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

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[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

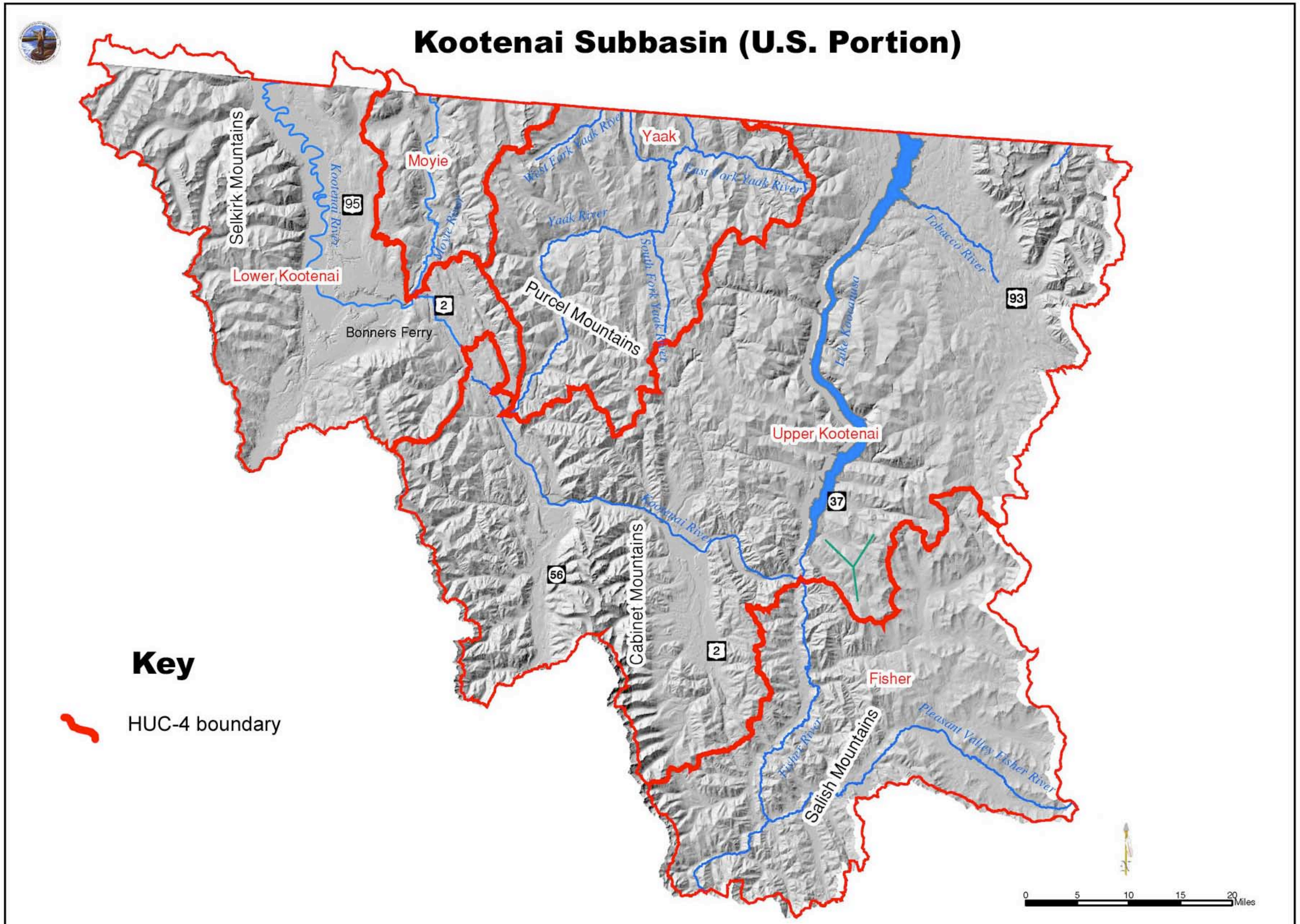

Figure 1.1. Kootenai Subbasin, U.S. Portion.

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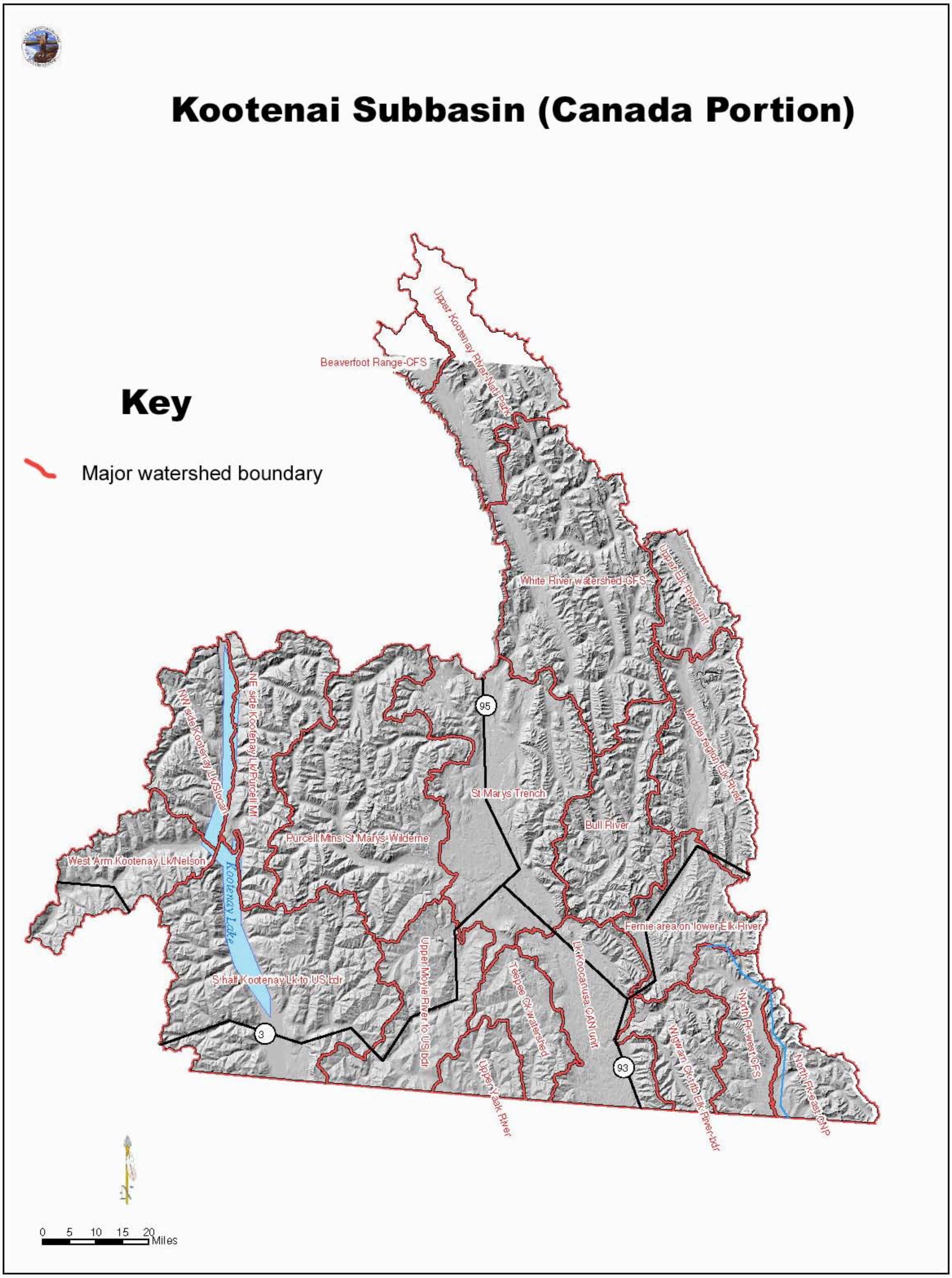

Figure 1.2. Kootenai Subbasin, Canada Portion.

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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.

Click Here

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

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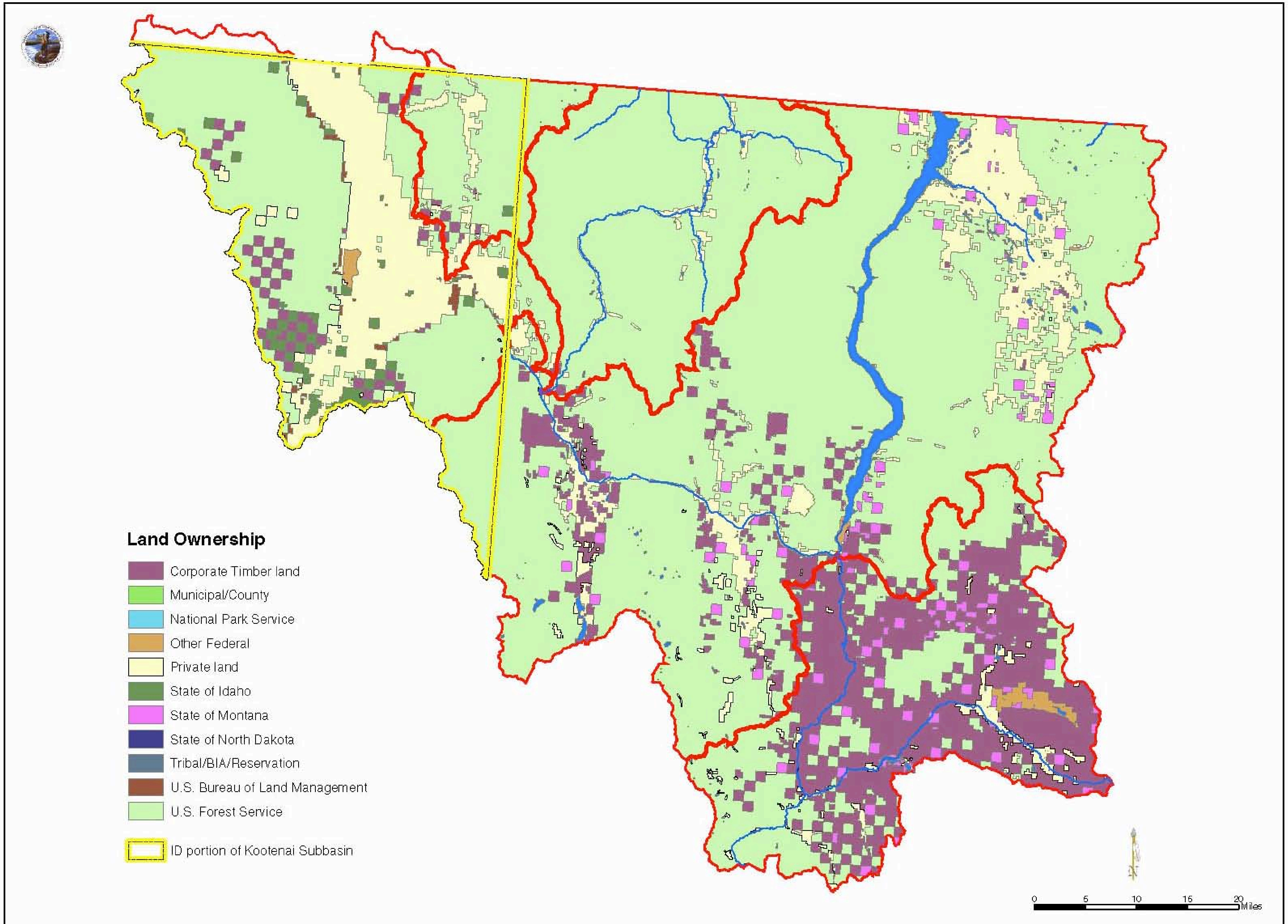

Figure 1.3. Landownership in the U.S. portion of the Kootenai Subbasin.

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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.

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.

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.

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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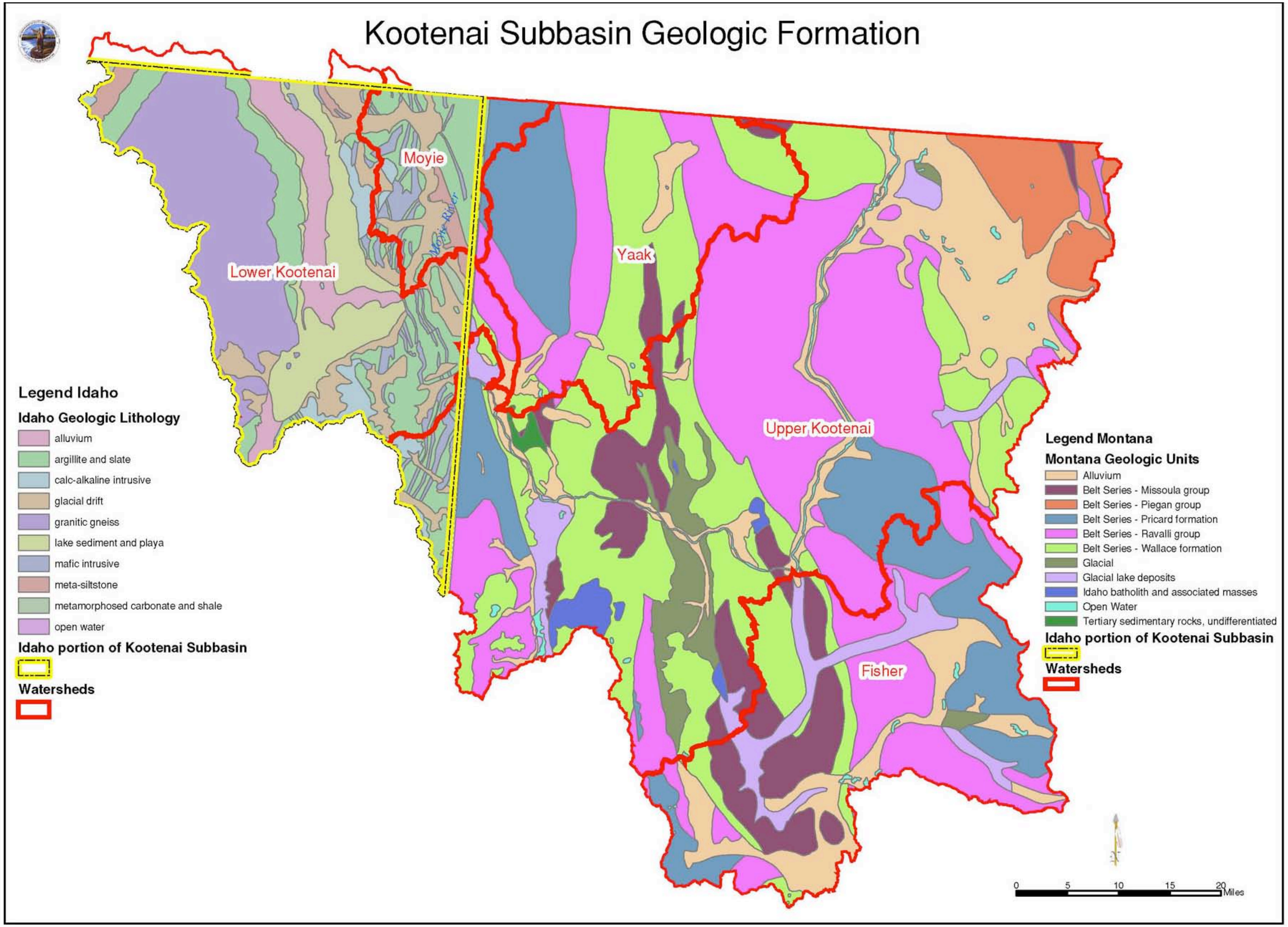

Figure 1.4. Geology of the U.S. portion of the Kootenai River Subbasin.

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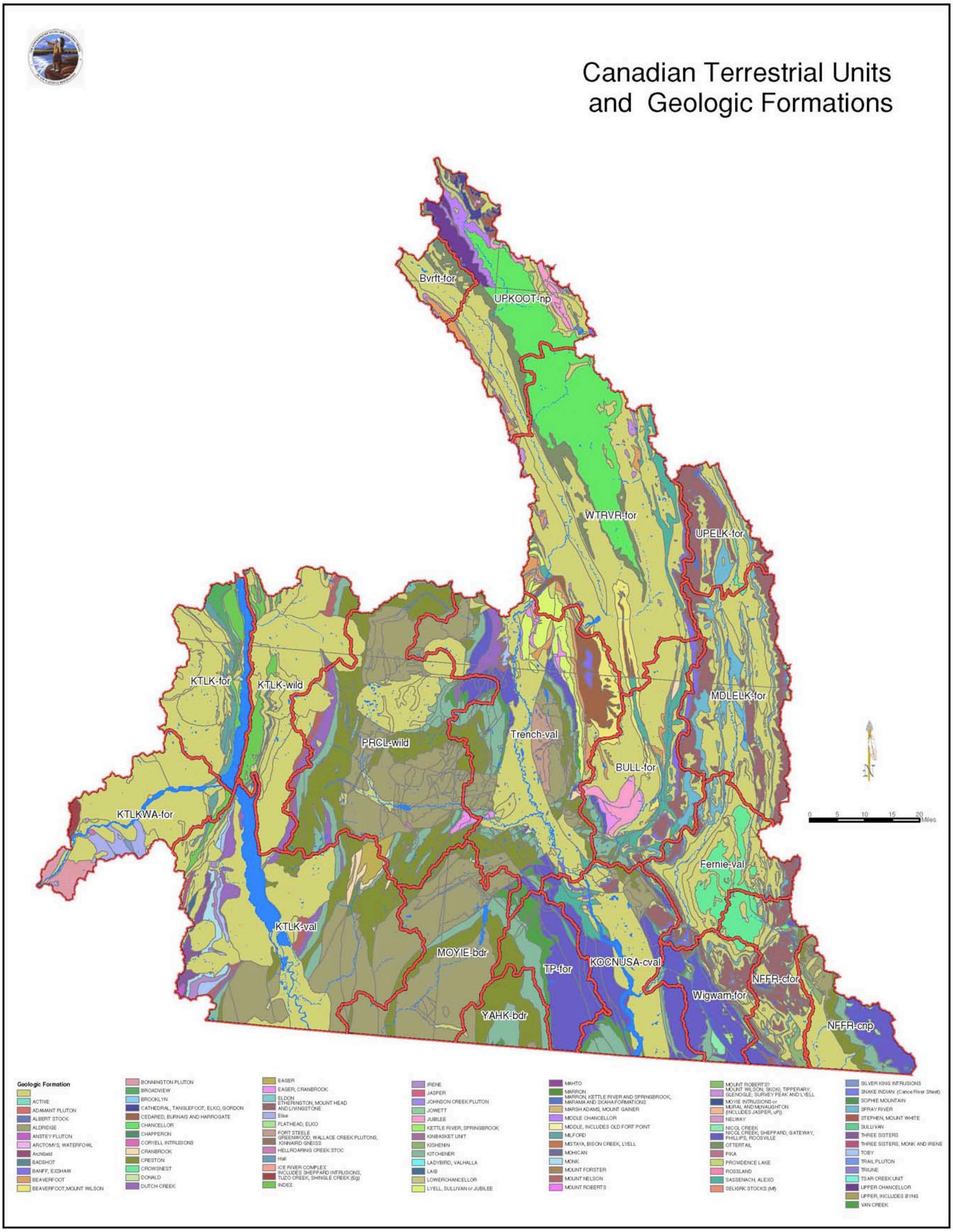

Figure 1.5. Geology of the Canadian portion of the Kootenai River Subbasin.

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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%

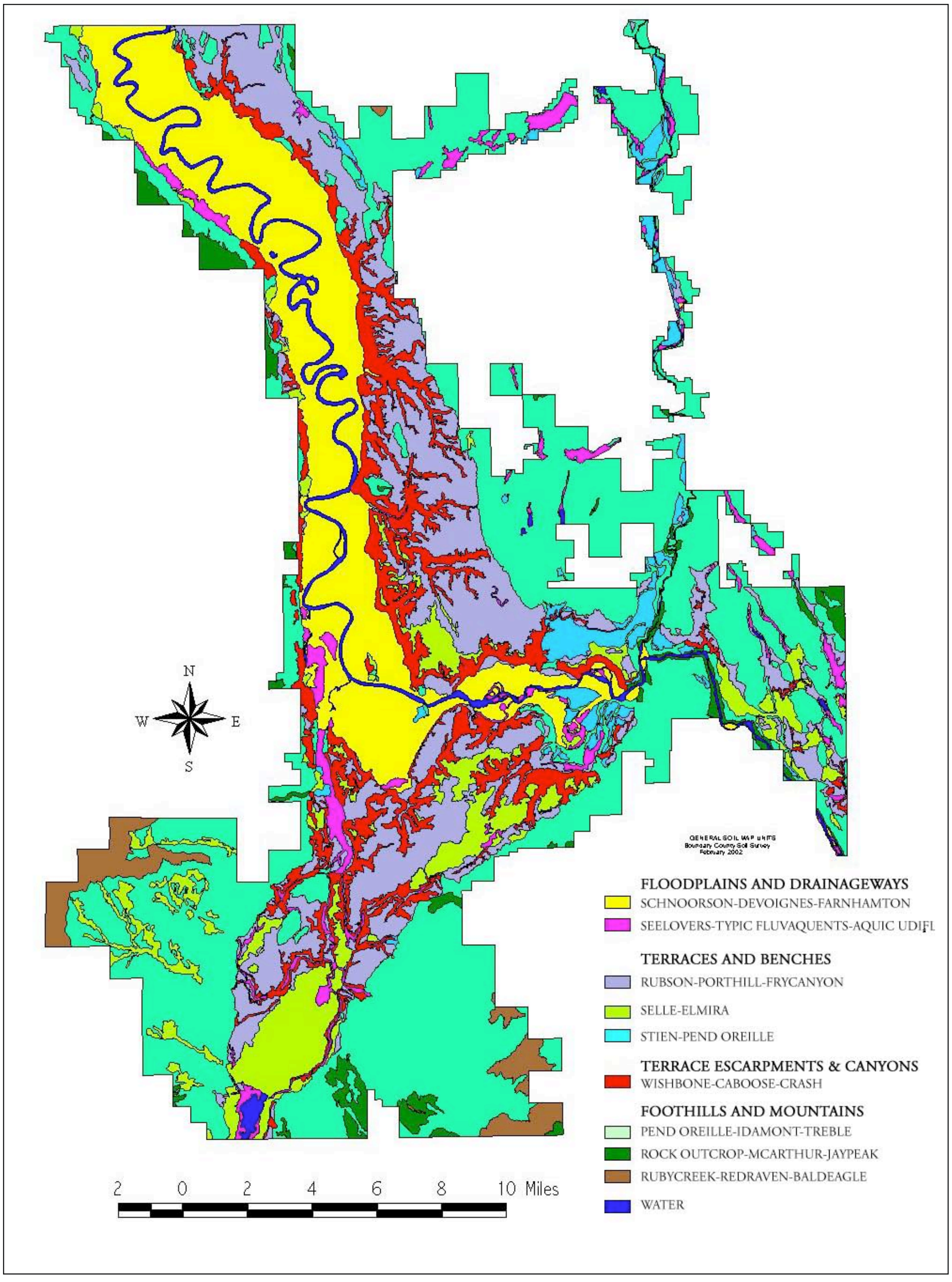

Figure 1.6. Major soil groups in the Idaho portion of the Kootenai.

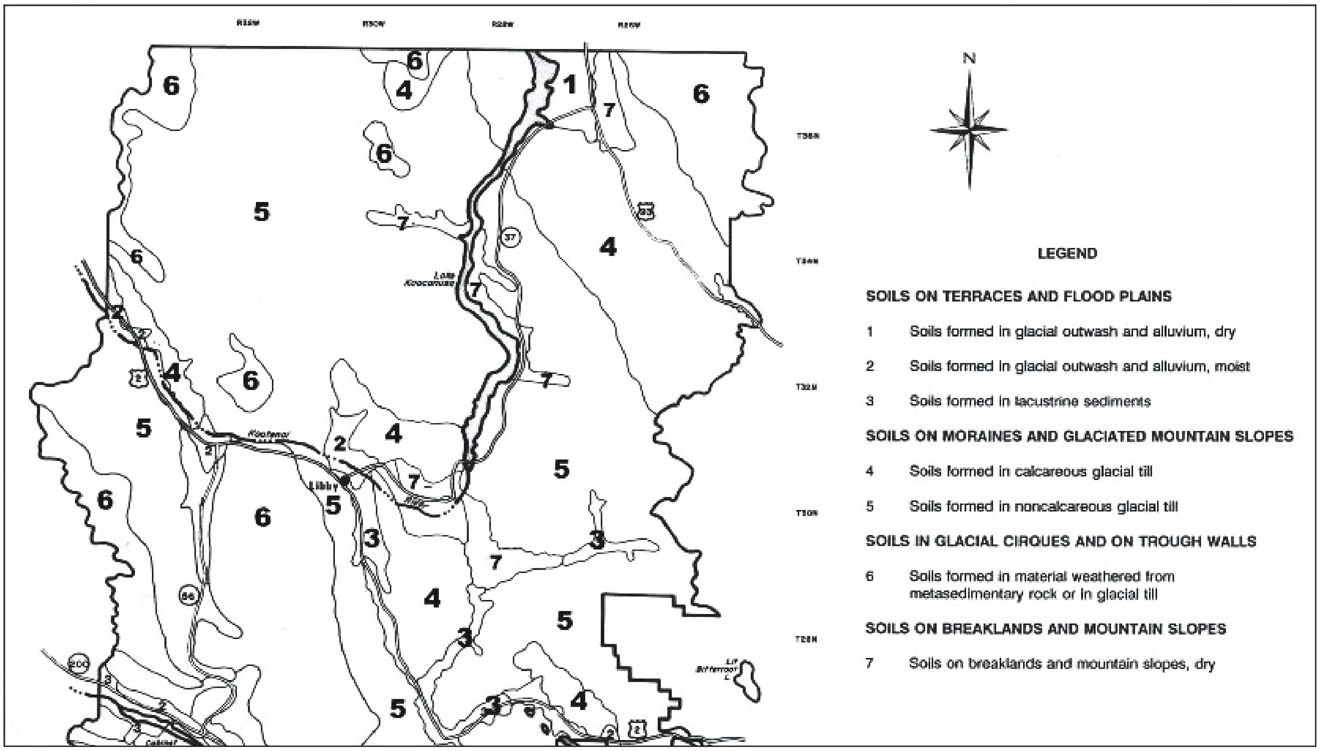

Figure 1.7. Major soil groups in the Montana portion of the Kootenai.

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

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

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.

[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

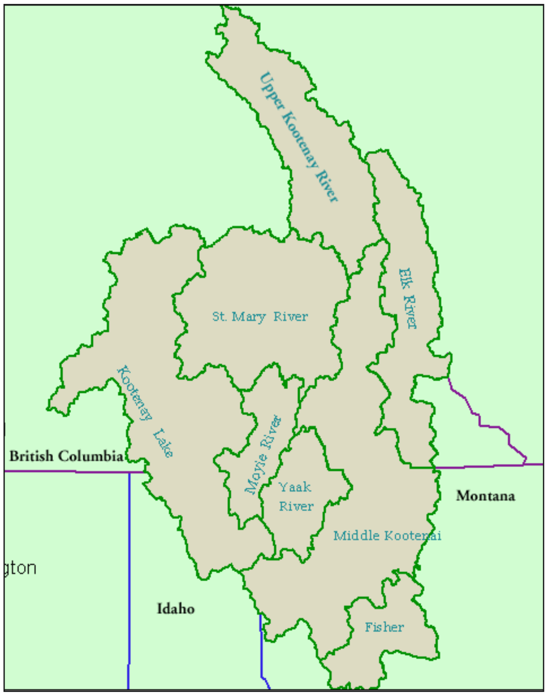

Figure 1.8. Kootenai Subbasin Watersheds delineated by the Kootenai River Network.

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

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

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

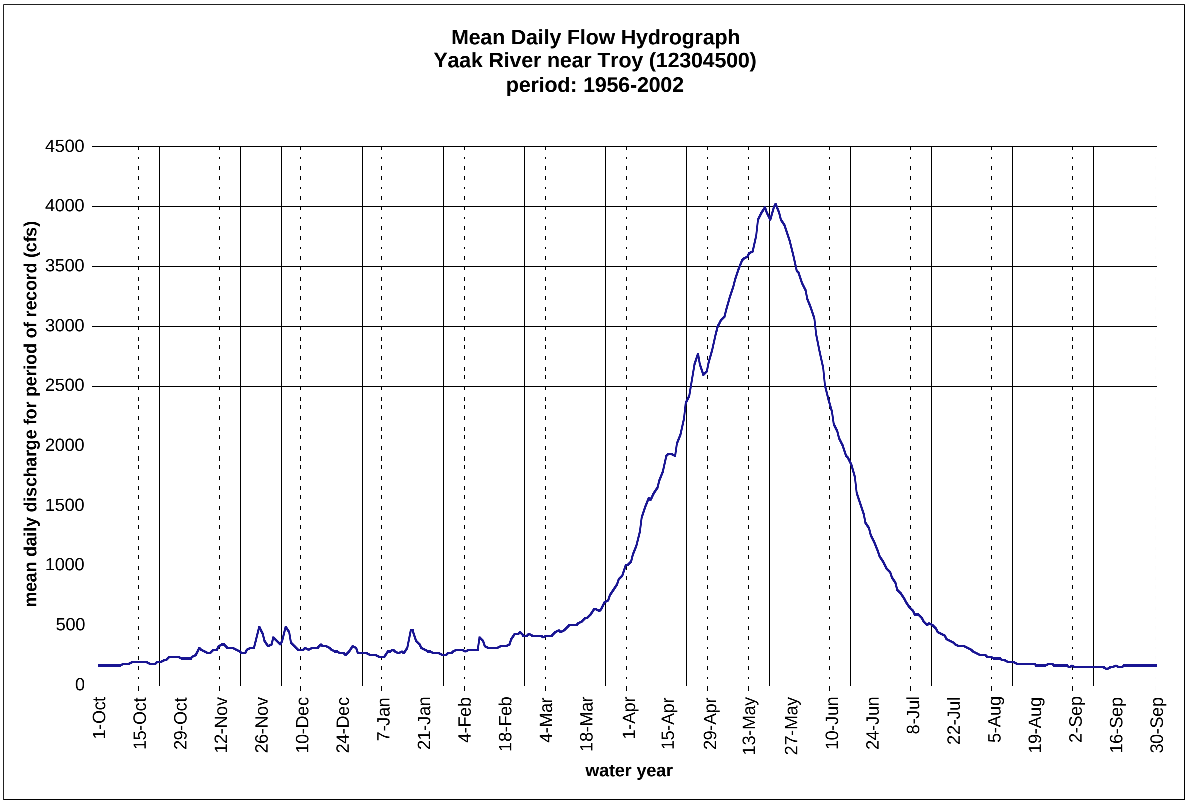

Figure 1.9. A representative hydrograph of the Kootenai Subbasin:Yaak River mean daily discharge values. Much of the subbasin has a snowmelt system prone to winter rain on snow events.

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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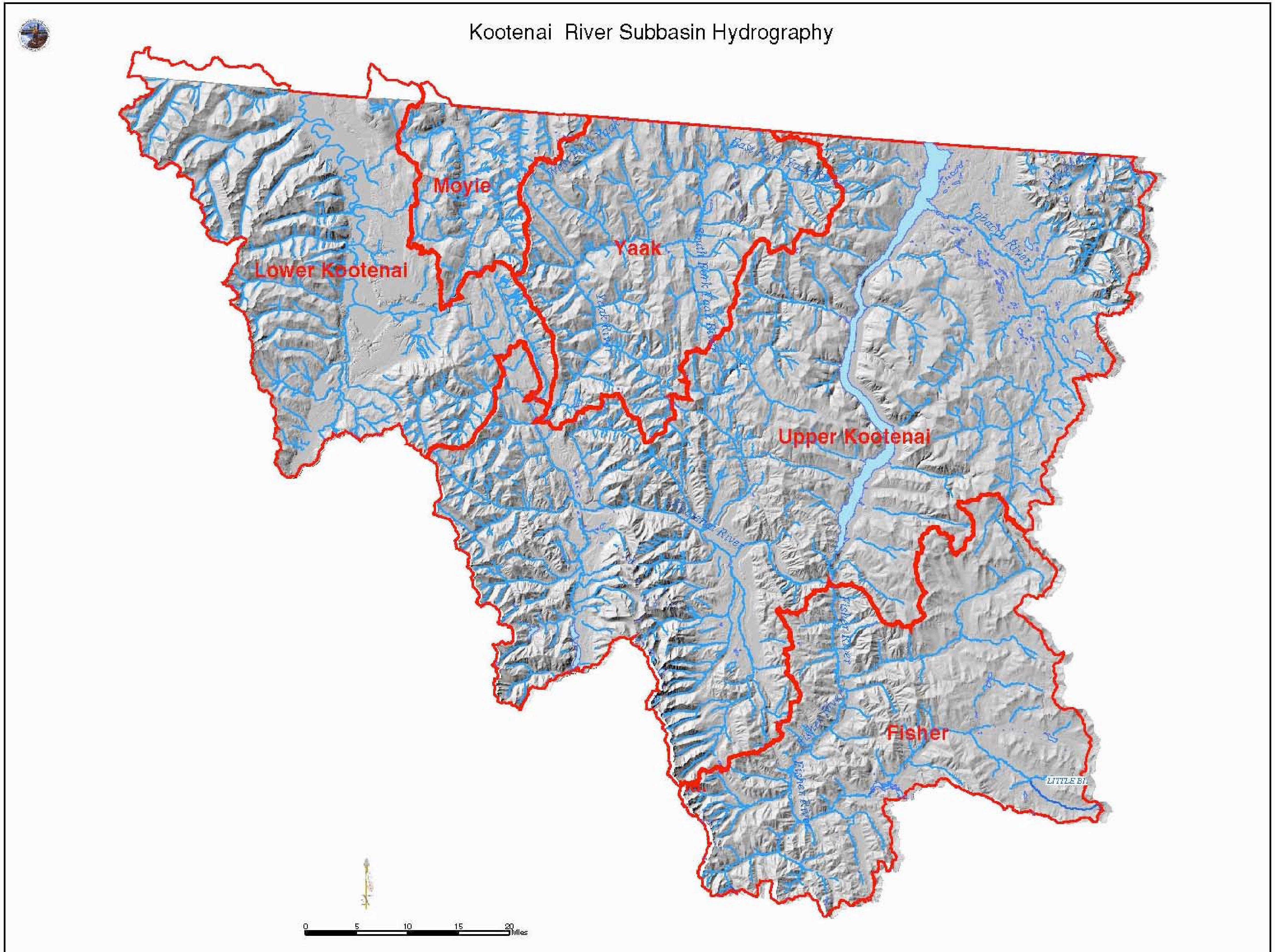

Figure 1.10. Hydrography of the U.S. portion of the Kootenai Subbasin.

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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.

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

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

[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

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.

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.

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

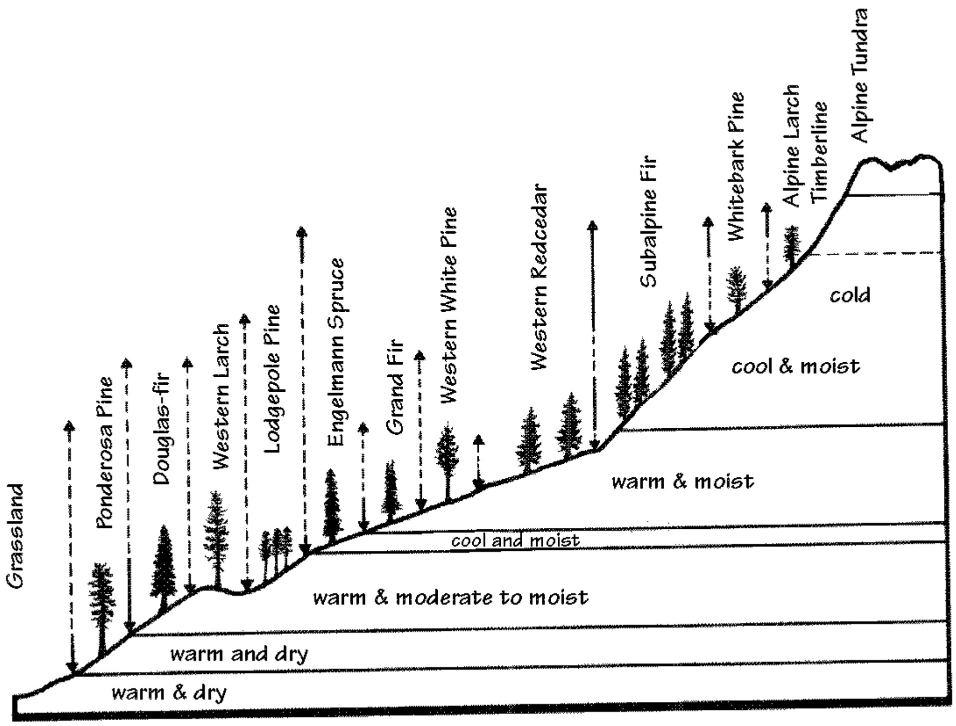

Figure 1.11. A generalized distribution of forest trees within the Kootenai Subbasin (after Pfister et al. 1977). The arrows show the relative elevational range of each species; the solid portion of each arrow indicates where a species is the potential climax and the dashed portion shows where it is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

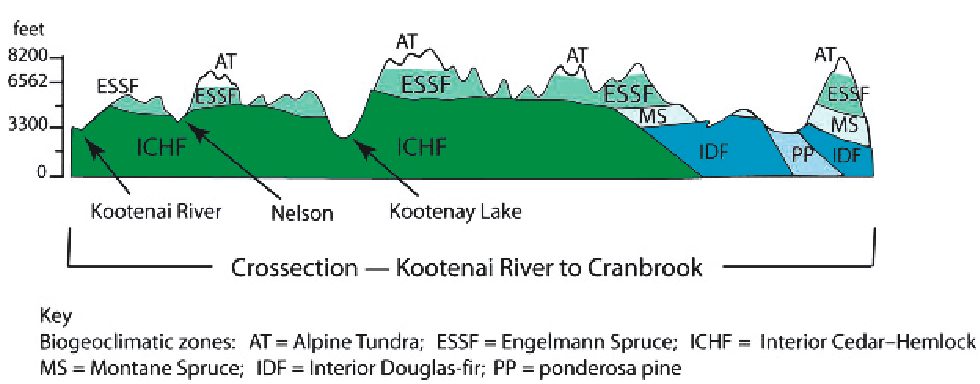

Figure 1.12. Representative crosssection of the B.C. portion of the Kootenai Subbasin showing elevational distribution of forest communities.

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).

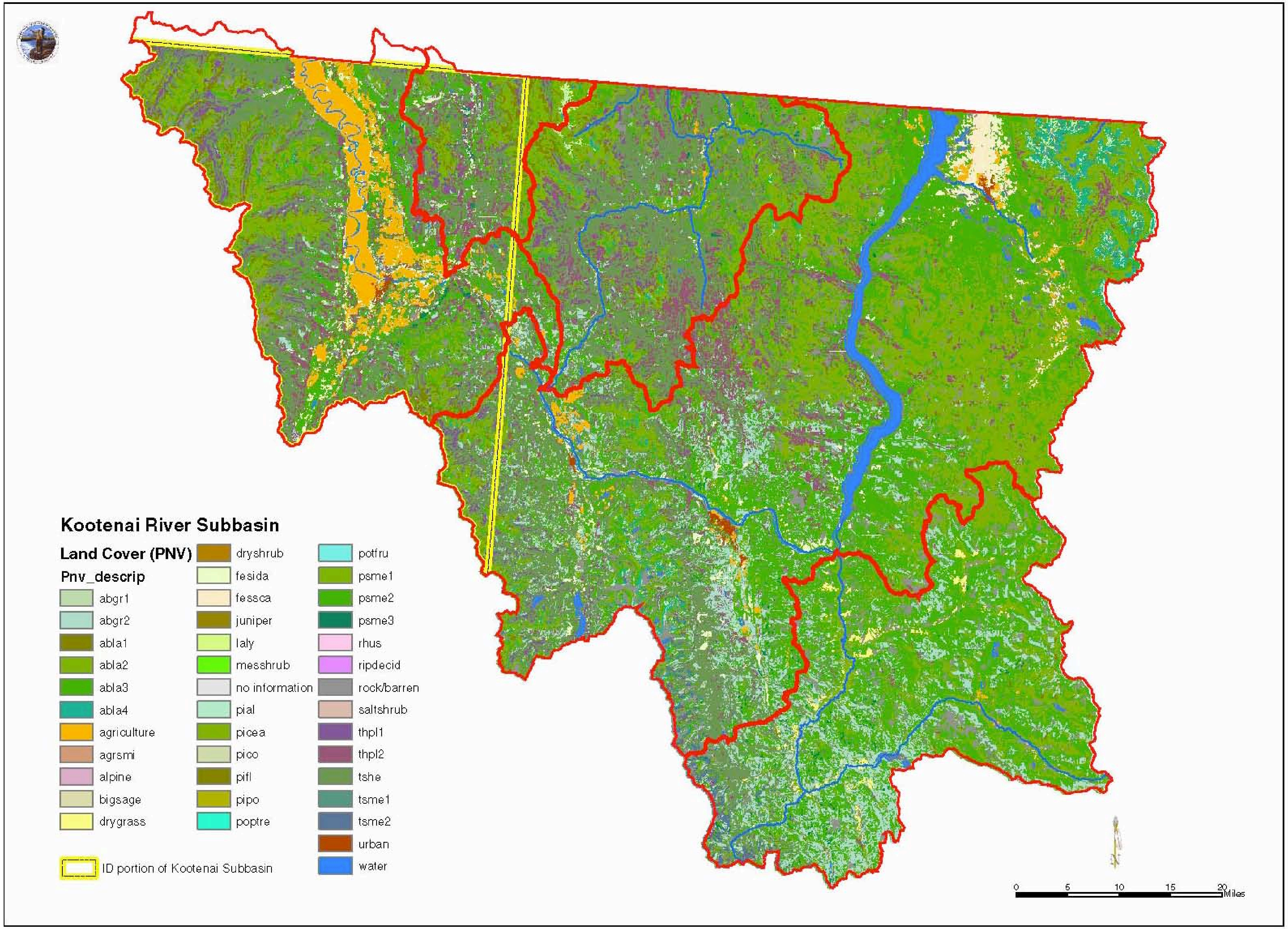

Figure 1.13. Potential Natural Vegetation of the U.S. portion of the Kootenai River Subbasin.

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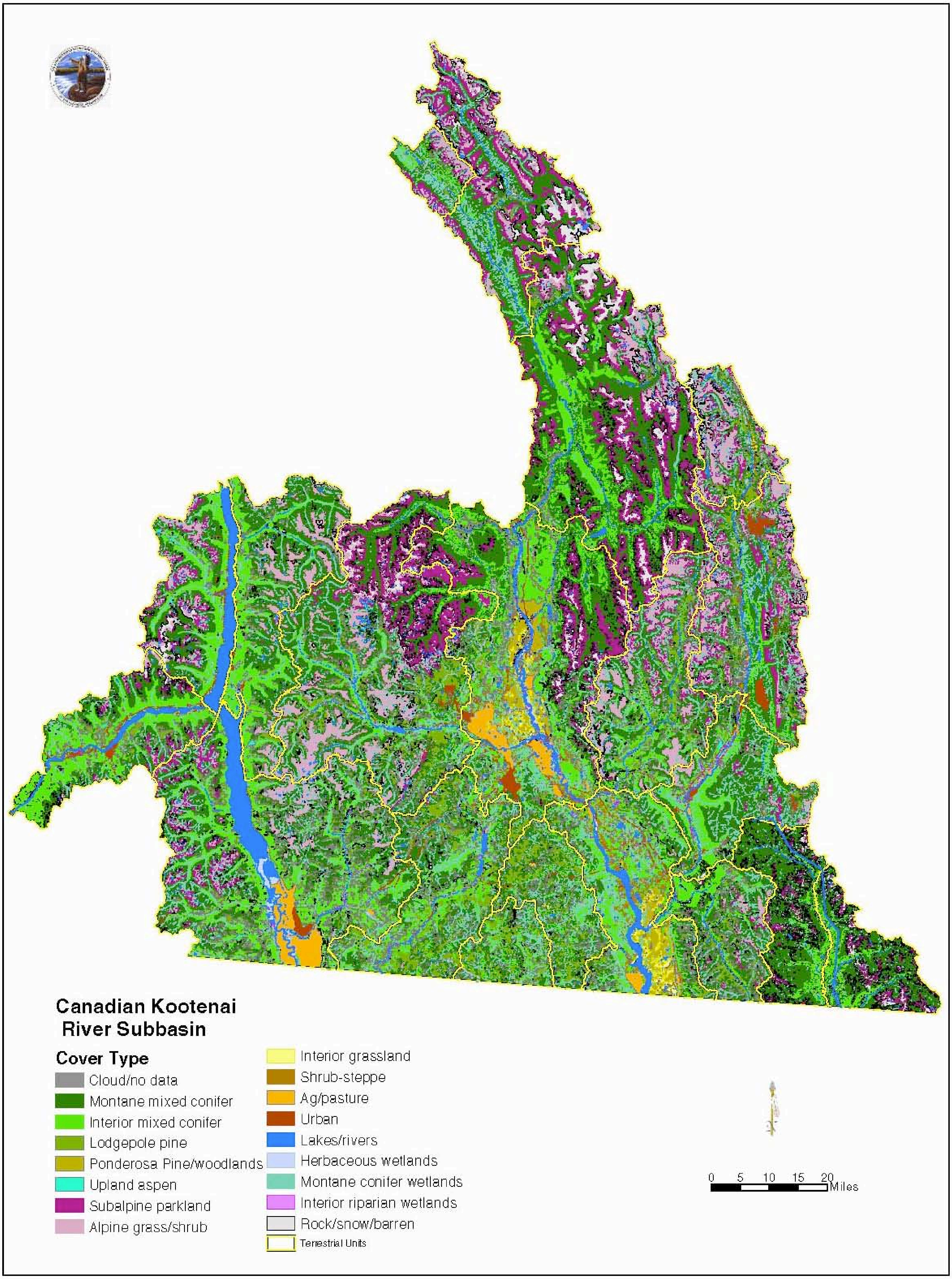

Figure 1.14. Cover types in the Canadian portion of the Kootenai River Subbasin.

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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.

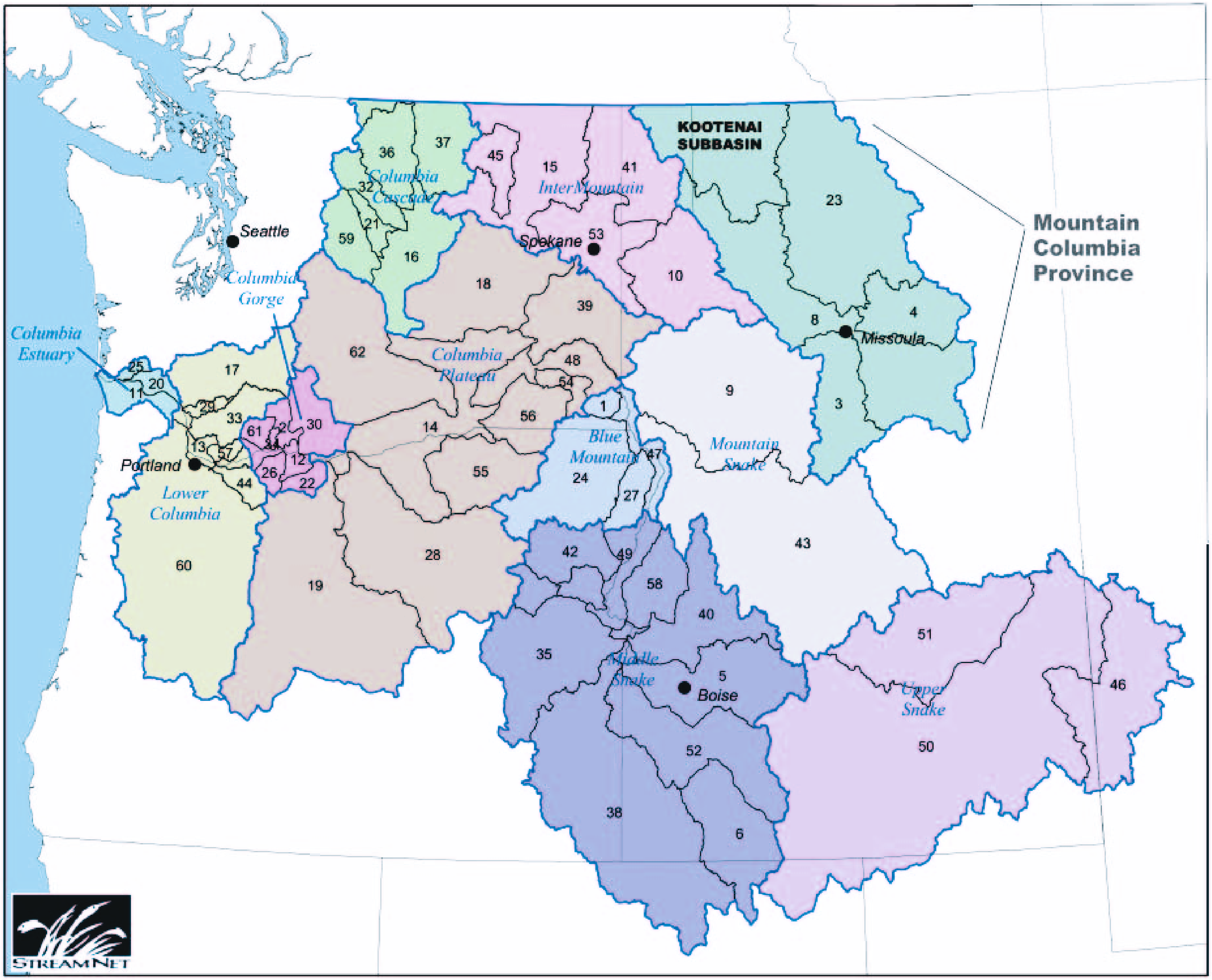

Figure 1.15. The Kootenai Subbasin is one of the northeastern-most drainages of the Columbia River.

- 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.

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;

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

[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

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

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).

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

(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.

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. 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.*