		
Upper Fisher River/Paradise Valley	Mesic mixed conifer	62%
Upper Fisher River/Paradise Valley	Xeric	48%
All Upper Fisher River/Paradise Valley	Wetlands	46%
Upper Fisher River/Paradise Valley	Grassland/shrub	50%
All Upper Fisher River/Paradise Valley	Riparian	45%
Average for Unit		**50%**
UPKOOT-np		
Upper Kootenay River-National Parks	Mesic mixed conifer	76%
All Upper Kootenai River-National Parks	Wetlands	55%
All Upper Kootenai River-National Parks	Riparian	68%
Average for Unit		**66%**

Table 6.10 (cont.). TBA scores as a percent of optimum for Kootenai Subunits.

Unit/Subunit	Biome	Percent of Optimum
Wigwam-bdr		
Wigwam Ck to CAN border	Mesic mixed conifer	71%
All Wigwam Ck to CAN border	Wetlands	59%
Wigwam Ck to CAN border	Xeric	59%
All Wigwam Ck to CAN border	Riparian	62%
Average for Unit		**63%**
Wigwam-for		
Wigwam Ck trib of Elk River	Xeric	62%
Wigwam Ck trib of Elk River-border	Mesic mixed conifer	75%
Wigwam Flats grassland	Grassland/shrub	64%
All Wigwam Ck trib of Elk River	Wetlands	51%
All Wigwam Ck trib of Elk River	Riparian	64%
Average for Unit		**63%**
WTRVR-for		
White River watershed-CFS	Xeric	64%
White River watershed-CFS	Mesic mixed conifer	70%
All White River watershed-CFS	Wetlands	53%
All White River watershed-CFS	Riparian	62%
Average for Unit		**62%**
YAAK-for		
Yaak River watershed S of CAN border	Mesic mixed conifer	65%
Yaak River watershed S of CAN border	Xeric	52%
All wetlands in Yaak River watershed	Wetlands	50%
Yaak River watershed S of CAN border	Grassland/shrub	56%
All riparian in Yaak River watershed	Riparian	61%
Average for Unit		**57%**
YAHK-bdr		
Upper Yahk(Yaak) River to US border	Mesic mixed conifer	67%
All Upper Yahk(Yaak) River to US border	Wetlands	51%
All Upper Yahk(Yaak) River to US border	Riparian	59%
Average for Unit		**59%**

LINKS

For the Idaho Conservation Data Center, which has species lists and information on species at risk in Idaho, go to *http://fishandgame.idaho.gov/tech/CDC/*

Click Here

For the Montana Natural Heritage Program website, which has species lists and information on species at risk in Montana, go to: *http://nhp.nris.state.mt.us/*

Click Here

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, white sturgeon, burbot, bull trout, Columbia River redband trout, and westslope cutthroat trout. Appendices 13, 14, 20, and 21 list species of concern within the US portion of the Kootenai, the Canadian portion of the Kootenai, and the Mountain Columbia Province, respectively.

The Montana Natural Heritage Program and the Idaho Conservation Data Center use a number of factors (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 6.11 shows the number of species within the U.S. portion of the Kootenai Subbasin that have been assigned to each rank category. Table 6.12 shows the number of species in the Kootenai Subbasin in each group by Endangered Species Act status category. Figure 6.1 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 130 state-classified species of concern in the Kootenai Subbasin, about 70 percent of which are plants. Of these, 39 are considered critically imperiled, just over 79 percent of that number being plants. Across the Flathead and Kootenai Subbasins, the grassland biome contains the highest number of sensitive species (species of concern). However, the herbaceous wetland biome has the highest number of declining or extirpated species, closely followed by the grassland and riparian/wetland biomes.

Table 6.11. The number of Montana Heritage Program and Idaho Conservation Data Center Species of Concern within the U.S. portion of the Kootenai Subbasin. The fish tally is for the Montana portion of the subbasin.

State Rank[1]	Amphibian	Bird	Fish	Mammal	Mollusk	Plant	Total
S1		3	2	2	1	31	**39**
S1,S3					1		**1**
S2	1		2	4		45	**52**
S2B		4					**4**
S2S3				1	1	1	**3**
S2B,S3N		1					**1**
S3	1	1		4		15	**21**
S3B		3					**3**
S3B,S3N		2					**2**
S4				1			**1**
S4N		2					**2**
SNR			1				**1**
SX						1	
Total	**2**	**16**	**5**	**12**	**3**	**92**	**130**

Grizzly bear is S3 in MT and S1 in ID, tallied as S3
Coeur D'Alene Salamander is S2 in MT and S3 in ID, tallied as S2
Harlequin duck is S2B in MT and S1B in ID, tallied as S2B
Bald eagle is S3B,S3N in MT and S3B,S4N in ID, tallied as S3B,S3N
Townsend Big-eared bat is S2,S3 in MT and S2 in ID, tallied as S2,S3
Northern bog lemming is S2 in MT and S1 in ID, tallied as S2
Lynx is S3 in MT and S1 in ID, tallied as S3
Gray wolf is S3 in MT and S1 in ID, tallied as S3

[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.
N A state rank modifier indicating breeding status for a nonbreeding population. Example: S1N.

Table 6.12. Number of species in the subbasin in each group by Endangered Species Act Status Categories. The fish tally is only for the Montana portion of the subbasin.

ESA Status[1]	Bird	Fish	Mammal	Plant	Total
LE		1	1		**2**
LT		1		1	**2**
PS			1		**1**
PS:LE	1				**1**
PS:LE,LT,XN			1		**1**
PS:LT			1		**1**
PS:LT,PDL	1				**1**
PS:LT,XN			1		**1**
Special Status		1			**1**
Total	**2**	**3**	**5**	**1**	**11**

[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 nonessential 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 USESA 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.

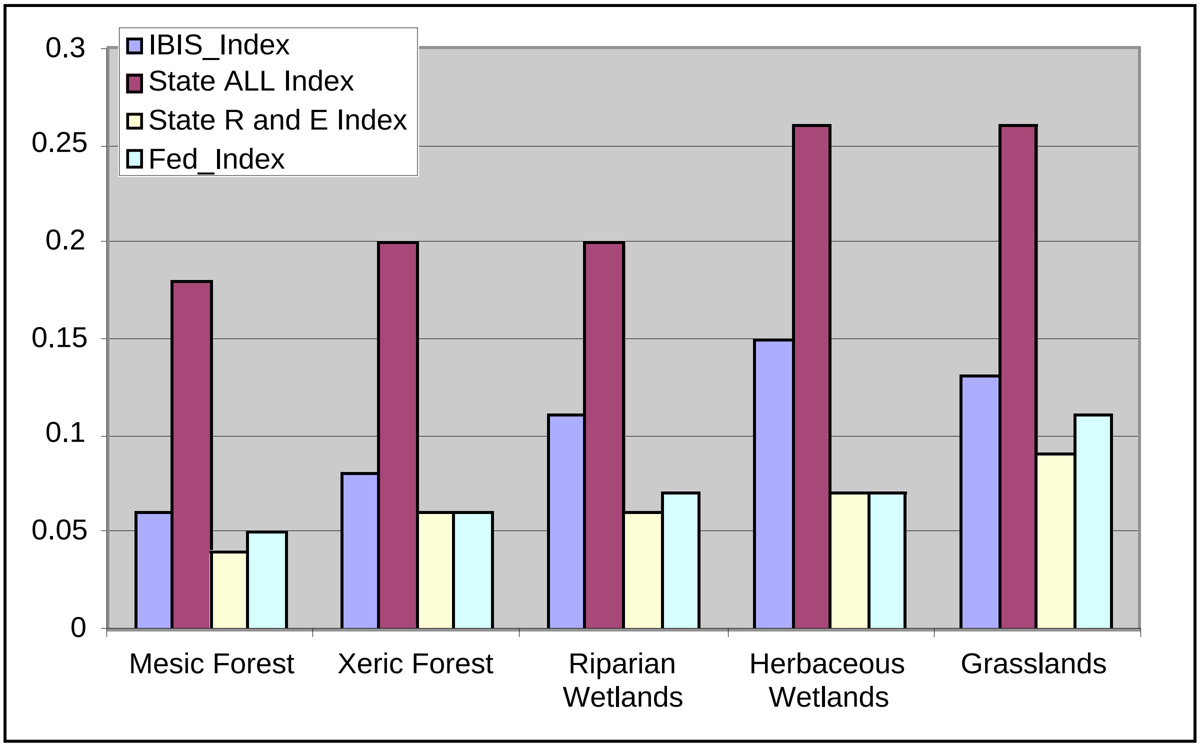

Figure 6.1. The percent of species at risk per total species in targeted biomes in the Kootenai and Flathead subbasins.

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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 6.13 shows the results of a Kootenai National Forest baseline assessment of the current condition of bull trout subpopulations in the Upper, Middle, and Lower Kootenai River in Montana (USFS KNF 2002b). The assessment is qualitative in nature and should be considered subjective, but the KNF analysis shows that subpopulation size is functioning at 73 percent of optimum, growth and survival at 70 percent, life history diversity at 76 percent of optimum, and persistence and genetic integrity at 70 percent. When all four parameters are considered together with equal weight, according to this assessment, bull trout in this part of the subbasin are operating at about 72 percent of optimum[2]. A similar analysis does not exist for the Idaho portion of the subbasin.

Table 6.13. Biological performance of bull trout subpopulations in the Montana portion of the Kootenai Subbasin.

Performance Measure	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Subpopulation Size	2	9	0
Growth and Survival	1	10	0
Life History and Diversity	3	8	0
Persistence and Genetic Integrity	1	10	0

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 12 percent of historically occupied habitat in the U.S. portion of the Kootenai Subbasin.

Shepard and others (2003) also assessed demographic and stochastic population risks for those existing westslope cutthroat trout conservation

[2] *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 2.16. If the optimum is 3, the species is functioning at about 72 percent of optimum with respect to these four measures.*

populations using criteria established by Rieman et al. (1993). All of the conservation populations in the subbasin were rated. Shepard's team considered four separate types of risk: temporal variability, population size, population productivity, and isolation (Appendices 71 and 72). 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 U.S. portion of the Kootenai Subbasin and found that when calculated by the number of populations, westslope cutthroat trout isolet populations are operating at 69 percent of optimum with respect to these risk factors (the lowest risk category being the optimum). Metapopulations are operating at about 81 percent of optimum. When calculated by stream miles occupied by each population, we found isolets were operating at about 74 percent of optimum and metapopulations at 79 percent of optimum.

Columbia River redband trout

The USFS reports that current populations on the Kootenai and Idaho Panhandle National Forests range from strong to depressed, although on the Idaho Panhandle National Forest, little is known about the status of Kootenai-drainage Columbia River redband trout populations. In all but five of the 6-field HUCs in the Idaho portion of the Kootenai, the Columbia River redband trout status is described by the USFS as "presence unknown." In three HUCs, redbands are known to be present but their population status is unknown, and in two they are present but depressed. Results of genetic surveys in Montana indicate that Columbia River redband trout, once native to low-gradient valley-bottom streams throughout the Kootenai River drainage, are presently restricted to a handful of headwater areas. In the Upper Kootenai Subbasin, Muhlfeld (2003) reports that genetically pure stocks of Columbia River redband trout have been identified in Callahan Creek, Basin Creek, the upper north (British Columbia) and east forks of the Yaak River, and upper Big Cherry Creek and Wolf Creek (Allendorf et al. 1980; Leary et al. 1991; Huston 1995; Hensler et al. 1996). Recent results of additional genetic testing conducted by MFWP (Allendorf 2003 unpublished) show the range of genetically pure populations of Columbia River redband trout also includes upper Libby Creek and the upper Fisher River (including the Pleasant Valley Fisher and East Fisher River drainages). The status of these Montana Columbia River redband trout populations is presumed to be stable (J. Dunnigan, MFWP, pers. comm. 2004). Allendorf and others (1980) surmised that “planting of hatchery rainbow trout has created a situation of tremendous genetic divergence among local populations."

Kokanee

From a Subbasin perspective, most kokanee populations appear relatively stable and abundant, bearing in mind that the impacts of the Duncan and Libby dams were never fully assessed. Therefore, pre-dam population levels are unknown. Abundance is a relative term, with today’s observations of abundance most likely considered sparse by previous generations of Native Americans and early Europeans. There are currently six major populations of kokanee in the Kootenai River Subbasin, in Idaho, Montana, and British Columbia: Trout Lake, Duncan Reservoir, Kootenay Lake, Moyie Lake, and Koocanusa Reservoir. All these lakes, the Kootenai River, and their tributaries support natural kokanee populations, albeit the Koocanusa population and most likely the Moyie Lake population are naturalized as a result of earlier introductions (Appendix 1 and 2). In addition to the above 6 kokanee populations, a native South Arm (Kootenay Lake) kokanee stock historically reared in the lake’s South Arm, and ascended upstream tributaries to spawn in BC and Idaho. However, this stock is thought to be functionally extinct (Ashley and Thompson 1994). In addition, the six major populations, there are probably dozens of other small lakes within the subbasin that support Kokanee.

Burbot

Substantial adult burbot populations in the Kootenai Subbasin currently exist in Lake Koocanusa and Trout Lake, with remnant populations between Libby Dam and Kootenai Falls and in the South Arm of Kootenay Lake. Burbot populations in the riverine portion of the Kootenai Subbasin and in the West Arm of Kootenay Lake have been reduced to substantially low levels and may be functionally extirpated. Very few burbot remain in the Kootenai River Subbasin between Kootenay Lake and Kootenai Falls. In this reach of the Subbasin, the greatest concentration occurs near and in the Goat River in B.C., and even there the numbers are quite small.

Imperiled status formed the basis for the petition to list Lower Kootenai River burbot as endangered under the Endangered Species Act (Prepared February 2, 2000, received by the USFWS February 7, 2000) (http://www.wildlands.org/w_burbot_pet.html). Based on most recent (2003) stock assessment modeling of burbot in this portion of the Subbasin, abundance estimates ranged between

50 and 500 fish, likely closer to 50 than 500 (Ray Beamesderfer, S.P. Cramer and Associates, personal communication, September 2003). No other current population abundance estimates exist for Kootenai Subbasin burbot.

Sturgeon

Empirical demographic modeling during 2002 revealed increasingly imperiled demographic status for the endangered Kootenai River white sturgeon population. Modeling suggested 90, 75, and 72 percent reductions in population abundance, biomass, and annually available spawners, respectively, during the past 22 years (1980-2002), and a current population "halving time" of 7.4 years. Recruitment failures continue to drive the decline of the Kootenai sturgeon population. No significant recruitment of juvenile sturgeon has occurred since at least 1974 and consistent recruitment has not occurred since at least 1965. A few wild juveniles are periodically captured (0-11 annually). Of 659 recently captured juveniles, 620 were hatchery-reared and 39 (~6 percent) were wild, confirming very low natural recruitment. Managed (augmented) flows have not stimulated recruitment to date as hoped. Thus, prospects for restoring natural production remain uncertain. Furthermore, this population may be currently or intermittently stock-limited (Anders et al. 2002).

6.1.4 Key Factors Impeding Optimal Ecological Functioning and Biological Performance

Aquatic System

Limiting factors vary by species and area. Tables 6.14 through 6.23 list the key factors identified through the use of QHA as the most limiting for aquatic focal species in the Kootenai Subbasin.

Table 6.14. Major limiting factors for bull trout in streams & reservoirs in the U.S. portion of the subbasin. Limiting factors (habitat attributes) are defined in tables 4.12 and 4.13.

Waterbody Type and Area	Primary Bull Trout Limiting Factors			
Streams	**Habitat-Related**			**Biological**
Subbasin-wide	Riaprian Condition	High Temperature	Channel Stability	Non-native Species
Regulated Mainstem	Altered Hydrograph	Riparian Condiiton	Fine Sediment	Non-native Species
Upper Kootenai	Riparian Condition	High Temperature	Channel Stability[1]	Non-native Species
Fisher	Riparian Condition	Fine Sediment	High Temperature	Non-native Species
Lower Kooteani	Channel Stability	High Temperature	Fine Sediment	Non-native Species
Moyie	Riaprian Condition	High Temperature	Channel Stability	Non-native Species
Reservoirs	**Habitat-Related**			**Biological**
Subbasin-wide	Migrat. Obstruction	Volumet. Turnover	Hydraulic Regime	Non-native Species

[1] *Channel Stability and Fine Sediment have the same QHA score.*

Table 6.15. Major limiting factors for bull trout in streams and lakes in the Canadian portion of the subbasin. Based on our QHA assessment, various data sets, and professional knowledge.

Waterbody Type and Area	Primary Bull Trout Limiting Factors			
Streams	**Habitat-Related**			**Biological**
Subbasin-wide	Channel Stability	Fine Sediment	Riparian Condition	Non-native Species
Bull River	Low Flow	Fine Sediment	Channel Stability	Non-native Species
Duncan Lake	Channel Stability	Fine Sediment	Riparian Condition1	Non-native Species
Elk	Fine Sediment	Channel Stability	Riparian Condition2	Non-native Species
Kootenay Lake	Channel Stability	Riparian Condition	Fine Sediment	Non-native Species
Slocan	Fine Sediment	Riparian Condition	Channel Stability	Non-native Species
St. Mary	Channel Stability	Fine Sediment	Riparian Condition	Non-native Species
Lakes	**Habitat-Related**			**Biological**
Subbasin-wide	Migrat. Obstruction	Trophic Status	Hydraulic Regime	Non-native Species

[1] *Riparian Condition and Habitat Diversity have the same QHA score.*

Table 6.16. Major limiting factors for westslope cutthroat trout in streams and lakes in the U.S. portion of the subbasin. Based on QHA assessment, various data sets, and professional knowledge.

Waterbody Type and Area	Primary Westslope Cutthroat Trout Limiting Factors			
Streams	**Habitat-Related**			**Biological**
Subbasin-wide	Riaprian Condition	Fine Sediment	Channel Stability	Non-native Spp & Introgression
Regulated Mainstem	Riparian Condition	Altered Hydrograph	Fine Sediment[1]	Non-native Spp & Introgression
Upper Kootenai	Riparian Condition	Fine Sediment	Habitat Diversity	Non-native Spp & Introgression
Fisher	Fine Sediment	Riparian Condition	Channel Stability[2]	Non-native Spp & Introgression
Lower Kooteani	Channel Stability	Riparian Condition	Fine Sediment	Non-native Spp & Introgression
Moyie	Riparian Condition	Habitat Diversity	Channel Stability	Non-native Spp & Introgression
Yaak	Riparian Condition	Fine Sediment	Channel Stability	Non-native Spp & Introgression
Lakes	**Habitat-Related**			**Biological**
Subbasin-wide	Shoreline Condition	Hydraulic Regime	Macrophytes	Non-native Spp & Introgression

[1] *Fine Sediment and Channel Stability have the same QHA score.*
[1] *Channel Stability and Habitat Diversity have the same QHA score.*

Table 6.17. Major limiting factors for westslope cutthroat trout in streams and lakes in the Canadian portion of the subbasin. Based on QHA assessment, various data sets, and professional knowledge.

Waterbody Type and Area	Primary Westslope Cutthroat Trout Limiting Factors			
Streams	**Habitat-Related**			**Biological**
Subbasin-wide	Riparian Condition	Channel Stability	Habitat Diversity	Non-native Spp & Introgression
Bull River	Fine Sediment	Habitat Diversity	Riparian Condition	Non-native Spp & Introgression
Elk	Habitat Diversity	Fine Sediment	Riparian Condition[2]	Non-native Spp & Introgression
Kootenay Lake	Habitat Diversity	Riparian Condition	Channel Stability	Non-native Spp & Introgression
Kootenay River	Riparian Condition	Channel Stability	Habitat Diversity	Non-native Spp & Introgression
St. Mary	Riparian Condition	Channel Stability	Habitat Diversity	Non-native Spp & Introgression
Lakes	**Habitat-Related**			**Biological**
Subbasin-wide	Shoreline Condition	Hydraulic Regime	Migrat. Obstruction	Non-native Spp & Introgression

[1] *Riparian Condition and Channel Stability have the same QHA score.*

Table 6.18. Major limiting factors for Columbia River redband trout in streams and lakes in the U.S. portion of the subbasin. Based on our QHA assessment, various data sets, and professional knowledge.

Waterbody Type and Area	Primary Redband Trout Limiting Factors			
Streams	**Habitat-Related**			**Biological**
Subbasin-wide	Riaprian Condition	Fine Sediment	Alterred Thermograph	Non-native Spp & Introgression
Regulated Mainstem	Altered Hydrograph	Riparian Condition	Altered Thermograph	Non-native Spp & Introgression
Upper Kootenai	Riparian Condition	High Temperature	Low Flow	Non-native Spp & Introgression
Fisher	Fine Sediment	Riparian Condition	High Temperature	Non-native Spp & Introgression
Lower Kooteani	Riparian Condition	Channel Stability	Fine Sediment	Non-native Spp & Introgression
Moyie	Riparian Condition	Channel Stability	Fine Sediment	Non-native Spp & Introgression
Yaak	Riparian Condition	Fine Sediment	High Temperature[1]	Non-native Spp & Introgression
Lakes	**Habitat-Related**			**Biological**
Subbasin-wide	Hydraulic Regime	Migrat. Obstruction	Shoreline Condition	Non-native Spp & Introgression

[1] *High Temperature, Channel Stability, and Low Flow have the same QHA score.*

Table 6.19. Major limiting factors for Columbia River redband trout in streams and lakes in the Canadian portion of the subbasin. Based on our QHA assessment, various data sets, and professional knowledge.

Waterbody Type and Area	Primary Redband Trout Limiting Factors			
Streams	**Habitat-Related**			**Biological**
Subbasin-wide	Riparian Condition	Channel Stability	Fine Sediment	Non-native Spp & Introgression
Duncan Lake	Channel Stability	Riparian Condition	Fine Sediment	Non-native Spp & Introgression
Kootenay Lake	Riparian Condition	Channel Stability	Fine Sediment	Non-native Spp & Introgression
Kootenay River	Riparian Condition	Channel Stability	Fine Sediment	Non-native Spp & Introgression
Slocan	Riparian Condition	Fine Sediment	Channel Stability	Non-native Spp & Introgression
Lakes	**Habitat-Related**			**Biological**
Subbasin-wide	Hydraulic Regime	Migrat. Obstruction	Shoreline Condition	Non-native Spp & Introgression

Table 6.20. Major limiting factors for kokanee in streams and lakes in the U.S. portion of the subbasin.

Waterbody Type and Area	Primary Kokanee Limiting Factors			
Streams		**Habitat-Related**		**Biological**
Subbasin-wide	Altered Hydrograph	Altered Thermograph	Pollutants	Non-native Species
Regulated Mainstem	Altered Hydrograph	Altered Thermograph	Fine Sediment[1]	Non-native Species
Lower Kootenai	Altered Thermograph	Channel Stability	Pollutants	Non-native Species
Moyie	Pollutants	Riparian Condition	Altered Hydrograph	Non-native Species
Lakes		**Habitat-Related**		**Biological**
Subbasin-wide	Hydraulic Regime	Volumetric Turnover	Migrat. Obstructions	Non-native Species

[1] *Fine Sediment and Channel Stability have the same QHA score.*

Table 6.21. Major limiting factors for kokanee in streams and lakes in the Canadian portion of the subbasin.

Waterbody Type and Area	Primary Kokanee Limiting Factors			
Streams		**Habitat-Related**		**Biological**
Subbasin-wide	Channel Stability	Fine Sediment	Riparian Condition	Non-native Species
Duncan Lake	Channel Stability	Fine Sediment	Riparian Condition	Non-native Species
Kootenay Lake	Riparian Condition	Fine Sediment	Channel Stability	Non-native Species
Slocan	FineSediment	Channel Stability	Riparian Condition	Non-native Species
Lakes		**Habitat-Related**		**Biological**
Subbasin-wide	Hydraulic Regime	Volumetric Turnover	Migrat. Obstructions	Non-native Species

Table 6.22. Major habitat and biological limiting factors for burbot in the mainstem Kootenai and lakes based on information from the KVRI Burbot Conservation Strategy (KVRI Burbot Committee 2004) and from Hammond and Anders (2003), Ahrens and Korman (2002), Paragamian (2002), and Anders et al. (2002).

Stream	Habitat Related	Biological
Upper Kootenai River	Increased winter water flow, Increased winter water temperature, Environmental degradation, Changes in primary and secondary productivity (downstream from Libby dam), and Altered ecological community composition	Small population size, Recruitment failure
Lower Kootenai River	Increased winter water flow, Increased winter water temperature, Environmental degradation, Changes in primary and secondary productivity (downstream from Libby dam), Kootenay Lake flood control, and Altered ecological community composition	Small population size, Recruitment failure
Kootenay River	Changes in primary and secondary productivity, Kootenay Lake flood control, and Altered ecological community composition	Small population size, Recruitment failure
Lakes	**Habitat Related**	**Biological**
Kootenay Lake	Changes in primary and secondary productivity, Kootenay Lake flood control, and Altered ecological community composition	Small population size, Recruitment failure
Duncan Lake		Small population size, Recruitment failure

Table 6.23. Major habitat and biological limiting factors for white sturgeon in the mainstem Kootenai and lakes.

Stream	Habitat Related	Biological
Upper Kootenai River	No sturgeon left/present	Small population size, Recruitment failure
Lower Kootenai River	Increased winter water flow, Increased winter water temperature, Environmental degradation, Changes in primary and secondary productivity (downstream from Libby dam), Kootenay Lake flood control, Loss of riparian habitat sloughs an side channels, and Altered ecological community composition	Small population size, Recruitment failure, loss of riparian habitat, sloughs, and side channels
Kootenay River	Increased winter water flow, Increased winter water temperature, Environmental degradation, Changes in primary and secondary productivity (downstream from Libby dam), Kootenay Lake flood control, and Altered ecological community composition	Small population size, Recruitment failure
Lakes	**Habitat Related**	**Biological**
Kootenay Lake	Environmental degradation, Changes in primary and secondary productivity (downstream from Libby dam), Kootenay Lake flood control, and Altered ecological community composition	Small population size, Recruitment failure

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 inhibiting populations of target species and ecological processes and functions. Those are listed in table 6.24 (not necessarily in order of importance).

Table 6.24. Human impacts inhibiting populations of target species and major terrestrial ecological processes and functions.

Regulated Mainstem					
Riparian	Altered Hydrograph	Diking			
Wetland	Altered Hydrograph	Diking			
Rest of the Subbasin					
Mesic Forest	Forest Management	Fire Exclusion	Non-native Species	Roads	Insect & Disease
Grassland/Shrub	Forest Encroachment	Land Conversion	Overgrazing	Human Developments	Non-native Species
Riparian	Forest Management	Land Conversion	Non-native Species	Human/Wildlife Conflicts	Impoundment Reduction in Nutrients/Productivity
Wetland	Roads	Land Conversion	Overgrazing	Forest Management	Impoundment Reduction in Nutrients/Productivity
Xeric Forest	Fire Exclusion	Forest Management	Non-native Species		

6.2 Subbasin Working Hypothesis

6.2.1 Aquatic System

Resident Salmonids

We developed the following four-part working hypothesis for resident salmonids at the subbasin scale in the U.S. portion of the subbasin:

1. The primary habitat factors limiting resident salmonids in the regulated mainstem portion of the subbasin are an altered hydrograph, riparian condition, turbidity and fine sediments, connectivity, and an altered thermal regime. Reduced nutrient loading to the Kootenai River downstream of Libby Dam (due to Koocanusa Reservoir acting as a nutrient sink) is also a primary factor limiting productivity of native species.

2. Habitat factors limiting resident salmonids in headwater and tributary streams on a subbasin scale are degraded riparian areas, channel stability, fine sediment, an altered thermal regime, and habitat diversity[3].

3. In lakes and reservoirs, the primary habitat factors for resident salmonids on a subbasin scale are hydraulic regime, migratory obstructions, shoreline conditions, and volumetric turnover rates.

4. The presence of nonnative species is a primary biological factor limiting resident salmonids on a subbasin scale.

We based this hypothesis on the QHA spreadsheet analysis, USFWS (2002), USFWS (1999), other published reports and studies, and professional knowledge and judgment. 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, westslope cutthroat trout, Columbia River redband trout, and kokanee are shown in table 6.25. Lake-habitat assumptions are shown in table 6.26.

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[3] *Our analysis of the QHA results did not identify habitat diversity as a major limiting factor for resident salmonids at the subbasin scale, however, it did identify it as a major limiting factor for westslope cutthroat trout in four of six HUC-4 watersheds. The Technical Team has therefore chosen to include it as part of our working hypothesis for resident salmonids.*

Table 6.25. Assumptions made with respect to focal species and their use of habitat. 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
Redband Trout												
Spawning and incubation	3	2.0	2.0	1.0	2.0	2.0	2.0	2.0	1.0	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	2.0	2.0	2.0	1.0
Migration	2	1.0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0
Kokanee												
Spawning and incubation	3	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0
Rearing (growth and feeding)	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Migration	2	1.0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	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 6.26. Assumptions made with respect to focal species 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
Redband Trout														
Spawning and incubation	4	2.0	2.0	2.0	0.0	2.0	0.0	0.0	0.0	0.0	2.0	1.5	0.0	2.0
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	0.0	1.0	0.5	0.5	0.5
Kokanee														
Spawning and incubation	4	2.0	2.0	0.5	0.0	2.0	0.0	0.0	0.0	0.0	2.0	2.0	0.5	2.0
Young of the Year	4	1.5	1.0	0.0	2.0	0.5	2.0	2.0	0.0	0.0	2.0	1.0	1.0	1.0
Juvenile	4	1.5	1.0	0.0	2.0	0.5	2.0	2.0	0.0	0.0	2.0	0.0	0.0	0.0
Adult	4	2.0	1.0	0.0	2.0	0.5	2.0	2.0	2.0	0.0	2.0	0.0	0.0	0.0

Burbot

We developed the following working primary (numbers) and secondary (letters) hypotheses to explain limitation for burbot at the subbasin level in the Kootenai River Subbasin:

1. Recent, ongoing recruitment failure is the main external driver of extinction for burbot in the Kootenai River basin.

2. Past overharvest (contributing to current recruitment failures), and post-development physical and biological changes in the Kootenai River ecosystem during the past 75 years have reduced the size and recruitment frequencies of burbot in the Kootenai River Subbasin.

   a. Currently used spawning and rearing habitats are altered and degraded, and along with the loss of large-river floodplain ecosystem functions and dynamics, appears to be an important external driver of extinction.

3. The current demographic conditions of riverine burbot populations, as well as post-development and post-hydro may have reduced success of spawning and spawning migrations.

   a. Reduced system productivity, altered thermographs and hydrographs in the post-dam system, and indirect reverberating ecological responses to system change contribute to burbot extinction risk.

These linked hypotheses represent findings and professional judgments based on several decades of intermittent empirical research of Kootenai River burbot. In some cases, the factors responsible for decline of extirpated or extremely depressed burbot stocks or populations can only be speculated in the absence of sufficient empirical data (Ahrens and Korman 2002).

LINKS

Holderman and Hardy (2004) discuss potential limiting factors for burbot, white sturgeon and other species in the Lower Kootenai.

Click Here

White Sturgeon

We developed the following working primary (numbers) and secondary (letters) hypotheses to explain limitation for white sturgeon at the Subbasin level in the Kootenai River subbasin:

LINKS

For a riparian habitat hypothesis for successful reproduction of white sturgeon (Coutant 2004), go to Appendix 118.

Click Here

1. Recent decadal recruitment failure is the main external driver of extinction for white sturgeon in the Kootenai River basin.

2. Current effects of post-development physical and biological changes in the Kootenai River ecosystem during the past 75 years have reduced the size and all but eliminated natural recruitment of the wild Kootenai River white sturgeon population.

   a. Currently used spawning and rearing habitats are altered and degraded, and along with the loss of large-river floodplain ecosystem functions and dynamics, appears to be an important external driver of extinction.

3. The current demographic condition of the population (n~600, 7.4 year mean halving time) appears to be the acute internal driver of extinction.

   a. Reduced system productivity, predation on and suffocation of early life stages, loss of riparian habitat, and indirect ecological responses to primary system change contribute to extinction risk.

These linked hypotheses represent findings and professional judgments based on several decades of empirical research of Kootenai River white sturgeon, and recent demographic simulation modeling that also used empirical data.

6.2.2 Terrestrial System

For the terrestrial system at the subbasin scale, we have developed the following working hypotheses:

1. The chief impacts limiting wildlife populations in the Mesic Forest Biome on a subbasin scale are forest management, fire exclusion, non-native species (noxious weeds), roads, and forest insects and diseases.

2. The chief impacts limiting wildlife populations in the Grassland/Shrub Biome on a subbasin scale are forest encroachment, land conversion, overgrazing, human developments, and non-native species.

3. On the regulated mainstem, the chief impacts limiting wildlife populations in the Riparian Biome are altered hydrographs and diking.

4. The chief impacts limiting wildlife populations in the Riparian Biome on a subbasin scale are forest management, land conversion, non-native species, human/wildlife conflicts, impoundments, and reductions in nutrients/productivity.

5. On the regulated mainstem, the chief impacts limiting wildlife populations in the Wetland Biome are altered hydrographs and diking.

6. The chief impacts limiting wildlife populations in the Wetland Biome on a subbasin scale are roads, land conversion, overgrazing, forest management, impoundments, and reductions in nutrients/productivity.

7. In the Xeric (Ponderosa Pine) Forest Biome, the chief limiting factors are fire exclusion, forest management, and non-natives.

These hypotheses are based on our TBA spreadsheet analysis and various published and unpublished reports and studies, and professional knowledge. (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, the level of habitat fragmentation, and hydrologic processes. Changes to any one of these parameters may have negative or postive affects, depending on the wildlife species at issue.)

6.3 Reference Conditions

6.3.1 Aquatic and Terrestrial

Focal and target species populations have *not* been modeled on a subbasin scale for various reference conditions referenced in the *Technical Guide for Subbasin Planners* (NWPCC 2001). Consequently, the Technical Team could not make quantitative estimates. Instead, table 4.27 presents general qualitative estimates based upon the results of this assessment.

Table 6.27. Estimate of species abundance and productivity under various reference conditions (current, potential, and future/no new action)[1].

Species	Bull Trout	Westslope Cutthroat Trout	Redband Trout	Kokanee	Sturgeon	Burbot	Target Wildlife Species[3]
Relation of Current Populations to Historic Condition	60% of Historic	20% of Historic	10% of Historic	40-50%	0 to 10% of Historic	0 to 10% of Historic	50 to 70% of Optimum
Estimate of Species Abundance and Productivity under Potential Reference Condition	80 to 90% of Optimum	80% to 90% of Optimum	30% to 45% of Optimum	70-80%	25 to 30% of Optimum	25 to 30% 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	0 to 20% of Optimum	40-50%	0 to 5% of Optimum	0 to 5% of Optimum	30 to 50% of Optimum
Confidence of Preditions[2]	1	1	1	1	2	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 predicitions of this nature on a species-by-species basis. The estimates presented here are general and a composite reference for all target species.

LINKS

For maps showing Class 1 and Class 2 aquatic 6th-code HUCs and terrestrial subunits (which are our near-term opportunities) as well as an overlay of aquatic and terrestrial protection and restoration areas, go to Appendix 112.

Click Here

6.4 Near-term Opportunities

Tables 6.28 to 6.30 list of near-term opportunities for protection and restoration of salmonids and potential reference sites. The lists are based on our QHA and TBA results. For aquatic opportunities we have lumped the Class 1 waters for all of the salmonid focal species to get near-term salmonid protection opportunities. Similarly, we lumped all the Class 2 and 2.5 waters for all the salmonid focal species to get the near-term salmonid 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. Within the group of Class 2 waters, streams and lakes with ESA-listed species will have a higher priority for restoration than those without ESA-listed species. Table 6.31 lists near term protection and restoration opportunities for burbot and white sturgeon. This list of near-term opportunities does not take into consideration socioeconomic concerns. The Planning Team will use the public review and management planning process to determine which opportunities are socially, economically, and politically feasible. The Kootenai Tribe of Idaho and Montana Fish, Wildlife & Parks consider all waters and lands in the subbasin worth of restoration and protection.

6.4.1 Aquatic

Class 1 Waters for Salmonids

Table 6.28. Class 1 waters for salmonids.

Class 1 Streams	
Upper Kootenai	
Kootenai River 1 / koocanusa	Kootenai River 5
Kootenai River 2 / koocanusa	Lake Koocanusa Valley
Kootenai River 3 / koocanusa	Ross Creek
Kootenai River 4 / koocanusa	
Lower Kootenai	
Long Canyon	Trout Creek
Parker Creek	
Moyie	
no name 3	
Bull River	
Quinn Creek	Upper West Bull
Upper East Bull	
Duncan Lake	
Asher Creek	Lake Creek
Cooper and Meadow Creeks	Lower Lardeau River
Duncan Lake Tribs.	Lower Trout
East Creek	Rapid Creek
Ferguson Creek	Stevens and Hall Creeks
Glacier Creek	Upper Duncan River
Hamill Creek	Upper Trout
Healy Creek	Westfall River
Houston Creek	Wilkie Creek
Howser Creek	
Elk	
Brule Creek	Lizard Creek
Cummings Creek	Mid East Elk
East Fernie	Upper East Elk
East Fernie	Upper West Elk
Grave Greek	West Fernie
Kootenay Lake	
Arrow/Duck	Nixon Creek
Cultus and Next Creeks	La France, Lockhart, Akokli and Sanca Creeks
Fletcher and Bjerkness Creeks	Midge Creek
Fry Creek	North Kootenay Lake
Grohman, Duhamel, Sitkum and Sproule Creeks	Powder and Cambell Creek
Kamma and leadville Creeks	South Arm Kootenay Lake
Kianuka Creek	Sullivan Creek
Kid Creek	Summit and Corn Creeks
Kokanee and Redfish Creeks	Sunrise and Sundown Creeks

Class 1 Waters for Salmonids (cont.)

Table 6.28 (cont.). Class 1 waters for salmonids.

Class 1 Streams (cont.)	
Kootenay Lake (cont.)	
Lasca and Five Mile Creeks	Upper Moyie River and Lamb Creek
Daer Creek	West Moyie
Fenwick Creek	Ochre Creek
Lower West White River	Simpson River
Meadow Creek	Tokumm Creek
Mid Vermillion	Upper Kootenay River
Middle Fork White River	Whiteswan
Slocan	
Bonanza Creek	Seaton and Carpenter Creeks
Hoder Creek	Slocan
Koch Creek	Winlaw Creek
Gwillim Creeks	
St. Mary	
Dewar Creek	West Canal Flats
East Canal Flats	
Class 1 Lakes	
Trout Lake	

Class 2 Waters for Salmonids

Table 6.29. Class 2 waters for salmonids.

Class 2 Streams	
Upper Kootenai	
Big Cherry Creek 1	Kootenai River 10
Big Creek	Lake Creek 1
Big Creek South Fork	Lake Creek 2
Big Creek South Fork East Branch	Libby Creek 1
Bobtail Creek	Libby Creek 2
Boulder Creek	Libby Creek 2 Valley
Boulder Creek 2	McGuire Creek
Bristow Creek	Meadow Creek
Callahan Creek	Middle Fork Parsnip Creek
Deep Creek	North Callahan Creek
Dodge Creek	OBrien Creek
Dunn Creek	Paramenter Creek
Fivemile Creek	Phillips Creek
Flower Creek	Pipe Creek
Fortine Creek 1	Pipe Creek 1
Fortine Creek 2	Pipe Creek 2
Fortine Creek 3	Quartz Creek
Granite Creek	Ruby Creek
Grave Creek 1	Sinclair Creek
Grave Creek 2	South Callahan Creek
Indian Creek	Star Creek
Jackson Creek	Sullivan Creek
Keeler Creek	Sutton Creek
Kootenai River 5 Valley	Therriault Creek
Kootenai River 6	Tobacco River
Kootenai River 7	Tobacco River Valley
Kootenai River 8	Wigwam River
Kootenai River 9	Young Creek
Fisher	
Bear Springs Creek	Pleasant Valley Creek
Cow Creek	Pleasant Valley / Fisher River
East Fisher Creek	Pleasant Valley Fisher River
Elk Creek	Pleasant Valley Fisher River 1
Fisher River 1	Pleasant Valley Fisher River 2
Fisher River 2	Silver Butte Fisher River
Fisher River 2 Valley	Weigel Creek
Fisher River 3	West Fisher Creek
Island Creek	Wolf Creek 1
Little Wolf Creek	Wolf Creek 2
Mainstem Fisher River Valley	Wolf Creek 2 Valley
MCGinnis Creek	Wolf Creek 3
McKillop Creek	

Class 2 Waters for Salmonids (cont.)

Table 6.29 (cont.). Class 2 waters for salmonids.

Class 2 Streams (cont.)	
Yaak	
Basin Creek	Yaak River 1
Burnt Creek	Yaak River 2
Hellroaring Creek	Yaak River 3
Pete Creek	Yaak River 4
Seventeenmile Creek 1	Yaak River 5
Seventeenmile Creek 2	Yaak River East Fork
South Fork Yaak River	Yaak River Upper West Fork
Spread Creek	Yaak Rvr. 2 Valley
Lower Kootenai	
Ball Creek	Fall Creek
Boulder Creek 1	Grass Creek
Boulder Creek 2	Kootenai River 9 Valley
Boundary Creek	Kootenai River 10 Valley
Caribou Creek	Mission Creek
Cow Creek	Myrtle Creek
Curley Creek	Smith Creek 1
Deep Creek 1	Smith Creek 2
Deep Creek 3	Snow Creek
Deep Creek 3 Valley	Twenty Mile Creek
East Fork Boulder Creek	
Moyie	
Canuck Creek	Moyie River Valley 2
Deer Creek	Moyie Tributaries
Lower Moyie River Tributaries	Round Prairie
Meadow Creek	Round Prairie Tributaries
Moyie River Valley 1	
Bull River	
Bull Below Dam	Mid Bull
Galbraith Creek	Phillipps Creek
Gold Creek	Plumbob and Chipka Creeks
Ha Ha Creek	Sand Creek
Kikomun Creek	Sulphur Creek
Linklater Creek	West Bull (above dam)
Lardeau Creek	Mobbs and Tenderfoot Creeks
Lower Trout	Poplar and Cascade Creeks
Elk	
Coal Creek	Michel Creek
Fording River	Morrissey Creek
Hosmer East	Sparwood
Hosmer West	Wigwam River

Class 2 Waters for Salmonids (cont.)

Table 6.29 (cont.). Class 2 waters for salmonids.

Class 2 Streams (cont.)	
Kootenay Lake	
Boundary Creek and Creston	Harrop Creek
Cottonwood Creek	Kaslo River
Crawford and Gray Creeks	Lower West Arm below Brilliant Dam
Goat River	Moyie River
Hawkins Creek	Woodbury and Coffee Creeks
Kootenay River	
Albert River	Lower East White River
Blackfoot, Thunder and East White	Middle Fork White River
Cochran Creek	Nine Mile Creek
Cross River	North White River
Elk Creek	Palliser River
Grave Greek	West Upper Kootenay River
Slocan	
Goose Creek	Slocan River
Silverton, Enterprise and Lemon Creeks	Wilson Creek
St. Mary	
Findlay Creek	Norbury Creek
Hellroaring and Perry Creeks	Redding and Meachen Creeks
Joseph Creek	Skookumchuck Creek
Lussier River	Upper St. Mary River
Mark Creek	Wasa
Mather and Lost Dog Creeks	Wild Horse River
Matthew Creek	
Class 2 Lakes	
Bull Lake	Koocanusa Reservoir
Boulder Lake	Leigh Lake
Duncan Lake	Moyie Lakes
Granite Lake	Sophie Lake
Kootenay Lake	Therriault Lake

HUCs with Segments or Reaches that can Serve as Reference Sites for Future Monitoring for Salmonids

Table 6.30. Waters that have segments or reaches that could serve as potential reference reaches for future monitoring for salmonids.

Potential Reference Waters	
US	
Big Creek South Fork	Long Canyon Creek
Big Creek South Fork East Branch	Middle Fork Parsnip Creek
Bristow Creek	Parker Creek
Canuck Creek	Pete Creek
Deer Creek	Phillips
Granite Creek	Phillips Creek
Grave Creek 1	Pipe Creek 1
Indian Creek	Ross Creek
Kootenai River 1 / Koocanusa	Silver Butte Fisher River
Kootenai River 2 / Koocanusa	Tobacco River
Kootenai River 3 / Koocanusa	Trout Creek
Kootenai River 4 / Koocanusa	West Fisher Creek
Kootenai River 5	Wigwam River
Lake Koocanusa Valley	Yaak River 3
Canada	
Arrow/Duck	Moyie River
Blackfoot, Thunder and East White	Nixon Creek
Cross River	North White River
Cummings Creek	Ochre Creek
Daer Creek	Quinn Creek
Dewar Creek	Simpson River
East Canal Flats	Skookumchuck Creek
East Fernie	Sparwood
East Fernie	St. Mary River
Fenwick Creek	Sullivan Creek
Findlay Creek	Sunrise and Sundown Creeks
Hawkins Creek	Tokumm Creek
Hosmer East	Upper East Bull
Hosmer West	Upper East Elk
Kamma and Leadville Creeks	Upper East Flathead
Kianuka Creek	Upper Kootenay River
Kid Creek	Upper St. Mary River
Kokanee and Redfish Creeks	Upper West Bull
Lasca and Five Mile Creeks	Upper West Elk
Lizard Creek	Upper West Flathead
Lower East White River	West Canal Flats
Lower West White River	West Fernie
Mark Creek	West Moyie
Meadow Creek	West Upper Kootenay River
Mid East Elk	Whiteswan
Mid Vermillion	Wigwam River
Middle Fork White River	

The list of reference HUCs (table 6.30) is preliminary and will be refined in the future as more data become available. Also note that when viewed as a whole, any given HUC on the list may be in relatively poor or moderate ecological condition. However, in our preliminary review, each was thought to contain at least one reach or segment that potentially could serve as a reference reach.

Prioritized list of River Reaches and Lakes for Protection and Restoration for Burbot and White Sturgeon

Table 6.31. River reaches and lakes that are a high priority for protection and restoration for burbot and white sturgeon.

Class 2 River Reaches: Restoration Priorities	
Braided Reach (Moyie River to Highway 95 Bridge)	Meander Reach (Deep Creek to Kootenay Lake)
Canyon (Idaho, MT Upstream to Kootenai Falls)	Straight Reach (Highway 95 Bridge to Deep Creek)
Class 1 Lakes: Protection Priorities	
Trout Lake	
Class 2 Lakes: Restoration Priorities	
Duncan Lake	Koocanusa Reservoir
Kootenay Lake	

6.4.2 Terrestrial

Class 1 Subunits (60 to 85 percent of optimum) by Biome

Table 6.32. Class 1 subunits by biome.

Grassland/Shrub Biome	
Trench-val	Old Kimberly Airport grasslands
Wigwam-for	Wigwam Flats grassland
Mesic Mixed Conifer Biome	
UPELK-for	Upper Elk River unit
UPKOOT-np	Upper Kootenay River-National Parks
BULL-for	Bull River
Wigwam-for	Wigwam Ck trib of Elk River-border
KTLK-wild	NE side of Kootenay Lk/Purcell Mtns
KTLK-for	NW side Kootenay Lk/Slocan
Wigwam-bdr	Wigwam Ck to CAN border
WTRVR-for	White River watershed-CFS
KTLK-val	S half Kootenay Lk to US border
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness
KTLKWA-for	West Arm Kootenay Lk/Nelson
MDLELK-for	Middle region Elk River
KOCNUSA-val	Koocanusa Res. east
YAHK-bdr	Upper Yahk(Yaak) River to US border
Fernie-val	Fernie area on lower Elk River
TBCO-val	Tobacco River watershed
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS
KOCNUSA-for	West of Koocanusa Res.-USFS
YAAK-for	Yaak River watershed S of CAN border
MOYIE-bdr	Upper Moyie River to US border
CABMTN-for	Lake Ck watershed-USFS
CABMTN-wild	Libby Ck watershed-Wilderness +
UPFSHR-for	Upper Fisher River/Paradise Valley
Trench-val	St Marys Trench
BNFRY-val	Deep Ck/Bonners Ferry south
LOFSHR-for	Lower Fisher River/Wolf Ck
TP-for	Teepee Ck watershed
Riparian Biome	
UPELK-for	All Upper Elk River
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness
UPKOOT-np	All Upper Kootenai River-National Parks
BULL-for	All Bull River
KTLK-val	Other S half Kootenay Lk to US border
KTLK-wild	All NE side of Kootenay Lk/Purcell Mtns
Wigwam-for	All Wigwam Ck trib of Elk River
WTRVR-for	All White River watershed-CFS
KTLK-for	All NW side Kootenay Lk/Slocan
Wigwam-bdr	All Wigwam Ck to CAN border
YAAK-for	All riparian in Yaak River watershed
MDLELK-for	All Middle Elk River
MOYIE-bdr	All Upper Moyie River to US border

Class 1 Subunits (60 to 85 percent of optimum) by Biome (cont.)

Table 6.32 (cont.). Class 1 subunits by biome.

Xeric Forest Biome	
WTRVR-for	White River watershed-CFS
BULL-for	Bull River unit
KTLK-val	S half Kootenay Lk to US border
Wigwam-for	Wigwam Ck trib of Elk River
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness

Class 2 Subunits (40 to 60 percent of optimum) by Biome

Table 6.33. Class 2 subunits by biome.

Grassland/Shrub Biome	
Trench-val	Premier Ridge grasslands
YAAK-for	Yaak River watershed S of CAN border
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS
CABMTN-for	Lake Ck watershed-USFS
MOYIE-for	Lower Moyie River S of CAN border
KOCNUSA-for	West of Koocanusa Res.-USFS
UPFSHR-for	Upper Fisher River/Paradise Valley
CABMTN-wild	Libby Ck watershed-Wilderness +
KOCNUSA-val	Koocanusa Res. east/US border portion Tobacco Plains
KOCNUSA-cval	Other Koocanusa Res. CAN grassland/shrub
BNFRY-val	Deep Ck/Bonners Ferry south
TBCO-val	Other Tobacco River grass/shrub
Trench-val	Skookumchuck grasslands
LOKOOT-val	Lower Kootenai River valley and bench
KOCNUSA-cval	Tobacco Plains in Koocanusa Res. CAN unit
LOFSHR-for	Lower Fisher River/Wolf Ck
TBCO-val	Tabacco Plains in the Tobacco River unit
Trench-val	Other St Marys Trench grassland/shrub
Mesic Conifer Forest Biome	
Bvrft-for	Beaverfoot Range-CFS
KOCNUSA-cval	Koocanusa Res. CAN unit
MOYIE-for	Lower Moyie River S of CAN border
LOKOOT-val	Lower Kootenai River valley and bench

Class 2 Subunits (40 to 60 percent of optimum) by Biome (cont.)

Table 6.33 (cont.). Class 2 subunits by biome.

Riparian Biome	
YAHK-bdr	All Upper Yahk(Yaak) River to US border
Bvrft-for	All Beaverfoot Range-CFS
Fernie-val	All Fernie area on lower Elk River
TP-for	All Teepee Ck watershed
CABMTN-for	All riparian in Lake Ck watershed-USFS
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS
KTLKWA-for	All West Arm Kootenay Lk/Nelson
Trench-val	All riparian St Marys Trench
CABMTN-wild	All riparian in Libby Ck watershed-Wilderness
MOYIE-for	All riparian in lower Moyie River watershed
KTLK-val	CVWMA (Creston Valley Waterfowl Mgmt Area)
KOCNUSA-for	All riparian West of Koocanusa Res.-USFS
BNFRY-val	Deep Ck valley riparian wetlands
UPFSHR-for	All Upper Fisher River/Paradise Valley
TBCO-val	All Tobacco River watershed
KOCNUSA-cval	All Canadian Koocanusa Res. unit
BNFRY-val	Other riparian in Deep Ck/Bonners Ferry unit
LOKOOT-val	All Lower Kootenai River valley and bench
Wetland Biome	
Wigwam-bdr	All Wigwam Ck to CAN border
CABMTN-for	Alpine wetlands in Lake Ck unit
UPKOOT-np	All Upper Kootenai River-National Parks
Bvrft-for	All Beaverfoot Range-CFS
PRCL-wild	Purcell Mtns in St Marys unit-Wilderness
BULL-for	All Bull River
MDLELK-for	All Middle Elk River
UPELK-for	All Upper Elk River
WTRVR-for	All White River watershed-CFS
KTLK-for	All NW side Kootenay Lk/Slocan
BNFRY-val	Curley Ck watershed forested wetlands
KTLK-wild	All NE side of Kootenay Lk/Purcell Mtns
Fernie-val	All Fernie area on lower Elk River
YAHK-bdr	All Upper Yahk(Yaak) River to US border
MOYIE-for	Round Prairie wetland complex
Wigwam-for	All Wigwam Ck trib of Elk River
MOYIE-for	Other wetlands in lower Moyie River watershed
YAAK-for	All wetlands in Yaak River watershed
Stmry-np	All wetlands St Marys Trench
LOKOOT-for	Selkirks west of lower Kootenai River valley-USFS
KTLK-val	Other S half Kootenay Lk to US border
CABMTN-for	Other wetlands in Lake Creek watershed-USFS
KTLKWA-for	All West Arm Kootenay Lk/Nelson
TP-for	All Teepee Ck watershed
CABMTN-wild	All wetlands in Libby Ck watershed-Wilderness
KOCNUSA-cval	All Canadian Koocanusa Res. unit
UPFSHR-for	All Upper Fisher River/Paradise Valley
MOYIE-bdr	All Upper Moyie River to US border
KOCNUSA-for	West of Koocanusa Res.-USFS
KTLK-val	CVWMA (Creston Valley Waterfowl Mgmt Area??)
BNFRY-val	Other wetlands in Deep Ck/Bonners Ferry unit
TBCO-val	All Tobacco River watershed
LOFSHR-for	All Lower Fisher River/Wolf Ck
LOKOOT-val	All Lower Kootenai River valley and bench

Class 2 Subunits (40 to 60 percent of optimum) by Biome (cont.)

Table 6.33 (cont.). Class 2 subunits by biome.

Xeric Forest Biome	
Wigwam-bdr	Wigwam Ck to CAN border
LOKOOT-for	All Selkirks west of lower Kootenai River valley-USFS
BNFRY-val	Deep Ck/Bonners Ferry south
MOYIE-for	Lower Moyie River S of CAN border
LOKOOT-val	Other Lower Kootenai River valley and E non-bench
YAAK-for	Yaak River watershed S of CAN border
KOCNUSA-cval	Koocanusa Res. CAN unit/CAN portion Tobacco Plains
CABMTN-wild	Libby Ck watershed-Wilderness +
KOCNUSA-val	Koocanusa Res. east/US border portion Tabacco Plains
CABMTN-for	Lake Ck watershed-USFS
Trench-val	St Marys Trench
TBCO-val	Tobacco River watershed
LOKOOT-val	Lower Kootenai River bench between valley and E mtns
KOCNUSA-for	West of Koocanusa Res.-USFS
UPFSHR-for	Upper Fisher River/Paradise Valley
LOFSHR-for	Lower Fisher River/Wolf Ck

Class 3 Subunits (Less than 40 percent of optimum) by Biome

Table 6.34. Class 3 subunits by biome.

Grassland/Shrub Biome	
Fernie-val	All Fernie area on lower Elk River
Trench-val	Wycliffe Prairie (in St. Marys Unit)
Riparian Biome	
LOFSHR-for	All Lower Fisher River/Wolf Ck
KOCNUSA-val	All Koocanusa Res. east
Wetland Biome	
KOCNUSA-val	All Koocanusa Res. east

6.5 Strategies

The Kootenai 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 Kootenai Subbasin Technical Team, Working Group, and the public.

LINKS

For high resolution near-term opportunity maps, go to Appendix 112.

Click Here

6.6 Maps Showing Near-term Opportunities

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 five HUC-4 scale maps (Upper Kootenai, Fisher, Yaak, Moyie, and Lower Kootenai). These same maps in a higher resolution format are included as Appendix 112.

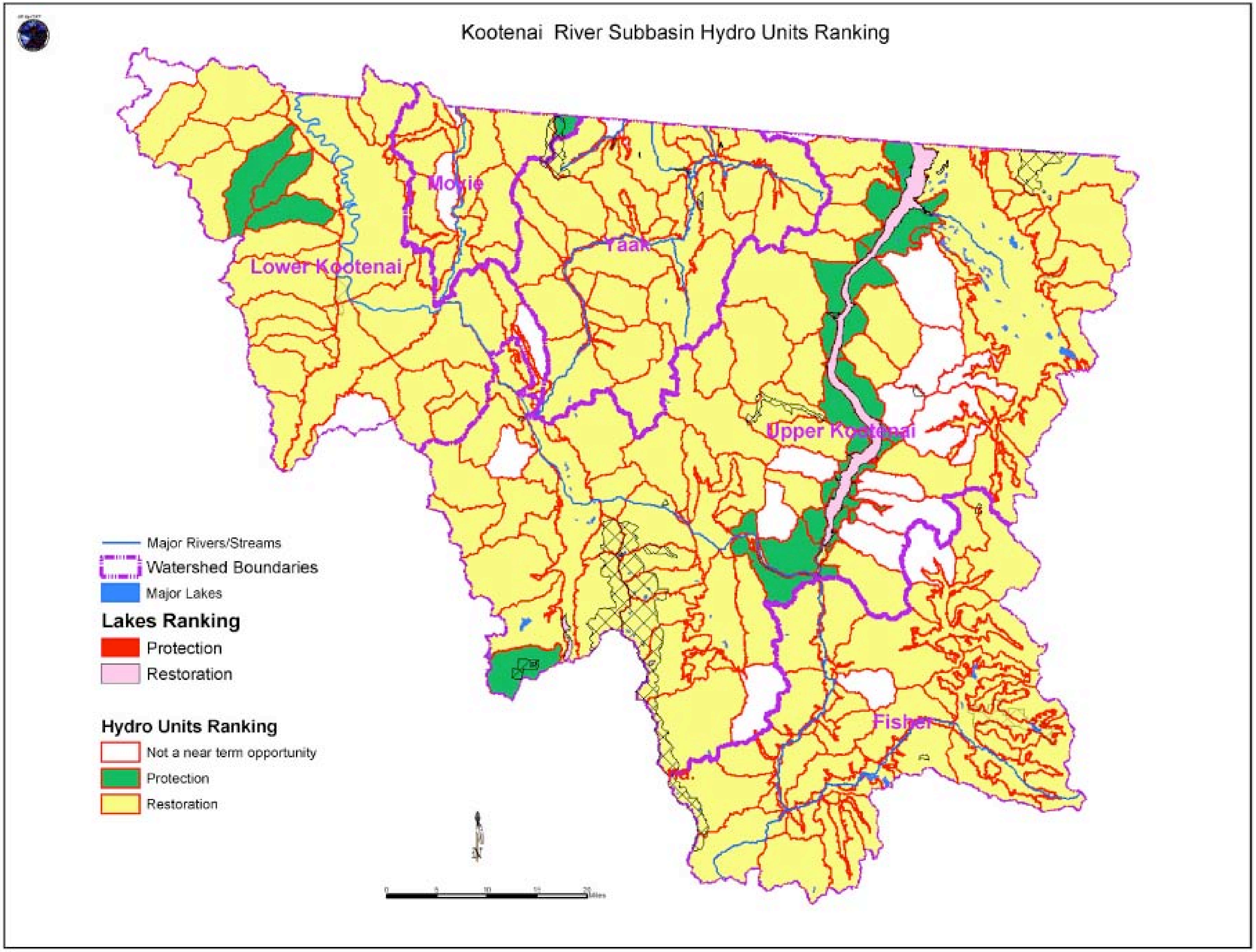

Figure 6.2. Aquatic near-term opportunities in the Kootenai Subbasin.

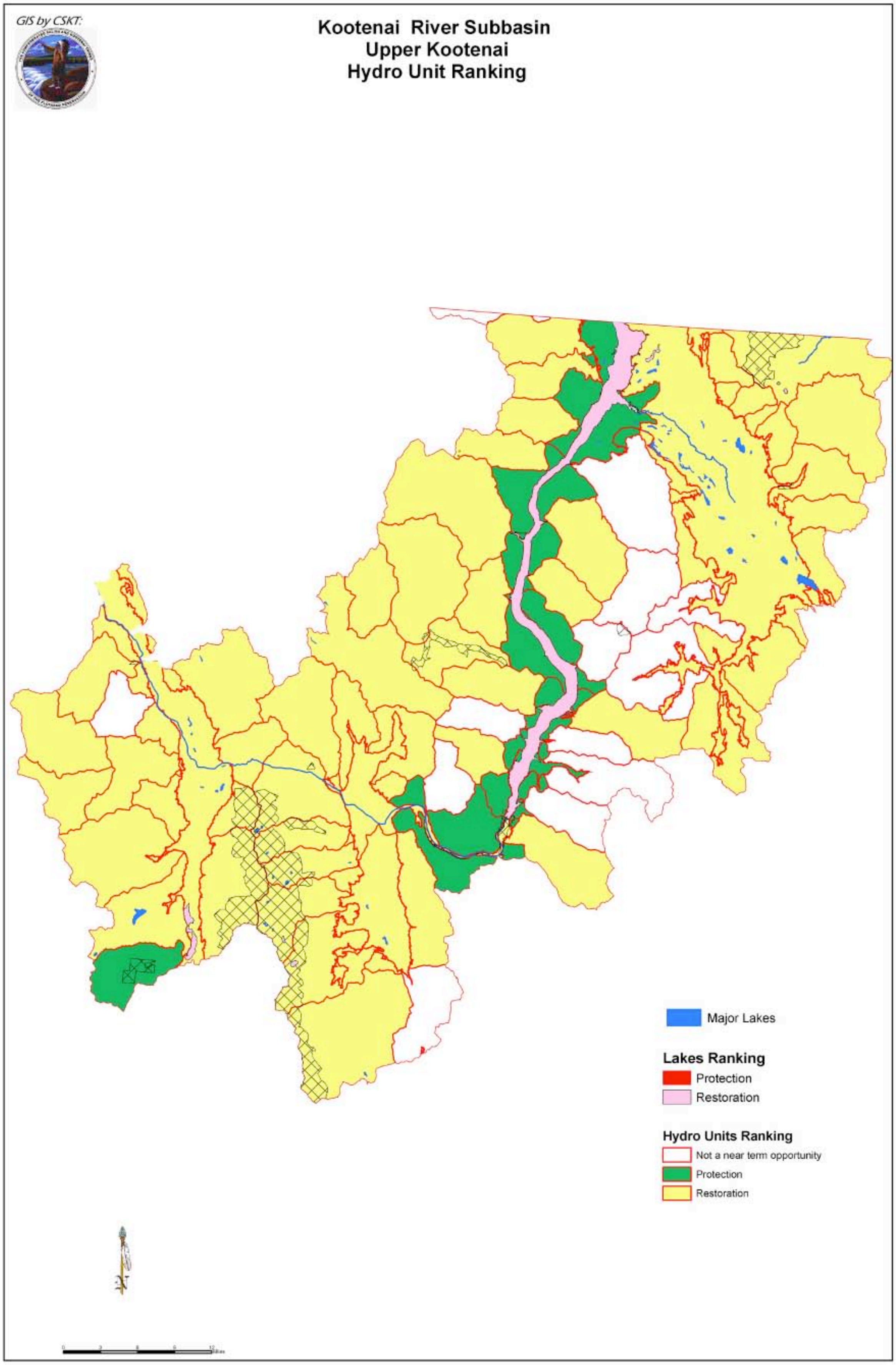

Figure 6.3. Aquatic near-term opportunities in the Upper Kootenai.

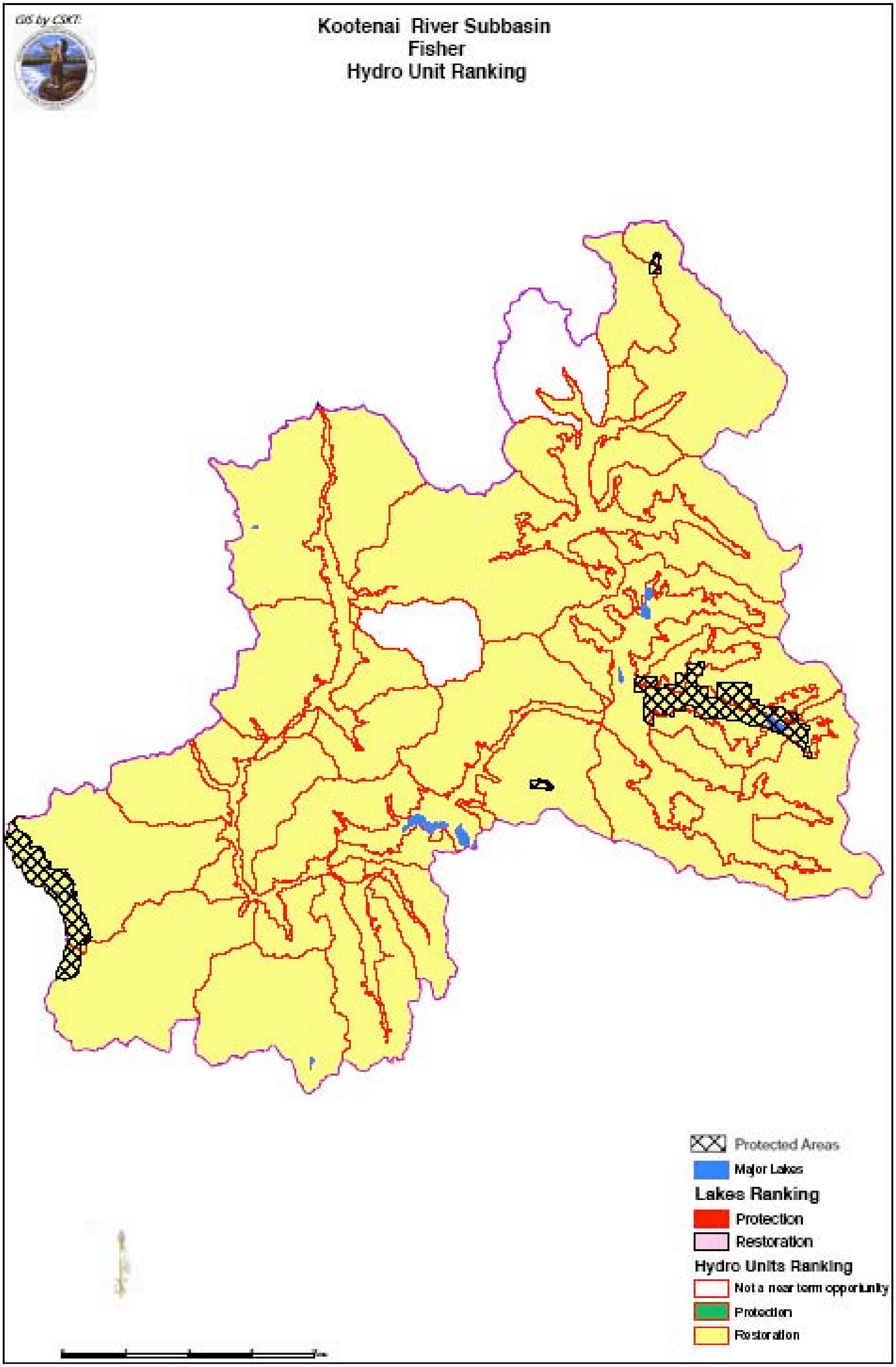

Figure 6.4. Aquatic near-term opportunities in the Fisher Watershed.

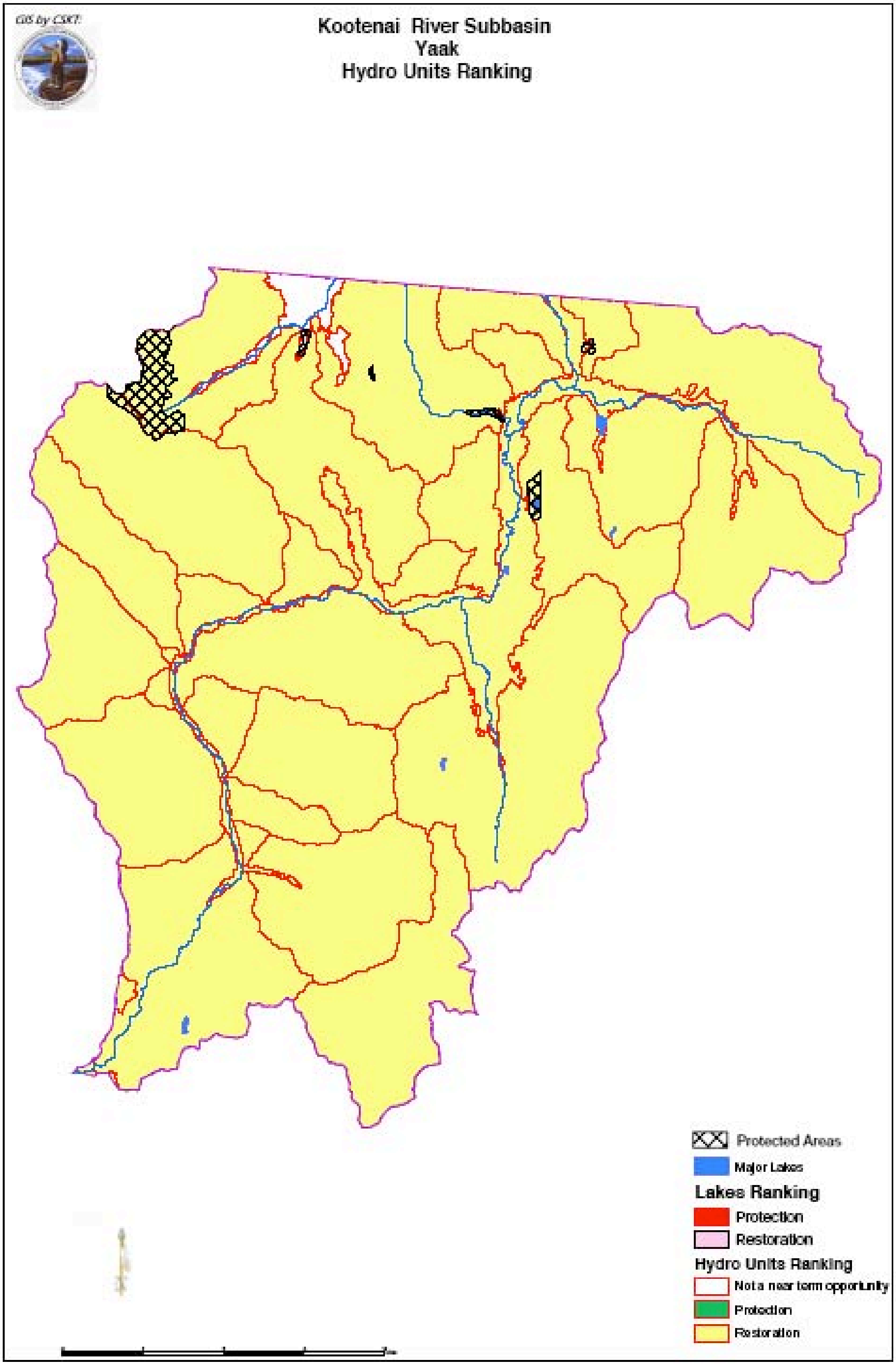

Figure 6.5. Aquatic near-term opportunities in the Yaak Watershed.

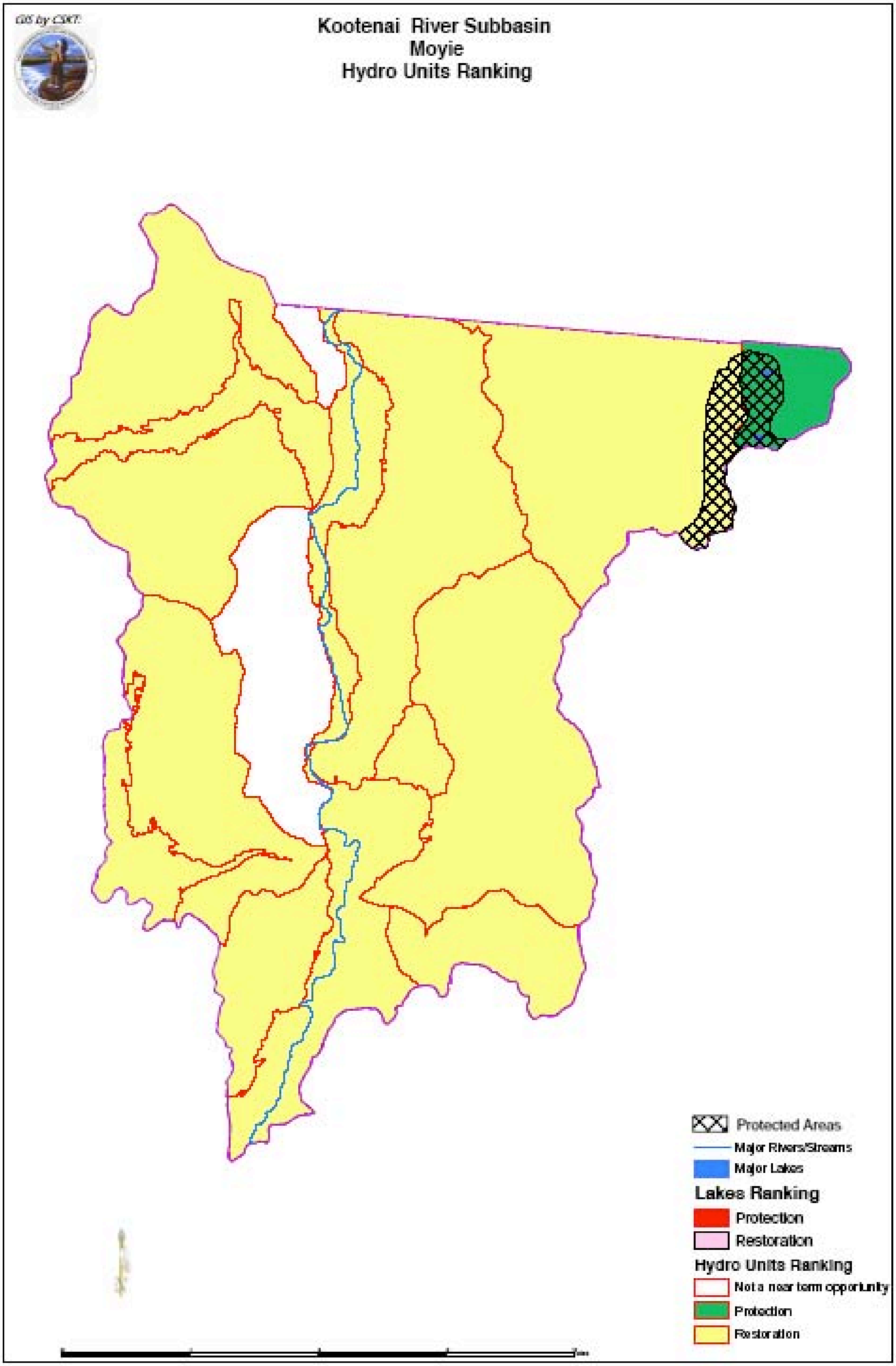

Figure 6.6. Aquatic near-term opportunities in the Moyie Watershed.

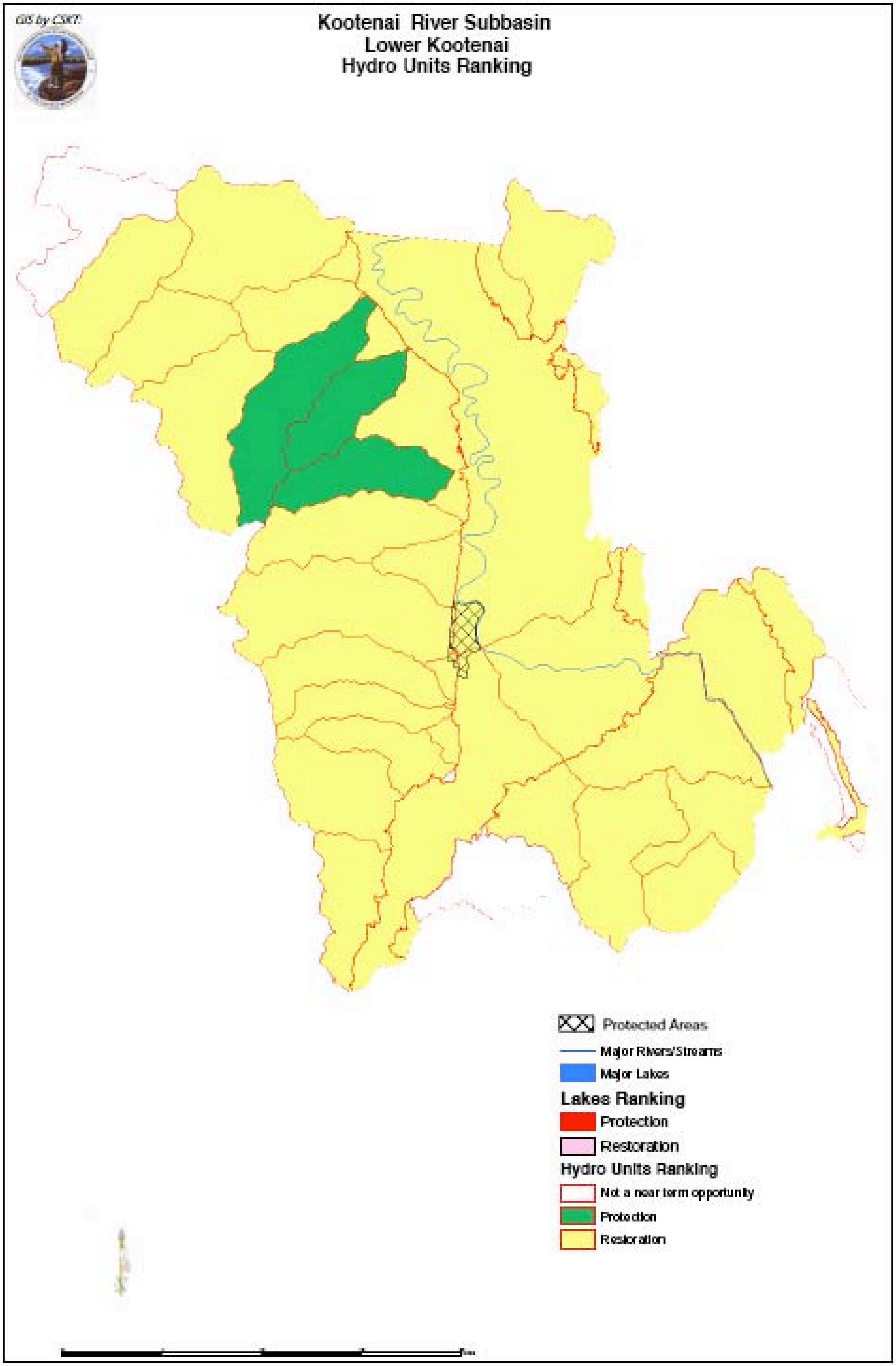

Figure 6.7. Aquatic near-term opportunities in the Lower Kootenai.

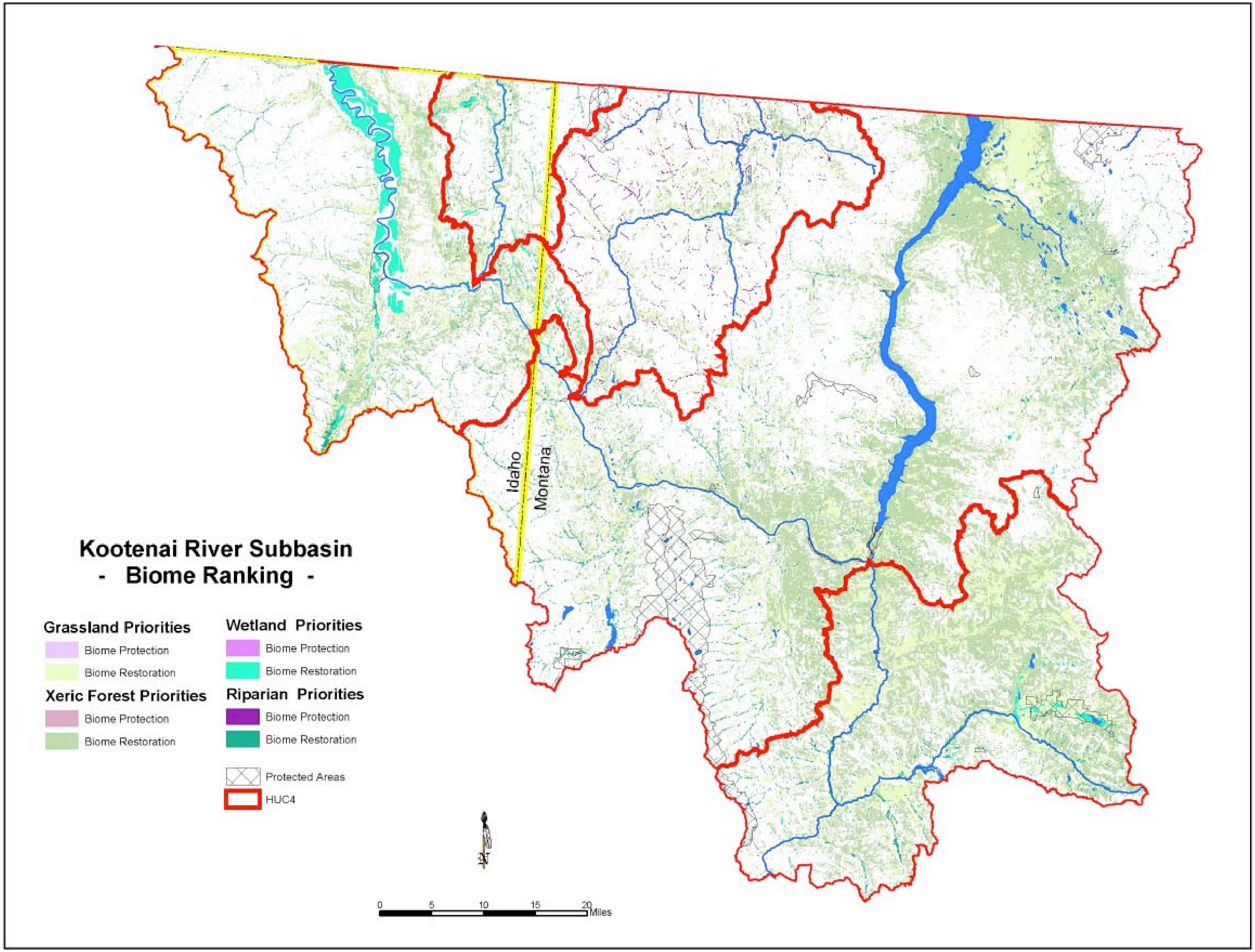

Figure 6.8. Terrestrial near-term opportunities in the Kootenai Subbasin.

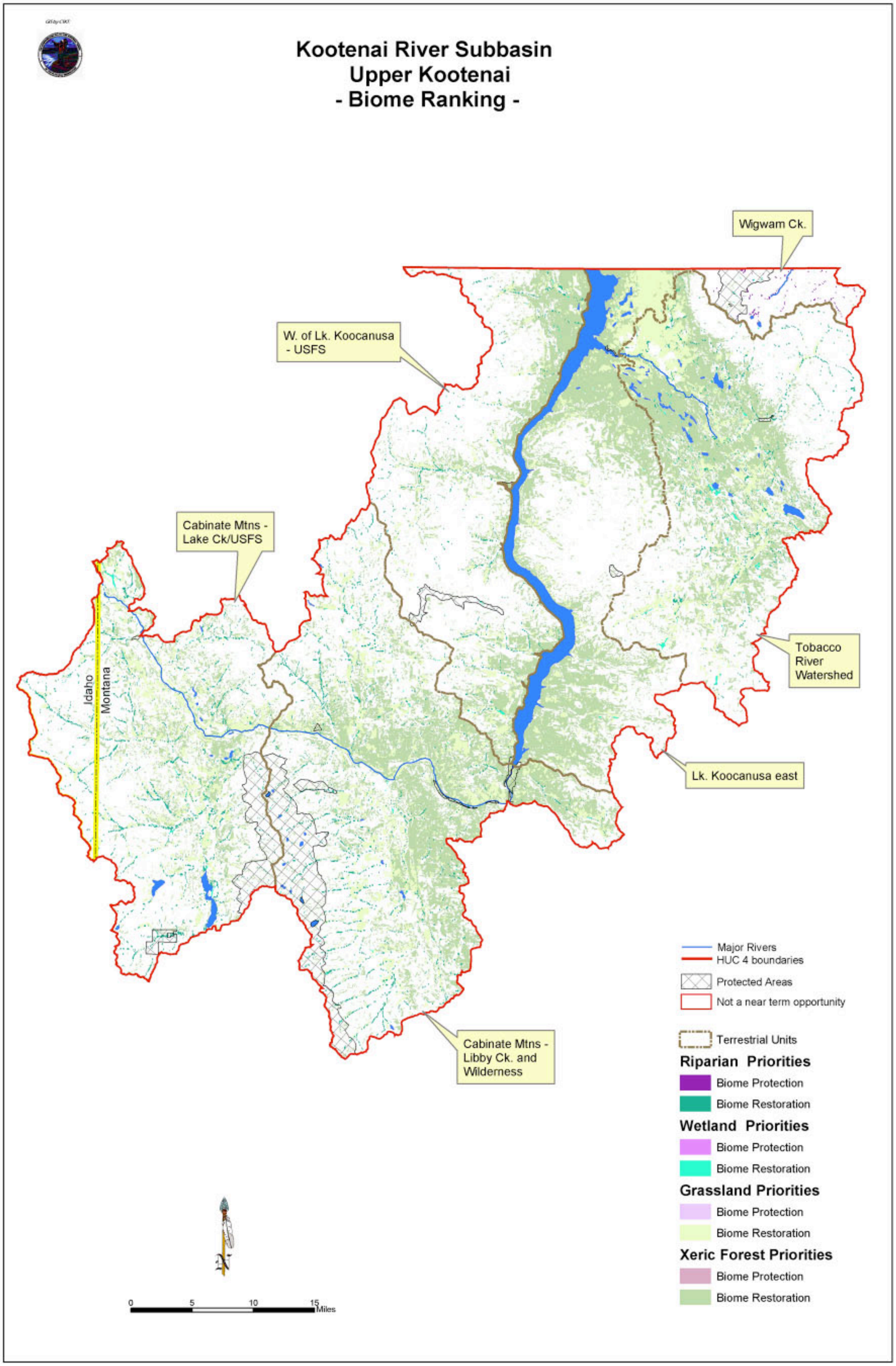

Figure 6.9. Terrestrial near-term opportunities in the Upper Kootenai.

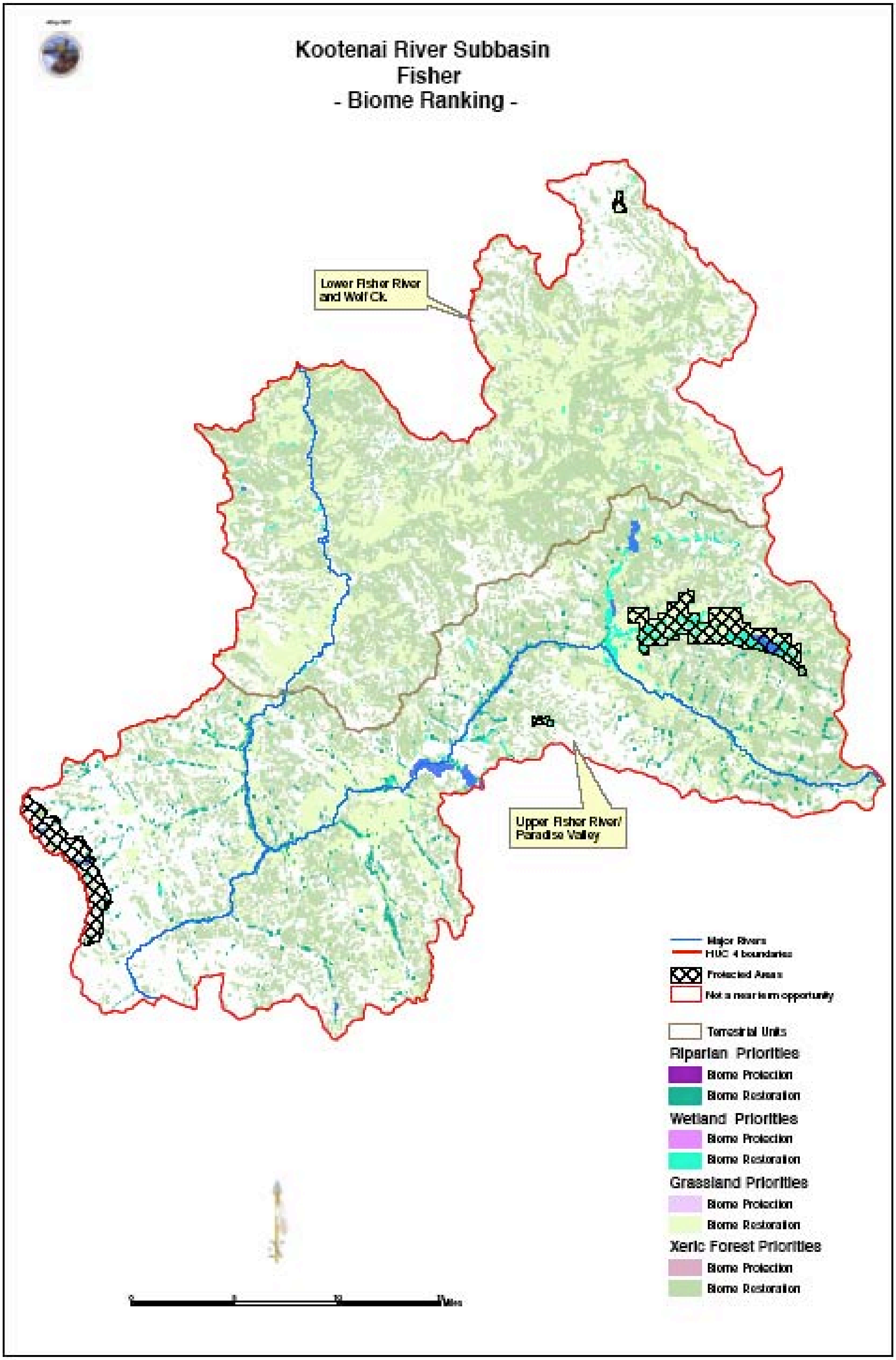

Figure 6.10. Terrestrial near-term opportunities in the Fisher Watershed.

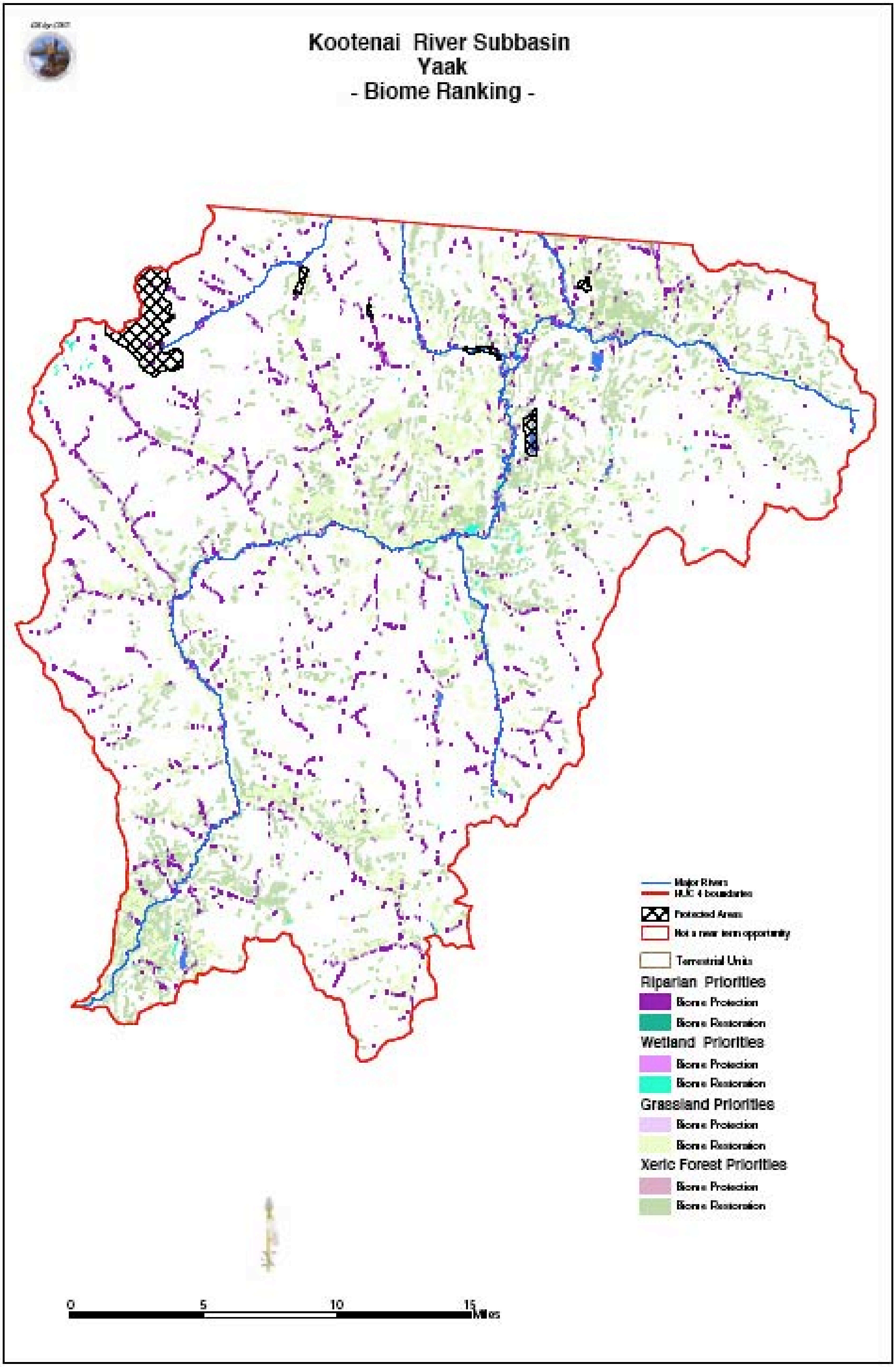

Figure 6.11. Terrestrial near-term opportunities in the Yaak Watershed.

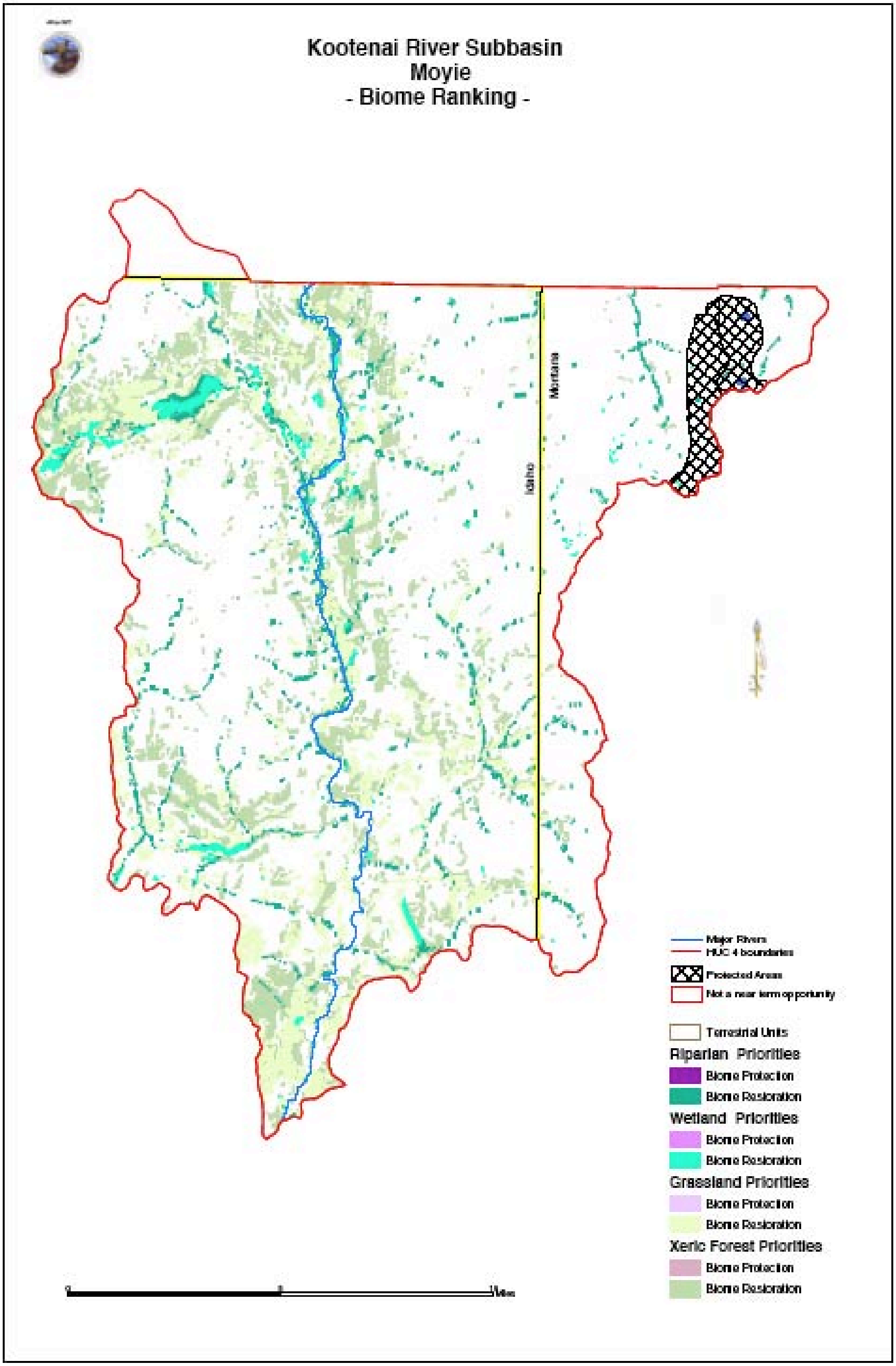

Figure 6.12. Terrestrial near-term opportunities in the Moyie Watershed.

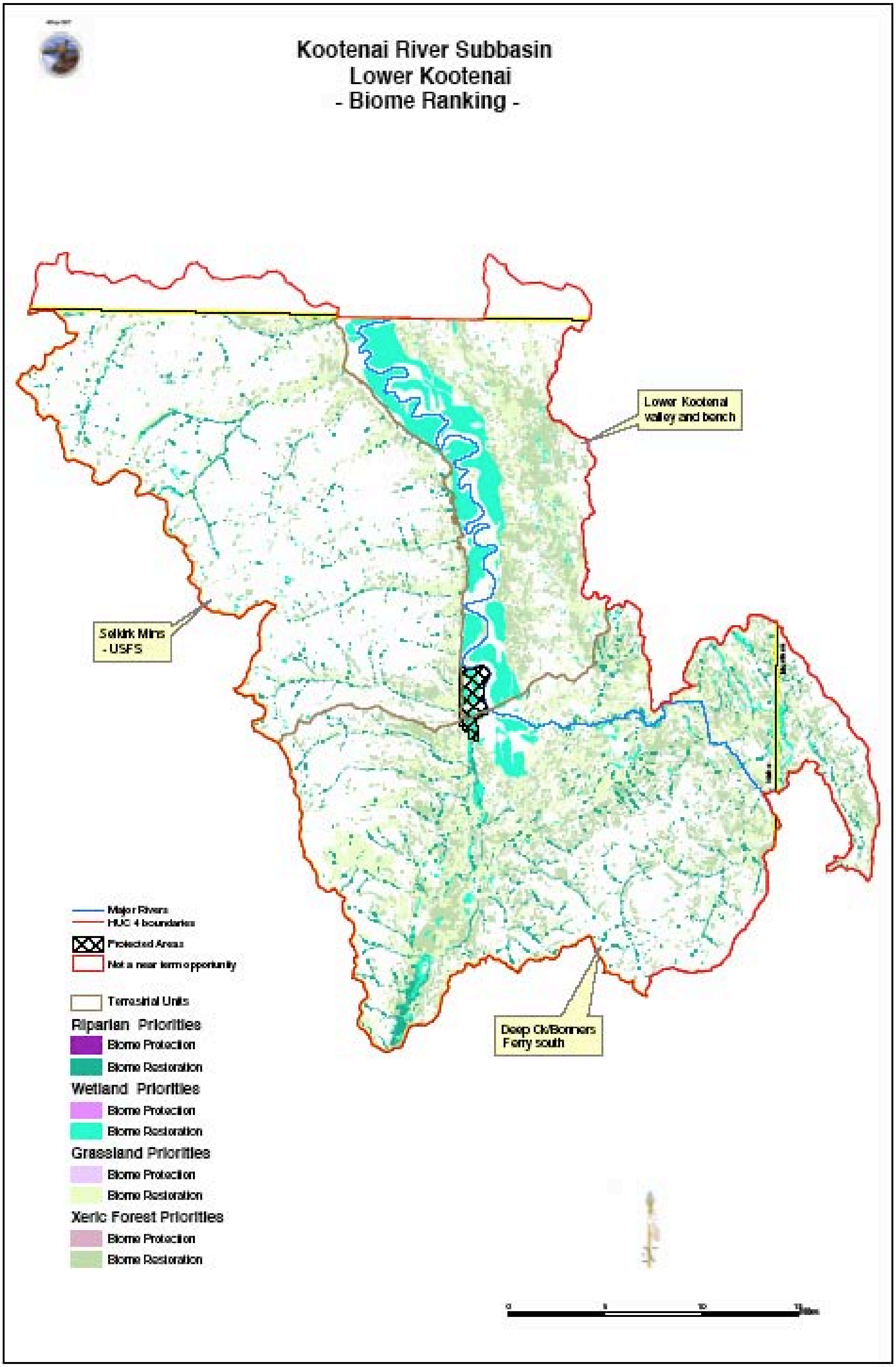

Figure 6.13. Terrestrial near-term opportunities in the Lower Kootenai.

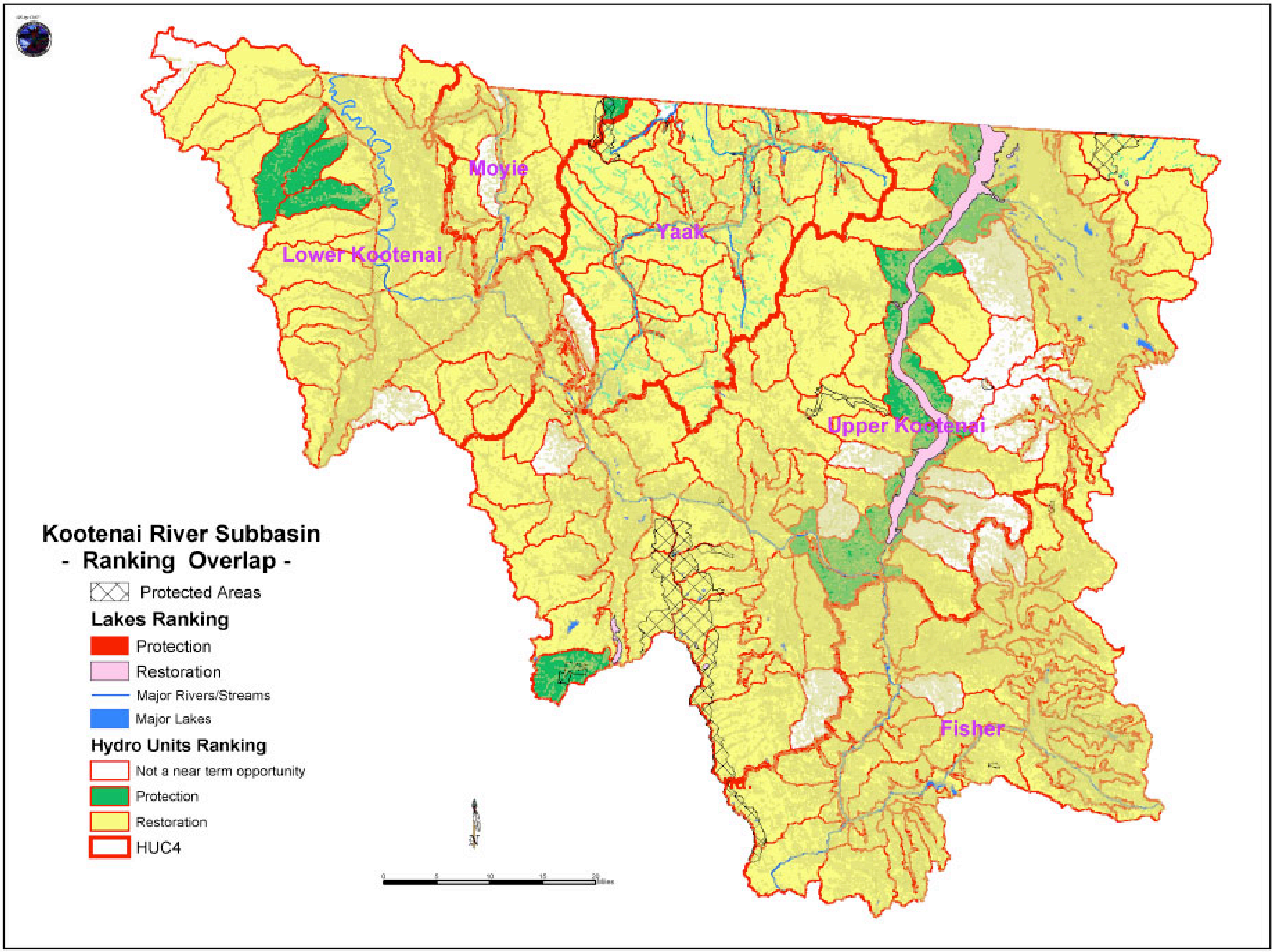

Figure 6.14. Overlay of aquatic and terrestrial near-term opportunities in the Kootenai Subbasin.

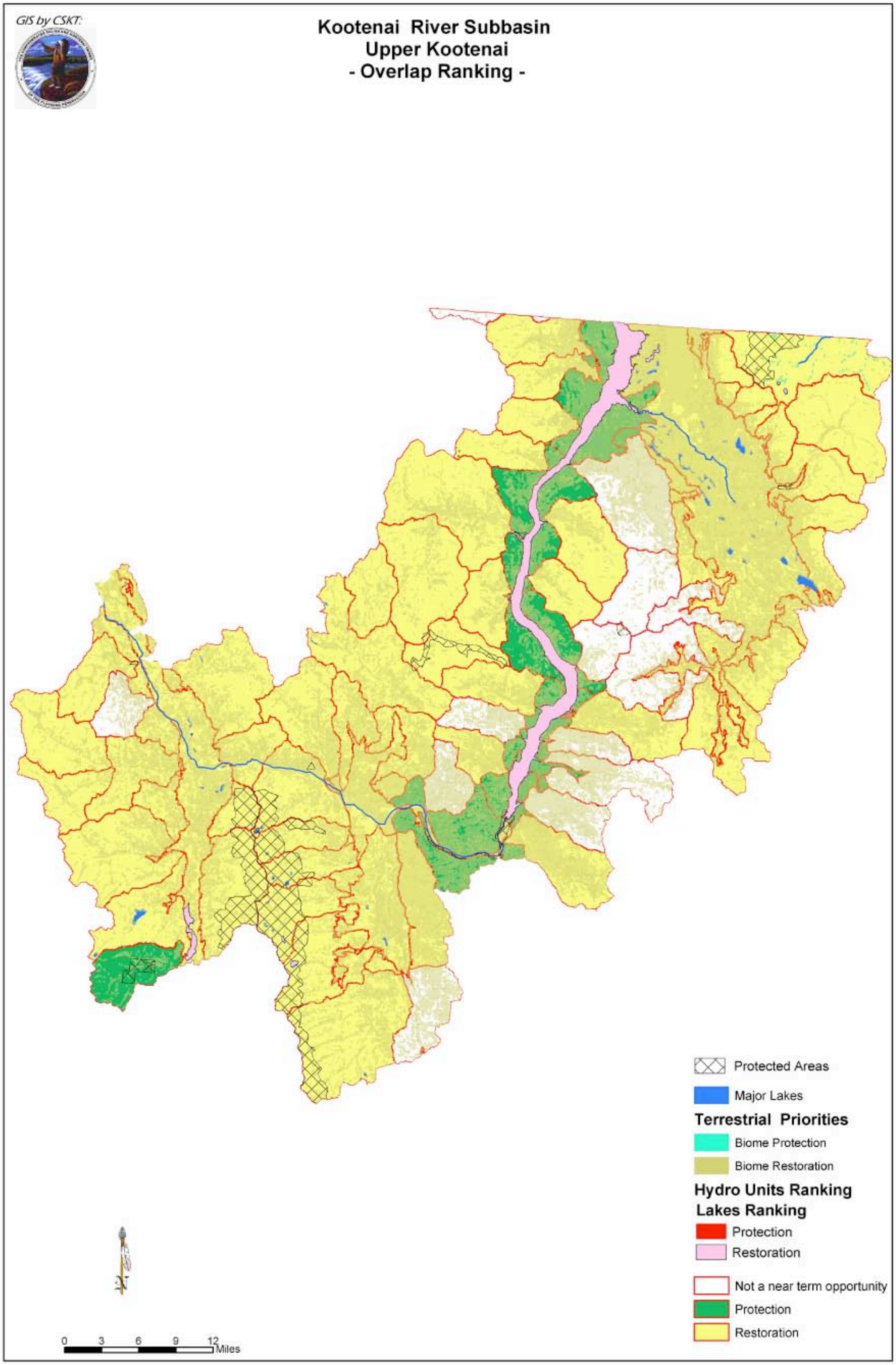

Figure 6.15. Overlay of aquatic and terrestrial near-term opportunities in the Upper Kootenai.

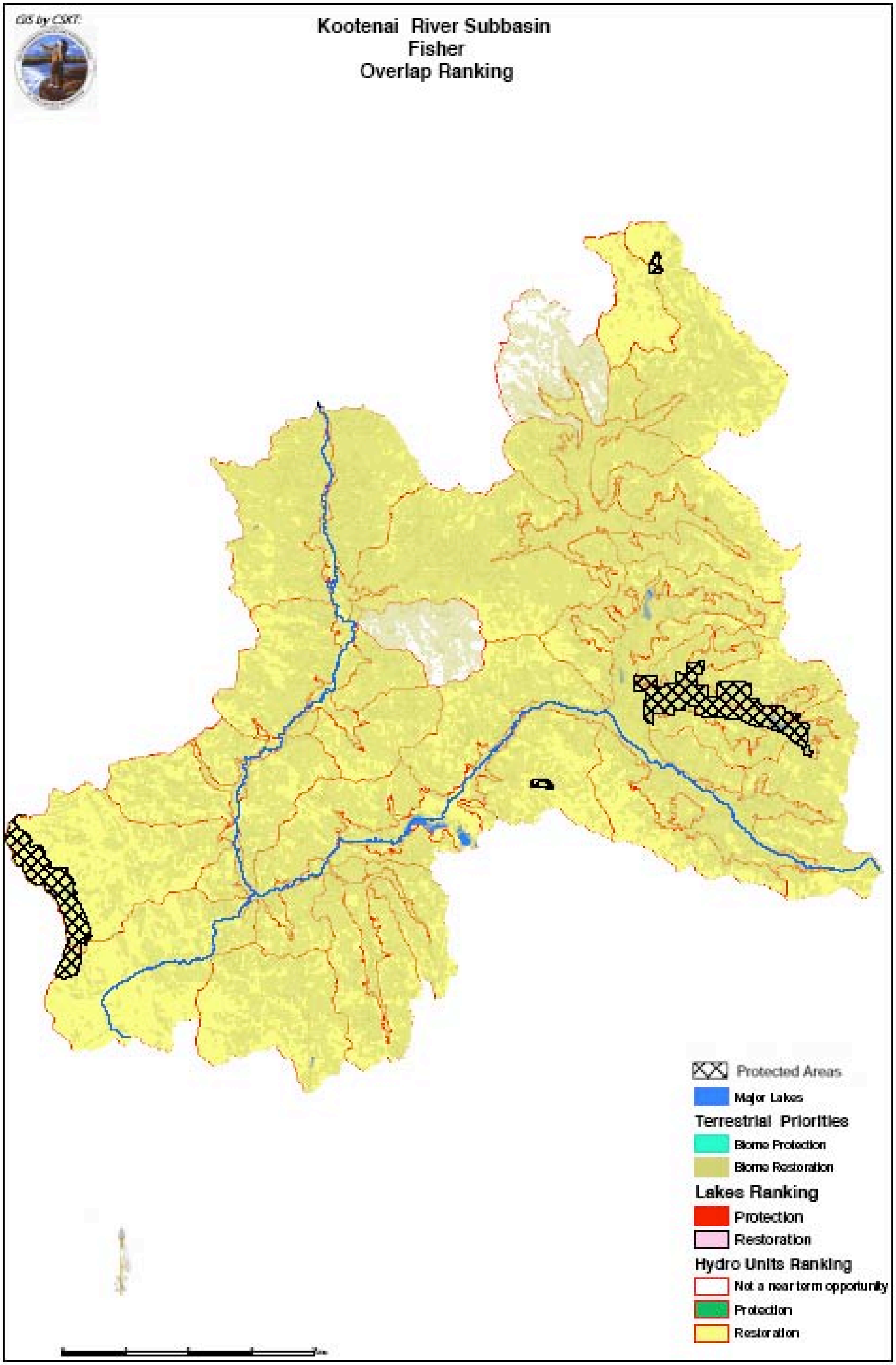

Figure 6.16. Overlay of aquatic and terrestrial near-term opportunities in the Fisher Watershed.

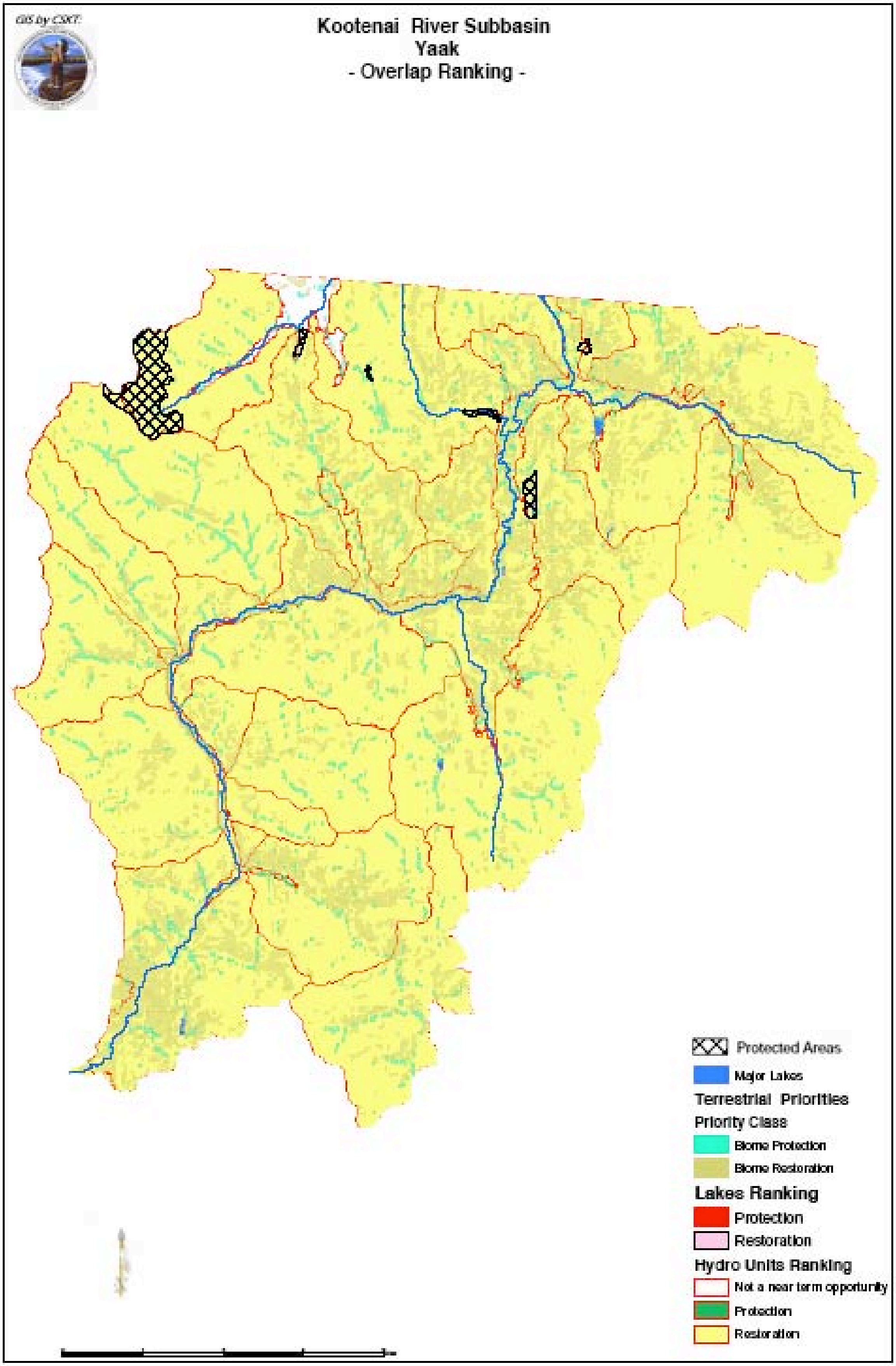

Figure 6.17. Overlay of aquatic and terrestrial near-term opportunities in the Yaak Watershed.

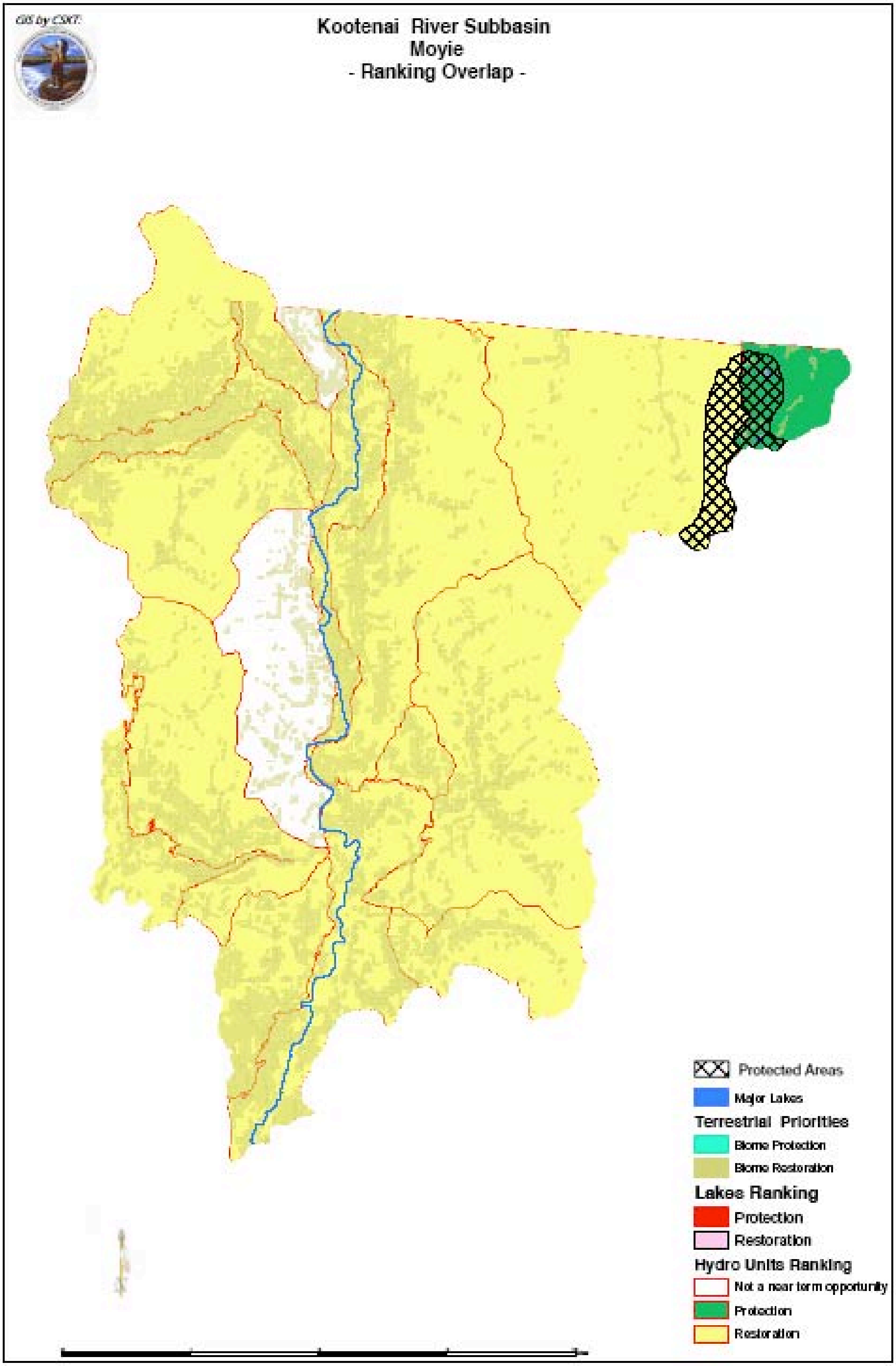

Figure 6.17. Overlay of aquatic and terrestrial near-term opportunities in the Moyie Watershed.

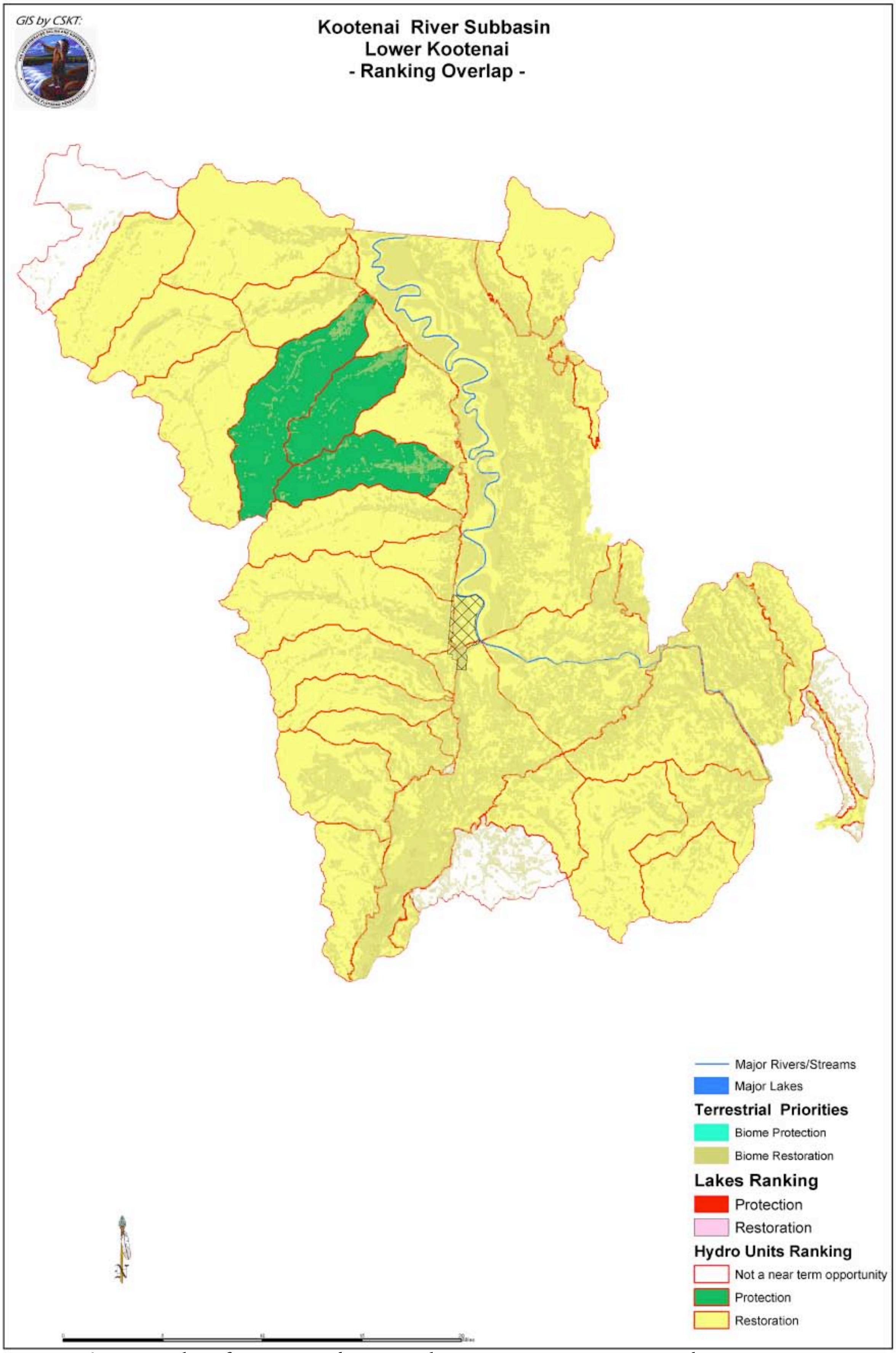

Figure 6.18. Overlay of aquatic and terrestrial near-term opportunities in the Lower Kootenai.

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