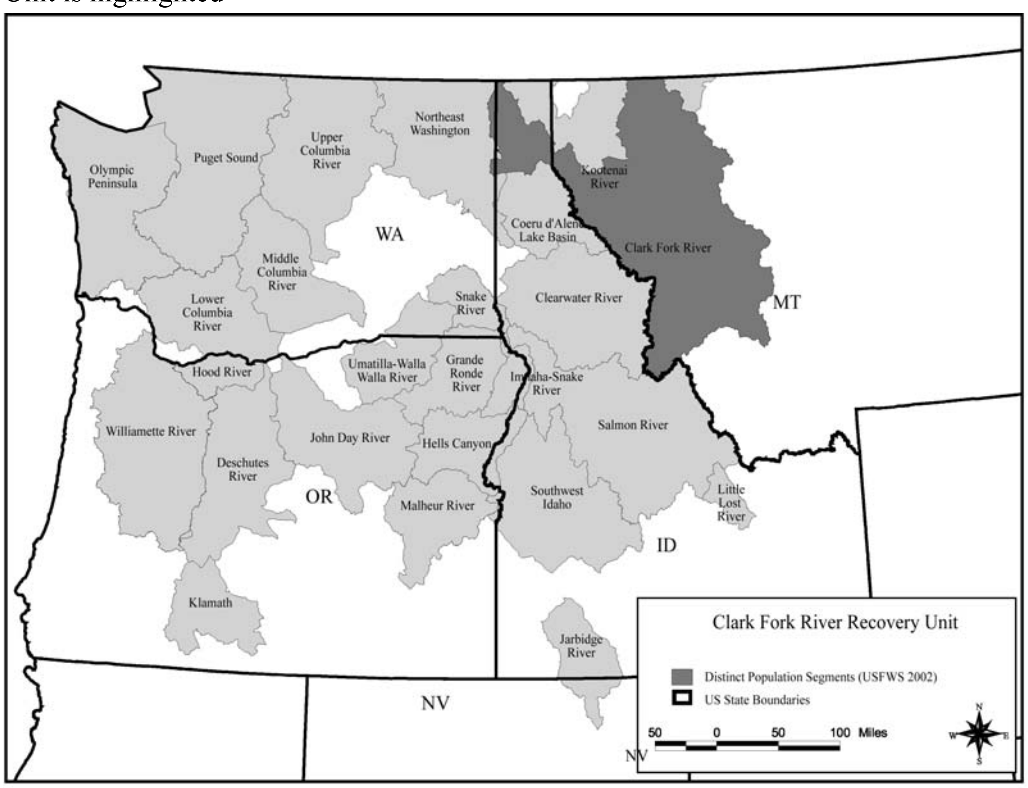
INTRODUCTION

Recovery Unit Designation

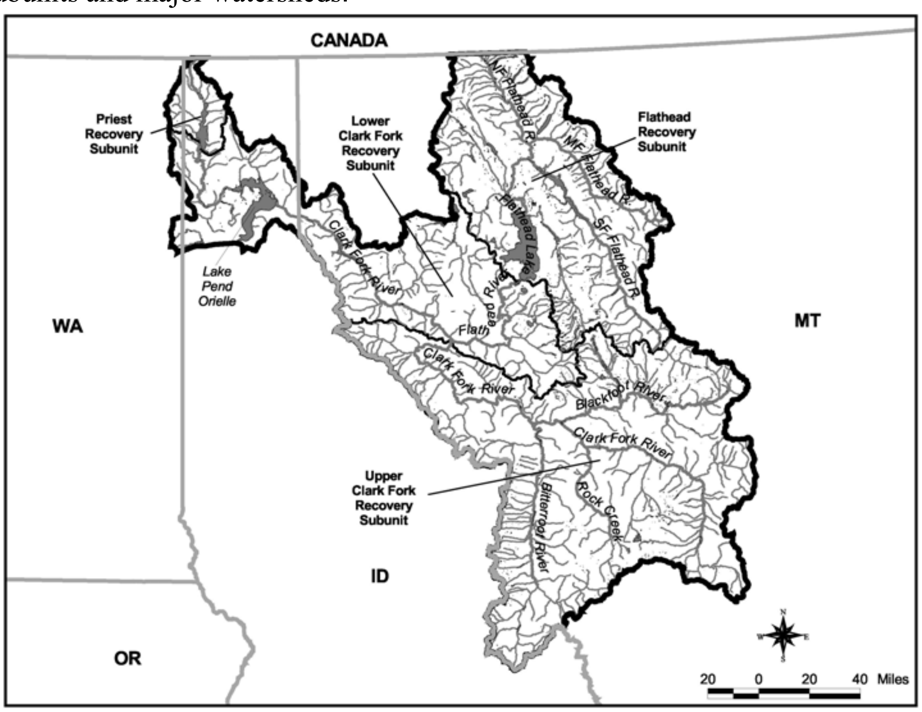
The Clark Fork River Recovery Unit is one of 22 recovery units designated for bull trout in the Columbia River basin (Figure 1). It is the largest recovery unit in the range of bull trout. Historically, the Clark Fork Recovery Unit contained one or more interconnected bull trout populations upstream of Albeni Falls, with migration of adult bull trout possible from Lake Pend Oreille, Priest Lake, and Flathead Lake upstream to most of the rest of the basin. It has been argued by the State of Montana that under the U.S. Fish and Wildlife Service distinct population segment policy, the Clark Fork River bull trout population(s) satisfy the criteria as a separate distinct population segment (Racicot, *in litt.*, 1998). Recent genetic information lends some support to this premise (Spruell *et al.* 2002), but formal action to analyze and reevaluate the designated population segment has not been initiated.

Figure 1. Bull trout recovery units in the United States. The Clark Fork Recovery Unit is highlighted



There is some uncertainty in the historical literature about which, if any, of the falls in the lower Pend Oreille River were absolute barriers to fish migration. Gilbert and Evermann (1895) concluded that Albeni Falls, near the outlet of Lake Pend Oreille, was not likely to provide a passage barrier to upstream migrating fishes. They indicated that Metaline Falls farther downstream might also be passable, though salmon are not known to have passed above that point. There is no information on whether bull trout passed these barriers. The Northeast Washington Recovery Unit Team is developing a separate recovery plan chapter for that portion of the Pend Oreille River between Albeni Falls Dam and Metaline Falls (see Chapter 23). The Clark Fork Recovery Subunit Teams recommend that a reevaluation of the distinct population segment designations for the Columbia River be considered based on genetic information and physical isolation. For recovery planning purposes, and because of the size of the basin and the complexity and diversity of issues associated with recovery planning at this scale, the lower boundary of the Clark Fork Recovery Unit has been set at Albeni Falls Dam and the upstream waters have been divided into four subunits (Figure 2).

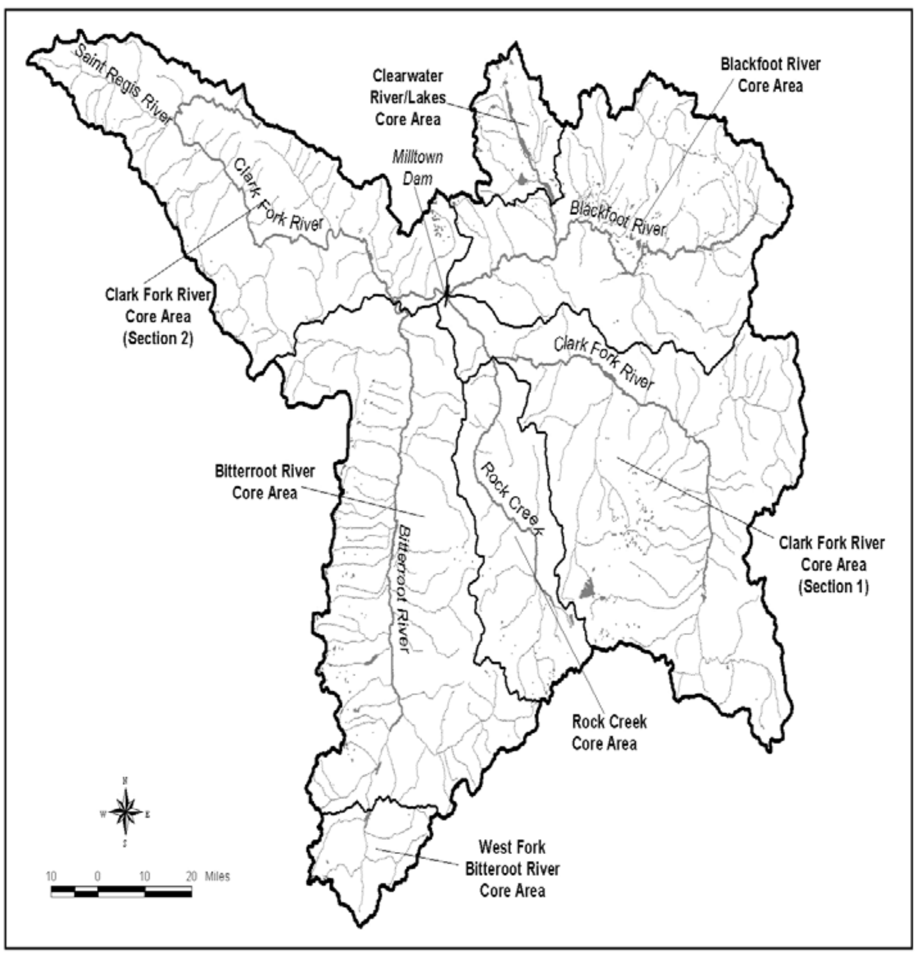
Figure 2. Map of the Clark Fork Recovery Unit showing relationship of recovery subunits and major watersheds.



These divisions are based, in part, on the presence of existing manmade barriers, and they are made to more effectively manage the size and complexity of the basin and to allow the recovery plan to focus upon areas (subunits) with common issues.

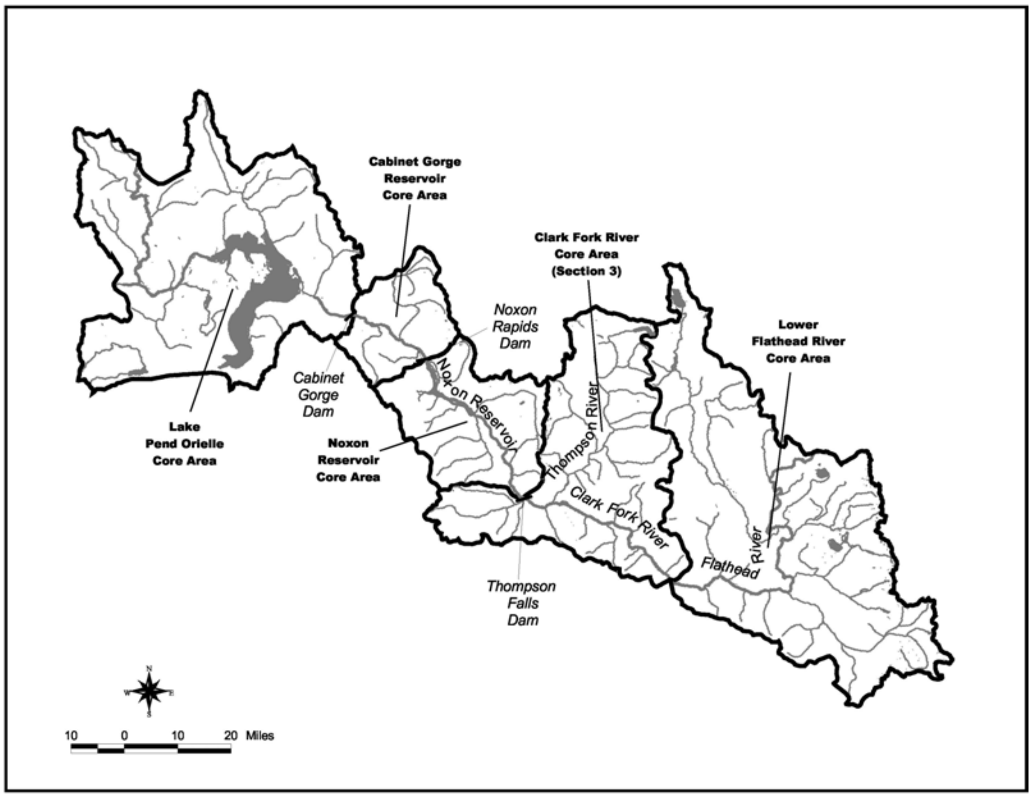
The **Upper Clark Fork Recovery Subunit** (Figure 3) includes the entire Clark Fork River basin in Montana upstream of the junction of the Flathead River. Major watersheds include, in addition to the Clark Fork River itself, the Blackfoot River, Bitterroot River, Rock Creek, and the St. Regis River. This recovery subunit has a drainage area of about 28,500 square kilometers (11,000 square miles) and covers much of the central portion of the Rocky Mountain slopes of western Montana.

Figure 3. Map of core areas in the Upper Clark Fork Recovery Subunit



The **Lower Clark Fork Recovery Subunit** (Figure 4) includes Lake Pend Oreille and its Idaho tributaries and the Clark Fork River and its tributaries in Montana upstream to the confluence with the Flathead River. Major basins include Lake Pend Oreille and direct tributaries in Idaho (the Clark Fork River; Gold, North Gold, Granite, Johnson, Lightning, and Trestle Creeks; and the Pack River watershed); the lower Priest River and tributaries in the East River system; the Bull River, Vermillion River, Prospect Creek, Thompson River, and the mainstem Clark Fork River in Montana. This recovery subunit also includes the Flathead River drainage upstream to Kerr Dam on the outlet of Flathead Lake, incorporating most of the Flathead Indian Reservation and including the Jocko River and Mission Creek watersheds. This recovery subunit has a drainage area of over 15,500 square kilometers (6,000 square miles) in Montana and Idaho.

Figure 4. Map of core areas in the Lower Clark Fork Recovery Subunit



The **Flathead Recovery Subunit** (Figures 5 and 6) includes Flathead Lake and its tributary system (North and Middle Fork Flathead, Stillwater, and Whitefish Rivers), Swan Lake and its tributaries, and the South Fork Flathead River watershed upstream of Hungry Horse Dam. About 27 natural lakes with adfluvial bull trout populations occur in this recovery subunit. A portion of the North Fork Flathead River lies in British Columbia, Canada. The drainage area upstream of Kerr Dam is about 18,400 square kilometers (7,100 square miles, including 427 square miles in British Columbia).

Figure 5. Map of core areas in the north half of the Flathead Recovery Subunit

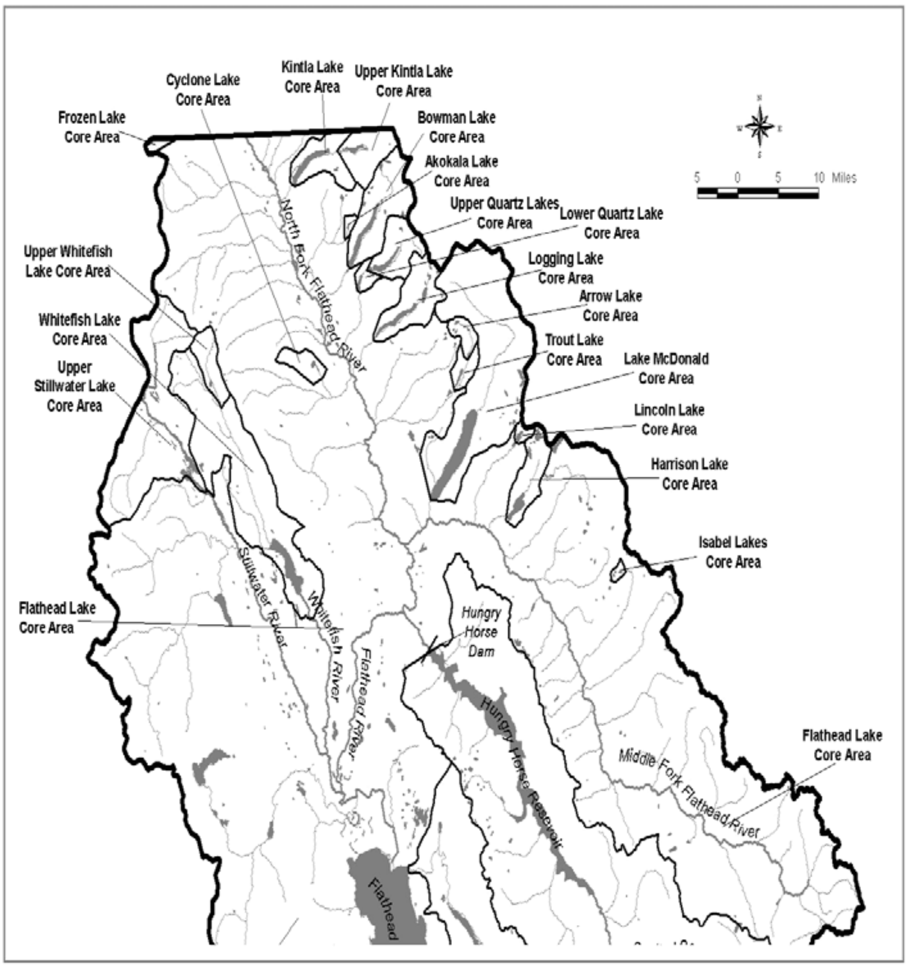
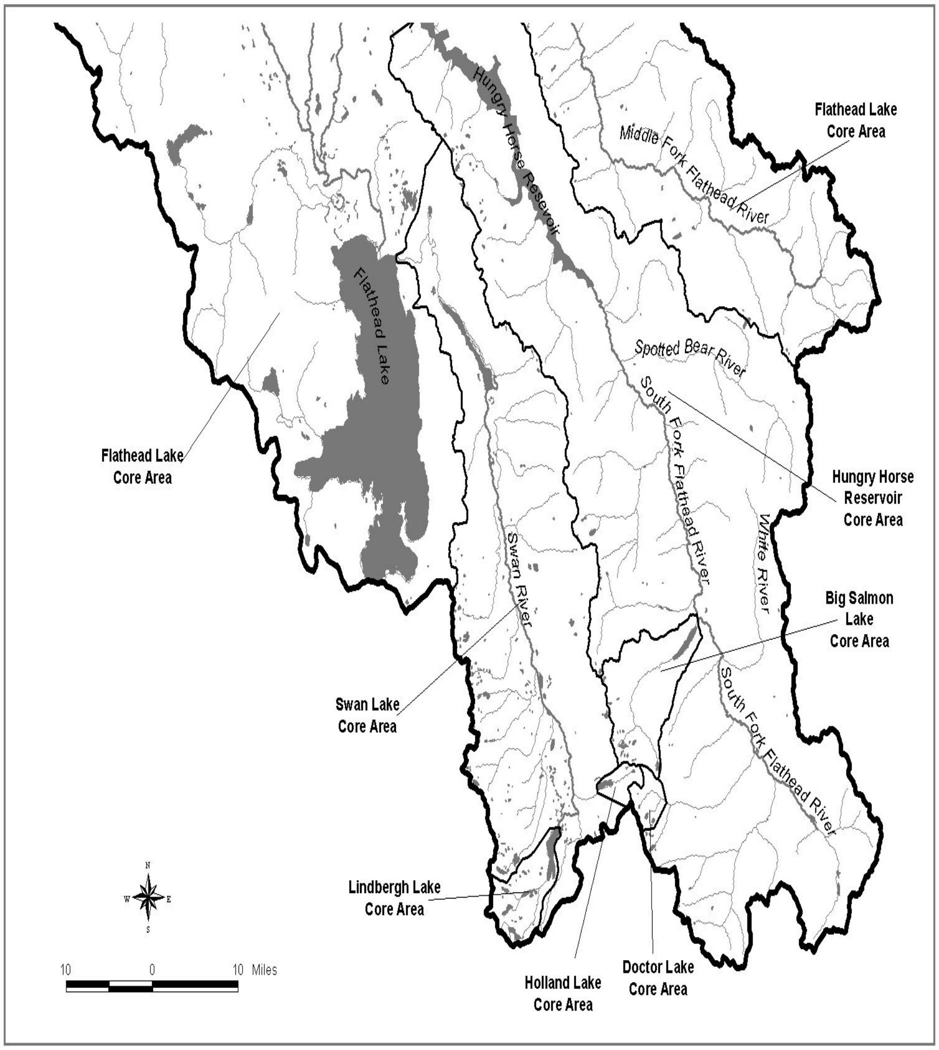
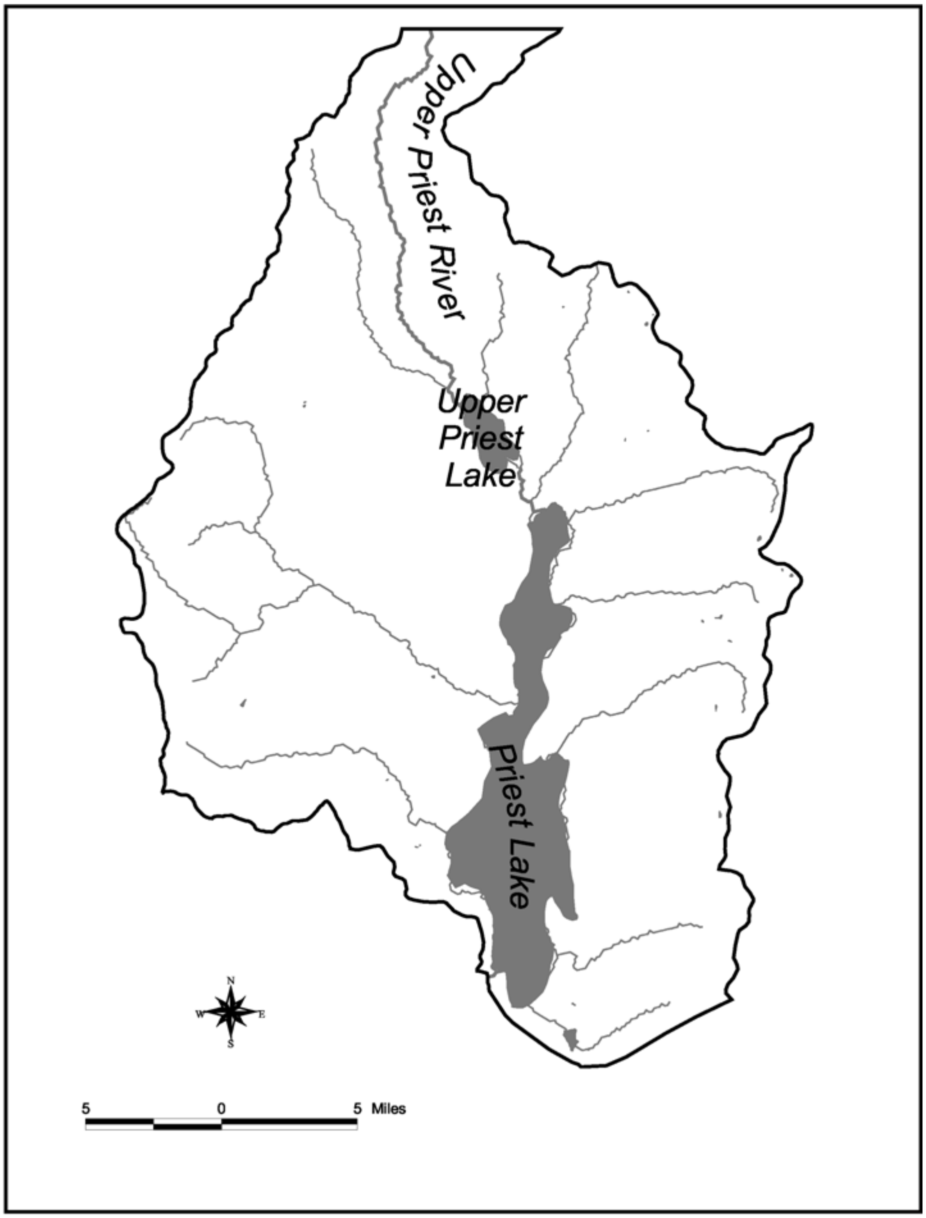


Figure 6. Map of core areas in the south half of the Flathead Recovery Subunit



The **Priest Recovery Subunit** (Figure 7) includes Priest Lake, its direct tributaries, and its tributary system upstream, including the Priest River Thorofare, Upper Priest Lake, and the Upper Priest River. The Priest River watershed is partially isolated from the Pend Oreille system by Priest Lake Dam. The entire Priest River has a drainage area of about 2,500 square kilometers (979 square miles) in Idaho and eastern Washington.

Figure 7. Map of core areas in the Priest Recovery Subunit



While there is no clear dividing line for bull trout recovery efforts between the upper and lower Clark Fork River basins, we have chosen to split the recovery unit at the confluence with the Flathead River. This location was chosen, in part, because reconnecting the migratory corridor of the lower Flathead and Jocko Rivers to Lake Pend Oreille is an important biological issue and critically important to the Confederated Salish and Kootenai Tribes. In a 200-kilometer (120-mile) reach of the Clark Fork River, extending from the mouth of the Flathead River upstream to Milltown Dam, bull trout are rare in the mainstem Clark Fork River. Radio telemetry studies of bull trout that congregate downstream of Milltown Dam have proven these fish are migrants and that they are attempting to return to the upper basin. Therefore, it was appropriate to group this reach of the Clark Fork River with watersheds in the Upper Clark Fork Recovery Subunit.

For similar reasons, the Flathead Recovery Subunit, upstream of Kerr Dam, is considered separate from the rest of the Clark Fork Recovery Unit. Thirty local populations in the Flathead River basin, identified in the status summary that was prepared for the listing rule (USFWS 1998), are all adfluvial stocks. There is little historical evidence of the presence of discrete fluvial or resident stocks in these waters, though recent radio telemetry work in the Flathead River indicates that individual fish may exhibit a primarily fluvial life history. Since 1938, the Flathead River basin has been physically isolated from the rest of the Clark Fork River basin by Kerr Dam, and due to natural thermal characteristics (warm outflow in the fall season), it's not likely that significant two-way genetic interchange with stocks from Lake Pend Oreille has occurred since the retreat of the last ice age about 10,000 years ago. The entire Flathead National Forest and portions of Glacier National Park are located within this subunit.

Geographic Description

The Clark Fork River originates at the confluence of Silver Bow and Warm Springs Creeks in the Deer Lodge Valley of Montana and flows primarily in a northwesterly direction (Figure 2) for about 564 river kilometers (350 miles) to its terminus at Lake Pend Oreille, Idaho (Watson 1985). The Clark Fork River is Montana's largest river in terms of stream discharge, with an average annual stream flow of 630 cubic meters per second (22,230 cubic feet per second) near Cabinet, Idaho, a few kilometers upstream of the mouth at Lake Pend Oreille. The total drainage area upstream of that point is 57,169 square kilometers (22,073 square miles) (USGS 2001). Downstream of Lake Pend Oreille, the river is renamed the Pend Oreille River. The Pend Oreille River flows across the northeast corner of the State of Washington for about 200 kilometers (125 miles) before joining with the Columbia River in southern British Columbia.

Most of the higher-elevation forested lands within the Clark Fork River drainage are National Forest. Private lands are primarily located within the nonforested valley floors or interspersed as small parcels within Forest Service boundaries. Within portions of the Clark Fork River basin, land ownership (by 4th code hydrologic unit or HUC) is as much as 60 percent private (upper Clark Fork River), but ranges to as high as 98 percent National Forest land in other watersheds (South Fork Flathead River). Substantial private timberlands (primarily Plum Creek Timber Company) occur within the Swan, Flathead, Blackfoot, and portions of the upper Clark Fork River drainages. Much of the upper Flathead River basin is in wilderness or Glacier National Park. Most of the lower Flathead River drainage is on the Flathead Indian Reservation.

Upper Clark Fork Recovery Subunit

The upper reach of the Clark Fork River (upstream of the junction of the Flathead River) is about 395 kilometers (246 miles) long and has an annual average streamflow of about 222 cubic meters per second (7,850 cubic feet per second) (USGS 2001). In an average year, most of the annual runoff occurs in May and June. The periods of greatest consumptive demand for water are July and August (MBTSG 1995e).

Rock Creek enters the Clark Fork River near Clinton at river mile 382 (measured upstream of the confluence of the Pend Oreille River and Columbia River) (MDNRC 1984). Rock Creek has a drainage area of 2,290 square kilometers (885 square miles) and an average annual flow of 15.3 cubic meters per second (541 cubic feet per second) (USGS 2001).

The Blackfoot River flows approximately 214 kilometers (133 miles) in a westerly direction through a mostly forested valley to its confluence with the Clark

Fork River near the town of Bonner, Montana, at river mile 364 (MDNRC 1984). The Blackfoot River has a drainage area of approximately 5,931 square kilometers (2,290 square miles). Average annual discharge near the mouth of the river is 45.2 cubic meters per second (1,597 cubic feet per second) (USGS 2001).

The Bitterroot River is formed at the junction of the East Fork and West Fork Bitterroot Rivers near the town of Conner, Montana, and from there, the mainstem flows north through the irrigated crop- and pastureland of the Bitterroot River valley approximately 137 kilometers (85 miles) to the Clark Fork River near Missoula at river mile 350 (MDNRC 1984). The Bitterroot River has 27 major tributaries on the west side and 12 on the east side, many of which today contain resident bull trout populations. It is speculated, though not documented, that many of these populations historically had a strong migratory component. The approximate mean annual flow of the Bitterroot River is 73.5 cubic meters per second (2,596 cubic feet per second) about 10 kilometers (6 miles) upstream of its confluence with the Clark Fork River (USGS 2001).

Topography and geology of the upper Clark Fork River basin and several of its tributaries were strongly influenced by glacial activity. Glaciers deposited extensive outwashes of gravel and morainal (masses of rock) drifts. These glacial deposits influence streamflows in some reaches of the main rivers and tributaries. Tributaries flowing through glacial deposits often have intermittent sections.

Resident bull trout are now the predominant life history form present in the upper Clark Fork River. Migratory fish are only found in significant numbers in the Rock Creek and Blackfoot watersheds. Fish that migrate out of Rock Creek or the Blackfoot River and pass downstream of Milltown Dam (river mile 364) cannot pass back upstream.

In general, the status of migratory bull trout in the Blackfoot River and Rock Creek drainages appears to be stable or increasing, though no statistically verified trend has yet been described. However, in some streams, numbers of bull trout have declined in recent years. No population data are available for other portions of the drainage such as the Clearwater Lakes system, mainstem Clark Fork River, St. Regis

River, or Fish Creek. However, anecdotal observations indicate an apparent widespread decline in abundance from historical levels in major portions of the basin.

The major life form of bull trout in the Bitterroot River drainage is resident fish that tend to live in higher-elevation streams within the Bitterroot National Forest. Migratory fish in the Bitterroot River are now rare (Nelson 1999), although historically they were more common. Overall, habitat in the drainage is fragmented by dewatering and diversions, and bull trout populations are characterized by local populations of small resident fish that have little or no genetic interchange.

Lower Clark Fork Recovery Subunit

The Lower Flathead River flows south and west for 116 kilometers (72 miles), from Kerr Dam downstream to its confluence with the Clark Fork River (river mile 245); about 60 kilometers (37 miles) upstream of Thompson Falls Dam. The Flathead River has an annual average discharge of 337.6 cubic meters per second (11,920 cubic feet per second) near its confluence with the Clark Fork River (USGS 2001). Flow in this portion of the Flathead River is partially regulated by Kerr Dam, located 6.4 kilometers (4 miles) downstream of the original outlet of Flathead Lake.

The Flathead Indian Reservation is the 486,000-hectare (1.2-million acre) home of the Confederated Salish and Kootenai Tribes. The reservation was established by the Hellgate Treaty in 1855. The entire reservation lies within the Clark Fork River basin and includes the southern half of Flathead Lake and approximately 109 kilometers (68 miles) of the lower Flathead River, as well as its associated tributary streams. Important tributaries for bull trout are the Jocko River and Mission Creek.

Lake Pend Oreille is the largest and deepest natural lake in Idaho (Panhandle Bull Trout Technical Advisory Team 1998). It covered about 33,696 hectares (83,200 acres) under natural conditions, and it now (post-impoundment by Albeni Falls Dam) has a surface area of about 38,362 hectares (94,720 acres) (PBTTAT 1998a). The lake has more than 282 kilometers (175 miles) of shoreline, with mean and maximum depths of 164 meters (538 feet) and 351 meters (1,152 feet), respectively. Nearly all of the waters currently accessible to bull trout from Lake Pend Oreille lie within the

State of Idaho, including 15 kilometers (9 miles) of the Clark Fork River upstream to Cabinet Gorge Dam (PBTTAT 1998a).

About 95 percent of Lake Pend Oreille's volume is in the large, southernmost basin, a glacially influenced portion of the Purcell Trench (PBTTAT 1998a). Average hydraulic residence time in the southern basin is estimated to exceed 10 years (PBTTAT 1998a). The main body of Lake Pend Oreille never freezes.

Lake Pend Oreille is an oligotrophic (nutrient-poor) lake. Woods (1991) compared recent water quality data to historical data and reported that the pelagic (open-water) zone of Lake Pend Oreille showed no major temporal changes in nutrient concentrations, chlorophyll *a* concentrations, or Secchi disc water transparency depths since the early 1950's (PBTTAT 1998a). Nutrient concentrations in shoreline areas and in the northern basin of the lake are considerably higher because of urbanization and suspended sediments in Clark Fork River inflow.

Cabinet Gorge Dam, constructed in 1952, partially regulates flows in the Clark Fork River. The Settlement Agreement with the Federal Energy Regulatory Commission for licensing Cabinet Gorge Dam provides for a minimum flow of 141.6 cubic meters per second (5,000 cubic feet per second). River flows are augmented by groundwater inflow, which contributes at least an additional 22.7 cubic meters per second (800 cubic feet per second) below the dam (PBTTAT 1998a). Cabinet Gorge Dam is operated as a peaking facility, and during low flow periods, releases typically vary from 141.6 cubic meters per second (5,000 cubic feet per second) to about 566.4 cubic meters per second (20,000 cubic feet per second) or more on a daily basis. This range may vary depending on availability of water and demand for electricity.

The Clark Fork River watershed upstream of Lake Pend Oreille includes most of western Montana and covers some 59,324 square kilometers (22,905 square miles) (PBTTAT 1998a). Average annual river flow is approximately 629.6 cubic meters per second (22,230 cubic feet per second) (USGS 2001). The river contributes approximately 92 percent of the annual inflow to the lake (PBTTAT 1998a) and most of the suspended sediment load.

The U.S. Army Corps of Engineers operates Albeni Falls Dam on the Pend Oreille River; the dam is located in Idaho near the Washington border. The Clark Fork River is renamed the Pend Oreille River as it exits the lake. This dam, also constructed in 1952, impounds 44 kilometers (28 miles) of the Pend Oreille River and regulates the lake's elevation between 625 meters (2,051 feet) mean sea level (winter) and 629 meters (2,062.5 feet) mean sea level (summer).

The lower Priest River originates at the outlet of Priest Lake. The lower Priest River flows a distance of 72 kilometers (45 river miles) to its confluence with the Pend Oreille River at the City of Priest River. Major tributaries include the Upper West Branch and Lower West Branch Priest Rivers and the East River.

Bull trout have been documented in the East River system and the lower Priest River downstream of Priest Lake. Based on the sizes of fish observed, speculations have been made that the bull trout in the East River are probably migrants from Lake Pend Oreille. East River bull trout may represent a rather unique population, whose adults migrate downstream from the main body of the lake into the Pend Oreille River arm, then up the Priest River system. Until genetic or radiotelemetry studies can confirm this, the lower Priest River fish will be treated as a local population of the Lake Pend Oreille core area. Tributaries to the lower Priest River were probably important historically for foraging and thermal refuge by adult and subadult bull trout.

Land ownership in the basins that are direct tributaries to Lake Pend Oreille is typically 75 to 98 percent U.S. Forest Service, with most of the remaining land in private ownership (PBTTAT 1998a). The exception is the Pack River drainage, which is 55 percent U.S. Forest Service land, 36 percent private land, 7 percent State of Idaho land, and 2 percent Bureau of Land Management land.

The Trestle Creek watershed enters Lake Pend Oreille from the Cabinet Mountains at the northern end of the lake. Trestle Creek is a 5,959-hectare (14,713-acre), third-order watershed that includes several smaller tributaries. Trestle Creek contains some of the highest-quality bull trout habitat remaining in the Lake Pend Oreille/lower Clark Fork River tributary system.

Lightning Creek is approximately 35 kilometers (22 miles) long and drains into the Clark Fork River 4 kilometers (2.5 miles) upstream of Lake Pend Oreille (PBTTAT 1998a). The Lightning Creek channel is unstable, and aerial photos from the 1930's suggest that lower Lightning Creek has shifted from a primarily single channel stream to a highly braided stream with an increased width to depth ratio. A barrier falls is present on Lightning Creek near Quartz Creek. Bull trout spawn in the upper mainstem of Lightning Creek below Quartz Creek, as well as in most major tributaries.

Pack River comprises the second largest watershed draining into Lake Pend Oreille. The Pack River basin has more glacial fluvial deposits than any other basin in the watershed, and the underlying geology is largely granitic in origin. As a result, sand-sized sediment is the primary material that is eroded and transported in streams of this basin. The Pack River basin supports diverse land uses and contains lands under private, State, and Federal ownership. These uses, coupled with the Sundance fire in 1967, have negatively influenced habitat conditions for bull trout in Pack River (PBTTAT 1998a). Loss of riparian vegetation and associated root masses due to fire, salvage, timber harvesting, livestock grazing, or clearing reduces bank stability and results in delivery of fine sediment to the stream channel.

Grouse Creek is a fourth-order watershed with a drainage area comprising 77,857 hectares (31,352 acres). It is an important tributary to the Pack River watershed for bull trout. Grouse Creek flows from the western side of the Cabinet Mountains and drains west by southwest into the Pack River. A large portion of the Grouse Creek watershed lies within the “transient snow zone,” identified as lands within an elevation range that exhibits frequent rain-on-snow events, resulting in flooding. The transient snow zone in northern Idaho is estimated at 762 to 1,372 meters (2,500 to 4,500 feet) in elevation (PBTTAT 1998a).

Gold and North Gold Creeks are adjacent drainages entering the southeast end of Lake Pend Oreille in close proximity to each other. Gold Creek is currently the second most important bull trout spawning stream in the watershed (after Trestle Creek), with an average of about 102 redds per year in 1983 to 1998 (LPOWAG 1999). Excess bedload (largely a result of the mining legacy), sediment, and a lack of large woody debris are considered to be the greatest limiting factors for bull trout habitat in the watershed. North Gold Creek has supported an average of about 30 redds per year and has been impacted by development of a homestead, which is now being reclaimed under U.S. Forest Service ownership. The creek has also been negatively impacted by past timber harvest activities.

Granite Creek is a large 41,264-hectare (16,712-acre) watershed on the east side of Lake Pend Oreille. Bull trout habitat is patchy and has been affected by urban development in the floodplain, roads, and timber harvest. Sullivan Springs is a spring-fed tributary that enters Granite Creek about 1 kilometer (0.6 mile) upstream of the lake, and it is an important spawning stream for bull trout and kokanee salmon. Bull trout spawning activity in the drainage has been erratic, varying from no redds in 1992 to as many as 132 redds in 1997 (LPOWAG 1999).

Bull trout in the interconnected Lake Pend Oreille watershed appear to be entirely adfluvial (PBTTAT 1998a). Some fish make extensive spawning migrations into the larger tributaries beginning in March and April (PBTTAT 1998a). A fall migration also occurs (August and September) into the Clark Fork River (Pratt and Huston 1993) and other Lake Pend Oreille tributaries.

Flathead Recovery Subunit

The North and Middle Forks of the Flathead River drainage comprise most of the remaining unblocked portion of the Flathead River system upstream of Flathead Lake. The headwaters of the North Fork Flathead River are in British Columbia. The North Fork Flathead River flows south into the United States and is bordered by Glacier National Park to the east and the Flathead National Forest to the west. The headwaters of the Middle Fork Flathead River are in the Bob Marshall and Great Bear Wilderness areas. From the confluence with Bear Creek downstream to its junction with the North Fork Flathead River, the Middle Fork Flathead River forms the southern boundary of Glacier National Park.

From the confluence of the North and Middle Forks of the Flathead River, the mainstem Flathead River flows approximately 88 kilometers (55 river miles) to the inlet of Flathead Lake. The South Fork of the Flathead River, controlled by Hungry Horse Dam since 1953, enters the Flathead River approximately 16 kilometers (10 miles) downstream of the confluence of the North and Middle Forks of the Flathead

River. These three forks of the Flathead River have a combined drainage area of 11,561 square kilometers (4,464 square miles) and an average annual discharge of 274.7 cubic meters per second (9,699 cubic feet per second), as measured at Columbia Falls (USGS 2001).

Other major tributaries of the Flathead River include the Stillwater and Whitefish Rivers, which drain the valley floor and mountain ranges to the west. The Whitefish River joins the Stillwater River about 5 kilometers (3 miles) before its confluence with the Flathead River, approximately 35 kilometers (22 miles) upstream of Flathead Lake. Bull trout are rarely encountered today in the Whitefish and Stillwater Rivers. Anecdotal data from newspaper accounts around 1900 indicate that, 100 years ago, bull trout, and particularly westslope cutthroat trout and mountain whitefish, were much more abundant in those streams (Inter Lake, *in litt.*, 1900). Large log drives were conducted down those rivers during that era, and several wooden dams that were built onstream at sawmills and lake outlets appear to have obstructed fish passage. At the dam sites, large numbers of migrating trout and whitefish were harvested by anglers, often with snag hooks and even dynamite, and the combined abuses appear to have rapidly depleted the fish runs (Inter Lake, *in litt.*, 1900). Today, these rivers were judged by the Montana Bull Trout Scientific Group to be low-priority streams for restoration because of the long-term nature of the decline and the existing degraded habitat conditions (MBTSG 1995c). Summer water temperatures are not suitable in these streams for bull trout, and they may also have been marginal historically due to the fact that the rivers flow through large lowland lakes (Upper and Lower Stillwater Lakes and Whitefish Lake).

Land ownership in the 2.4 million-hectare (5.9 million-acre) Flathead River basin (including the South Fork Flathead, Swan, and lower Flathead Rivers) is 40 percent U.S. Forest Service (including 445,500 hectares [1.1 million-acres] of wilderness), 10 percent National Park Service (Glacier National Park), 10 percent Confederated Salish and Kootenai Tribes, 3 percent State of Montana, and 31 percent private (Flathead River Basin Environmental Impact Statement 1983). Nearly 5 percent of the drainage basin lies in the headwaters of the North Fork Flathead River in British Columbia.

Flathead Lake has the largest surface area of any natural freshwater lake in the western United States, covering 49,613 hectares (122,500 acres) (Flathead River Basin Environmental Impact Statement 1983). It has a mean depth of 50 meters (165 feet) and a maximum depth of 113 meters (370 feet). Most of the lake exceeds 20 meters (65 feet) in depth, except for South Bay, which has a maximum depth of 10 meters (33 feet).

The Flathead Lake bull trout population is among the most intensively studied and monitored bull trout populations in the world. Within the Flathead Recovery Subunit, at least 27 natural lakes have historical evidence of bull trout populations, and most of these lake populations form their own bull trout core areas. Some lakes are small (including 8 that are less than 100 acres) and may have historically held only low numbers of bull trout. Available fisheries information indicates that the migratory life form of bull trout predominates in all these lake and river systems. Adult bull trout migrate into tributary drainages, usually upstream of each lake, to spawn. The juvenile fish rear in the tributaries for one to three years before moving back downstream to the river and lake, where they spend several additional years as subadults prior to maturity at the age of about six years (Fraley and Shepard 1989). The resident life form of bull trout may occur in low numbers in some tributary streams, but conclusive documentation of this life form is not currently available.

The Swan River flows generally north for approximately 106 kilometers (66 miles) from its headwaters in the Swan and Mission Mountain ranges to Flathead Lake, where it enters at the town of Bigfork, Montana. Fifty-three named tributaries enter the river from the Swan and Mission Mountain ranges. Three relatively large lakes are linked directly to the Swan River drainage. The southernmost lake, covering 294 hectares (726 acres), is Lindbergh Lake, which the upper Swan River flows through. Approximately 8 kilometers (5 miles) downstream of Lindbergh Lake, Holland Creek enters the river after flowing through the 165-hectare (408-acre) Holland Lake. The Swan River then flows approximately 56 kilometers (35 miles) to 1,085-hectare (2,680-acre) Swan Lake, the largest lake in the drainage. Leaving Swan Lake, the river continues for 23 kilometers (14 miles) downstream to a small run-of-the-river impoundment created by Bigfork Dam. This dam (built after the power plant was first installed in 1902) is 3.67 meters (12 feet) high and contains a 4.1-megawatt hydroelectric facility. It is currently owned and operated by PacifiCorp and is scheduled for Federal Energy Regulatory Commission relicensing in 2002. Downstream of Bigfork Dam, the Swan River cascades through a 2-kilometer (1-mile) high-gradient reach before entering Flathead Lake. The Swan River drainage area is 1,080 square kilometers (671 square miles), measured at the outlet of Swan Lake.

Land ownership in the Swan River basin is mixed. Approximately 45 percent of the drainage is managed by the Flathead National Forest, 20 percent by Plum Creek Timber Company, 10 percent by the Montana Department of Natural Resources, and 25 percent by other private landowners. Timber production is the dominant land management activity.

Historically, because of the deterrent effect of warmer water in Swan Lake outflows on upstream-migrating adults, fish from Flathead Lake probably did not routinely migrate upstream through Swan Lake. Similarly, warmer lake outflows may have limited travel of other adfluvial bull trout populations among the interconnected lakes in this subunit.

Construction of Hungry Horse Dam in 1953 blocked access to the entire South Fork Flathead River drainage, and about 38 percent of the total stream length that was once available to Flathead Lake bull trout was cut off (Zubik and Fraley 1987). Bull trout upstream of the dam now reach maturity in Hungry Horse Reservoir, or possibly in the South Fork Flathead River, instead of in Flathead Lake or the main Flathead River.

The South Fork Flathead has a drainage area of 4,307 square kilometers (1,663 square miles) and an average annual discharge of 100.5 cubic meters per second (3,549 cubic feet per second), measured 3 kilometers (2 miles) downstream of Hungry Horse Dam (USGS 2001). Water stored in Hungry Horse Reservoir is used for power production, irrigation, recreation, and most recently to provide downstream flows for salmon passage in the lower Columbia River. The usable capacity of the reservoir is 62,907 cubic kilometers (51,000 acre-feet), an amount that allows for substantial flood control storage in the headwaters of the Columbia River system.

Little quantitative information exists about historical bull trout distribution and abundance in the South Fork Flathead River drainage. Before Hungry Horse Dam was constructed, this drainage was considered a major spawning and rearing area for the migratory bull trout from Flathead Lake (Zubik and Fraley 1987). Anecdotal information suggests that large adult fish from Flathead Lake were seasonally common in the South Fork Flathead River and several of its major tributaries.

A population of migratory bull trout, trapped behind the impoundment, now occupies Hungry Horse Reservoir and the South Fork Flathead River. These fish migrate into tributary drainages to spawn and rear. Land in the South Fork Flathead River drainage is almost entirely (98 percent) within the Flathead National Forest. Reservoir tributaries and the lower one-third of the South Fork River drainage are managed timberlands, while the upper two-thirds of the South Fork Flathead River drainage lies within the Bob Marshall Wilderness Area.

Priest Recovery Subunit

The entire Priest River basin is 2,536 square kilometers (979 square miles) in size (PBTTAT 1998b). The basin is primarily within the northwest corner of the Idaho Panhandle, within Bonner and Boundary Counties. Approximately 62 square kilometers (24 square miles) of the basin are in British Columbia, where the headwaters of the Upper Priest River originate in the Nelson Mountain Range. Headwaters of major tributaries on the western side of the basin are located in northeast Washington. The basin is flanked on the east and west sides by the Selkirk Mountain Range. Elevation within the basin ranges from 625 meters (2,051 feet) at low winter pool of Lake Pend Oreille (reservoir) behind Albeni Falls Dam to more than 2,135 meters (7,000 feet) within the Selkirk Mountains.

The lake complex is made up of Upper Priest Lake, a 4.3-kilometer (2.7-mile) connecting channel called the Priest River Thorofare, and Priest Lake. Priest Lake is the third largest natural lake that is entirely within Idaho and second largest in terms of volume. Water levels in the lakes and Priest River Thorofare are partially controlled by an outlet dam and structure at the southwest corner of the lower lake.

The climate in the Priest River watershed is transitional between a northern Pacific coastal type and a continental type (PBTTAT 1998b). July and August are the only distinct summer months, and temperatures are relatively mild because of the Pacific maritime influence (average daily summer maximums are around 28 degrees Celsius [82 degrees

Fahrenheit]). Winter temperatures are also relatively mild compared with areas east of the Rocky Mountains. Annual precipitation (rain and melted snow) averages 81 centimeters (32 inches) at lake surface equivalent elevation. Average precipitation within the peaks of the Selkirk Mountains can reach 152 centimeters (60 inches). At elevations above 1,463 meters (4,800 feet), snowfall accounts for more than 50 percent of total precipitation (PBTTAT 1998b). The wettest months are normally November, December, and January.

Upper Priest Lake has a surface area of 542 hectares (1,338 acres), a mean depth of 18.3 meters (60 feet), and a volume of 0.1 cubic kilometers (80,000 acre- feet) (PBTTAT 1998b). The lake has a short hydraulic residence time, about 3 months on average, and is heavily influenced by the major tributary, Upper Priest River. Lake level is controlled by the outlet dam on Priest Lake since the upper lake, connecting channel, and lower lake are all at the same elevation at summer pool. The main, or lower, Priest Lake has a surface area of 9,437 hectares (23,300 acres), a mean depth of 39 meters (128 feet), and a volume of 3.7 cubic kilometers (3,000,000 acre-feet). Average hydraulic residence time is about three years. The Priest River Thorofare contributes about 40 percent of the annual inflow to Priest Lake.

The Priest River basin has numerous tributaries. The Upper Priest River portion of the watershed complex drains into the upper lake and into the Thorofare, with a total drainage area of 528 square kilometers (204 square miles). Two large tributaries to the lake, Upper Priest River and Hughes Fork, join before entering the northwest corner of the lake. From the Canadian border, Upper Priest River flows through a steep side canyon at a moderate gradient (around 20 meters per kilometer or 100 feet per mile), and then flattens into a fairly large floodplain for the last 3 kilometers (2 miles). A waterfall about 1 kilometer (0.6 mile) south of the border is the limit of upstream fish migration. Hughes Fork has a moderate gradient and includes a large wetland area, Hughes Meadows. Trapper Creek, which drains the northeast corner of the upper lake watershed, and Caribou Creek, which drains to the Thorofare from the east about 1.5 kilometers (1 mile) upstream of its mouth, are the other major watersheds in the Upper Priest Lake drainage. These tributaries originate in the Selkirk Mountains and have typically high gradients.

The main Priest Lake portion of the drainage begins near the mouth of the Priest River Thorofare and extends to the southern end of the lake near the town of Coolin. The Thorofare, draining the upper lake, is by far the highest flow volume tributary to the lower lake. Major streams draining the Selkirk Range on the east side of the lake are Lion Creek, Two Mouth Creek, Indian Creek, Hunt Creek, and Soldier Creek. All these streams, except Soldier Creek, are relatively confined and of high gradient above the reaches that are near the mouths. The lower end of Soldier Creek has a flat gradient and a large associated wetland. Seven minor flow streams are interspersed between the major east-side tributaries. From Squaw Creek south to Fenton Creek, headwaters are at lower elevations, about halfway up the Selkirk Range. Chase Creek is outflow from Chase Lake. While Chase Creek is a moderately sized subwatershed, Chase Creek flow volume into Priest Lake is low. This watershed is flat, with primarily groundwater resources, which do appear to be hydraulically linked to the lake (PBTTAT 1998b).

The west side of the Priest Lake subbasin extends from Beaver Creek, discharging just south of the Thorofare, to the southern end of the lake (PBTTAT 1998b). The subbasin has one major stream, Granite Creek, and one moderate-size stream, Kalispell Creek. The remaining tributaries are of low volume. The Granite Creek subwatershed is the single largest in the basin. Headwaters of the South and North Forks Granite Creek are at lower elevations than east-side streams, mostly between 1,200 to 1,500 meters (4,000 to 5,000 feet). Overall, the average gradient of Granite Creek is low, and many flat sections have associated wetlands. The subwatersheds of Reeder Creek, Kalispell Creek, Reynolds Creek, and Lamb Creek have large areas of flat gradient in the middle and lower elevations. The groundwater systems are extensive in these watersheds, and many branch streams go subterranean prior to discharging into the primary tributary channels.

Vegetation of the area varies in association with soil moisture conditions, slope aspect, elevation, precipitation, temperature, wildfire history, and land use patterns. The area is predominately coniferous forest of mixed species. The make-up of coniferous species has changed through time because of timber harvesting and replanting, fire, and plant diseases. The majority of west-side land is in the Kaniksu National Forest (Priest Lake Ranger District). The northern boundary extends to, and includes, the Upper Priest River watershed to the Canadian border. The U.S. Forest Service also manages the three large islands on the lower lake: Kalispell, Bartoo, and Eightmile Islands. The Upper Priest River headwater lands are administered by the British Columbia Ministry of Forests. Private property comprises approximately 10 percent of the west-side land total (PBTTAT 1998b). In the Nordman and Lamb Creek areas, some blocks of commercial timberlands are owned by Stimson Lumber, and a few large private holdings are in agricultural use.

More than 90 percent of the east side of the basin is owned by the State of Idaho, with the northern boundary incorporating the Trapper Creek watershed (PBTTAT 1998b). Most of this land is administered by the Idaho Department of Lands under the State Endowment Trust. Some State land is managed by the Idaho Department of Parks and Recreation as the Priest Lake State Park. Through the years, various property exchange agreements have transferred a substantial acreage of private, commercial timberlands to the State, although some blocks of private forest land still exist.

Around the 116 kilometers (72 miles) of Priest Lake shoreline, approximately 26 percent of the property is privately owned (PBTTAT 1998b), and the most concentrated residential and business development has occurred on this property. Within the Federal- and State-owned lands, considerable waterfront development has occurred through lease lot programs.

Information on bull trout distribution in the Priest River basin in pre-development times (pre-1880's) is scarce and is presented mostly in oral histories of long-time residents (PBTTAT 1998b). Few manmade barriers to fish movement existed in the 1800's, so migratory stocks in the Priest Lake basin could access and potentially exchange genetic material with other stocks residing in the Priest River, Pend Oreille River, and Lake Pend Oreille (Gilbert and Evermann 1895; PBTTAT 1998a).

Bull trout have been reported in most of the large accessible tributaries to Upper Priest Lake and Priest Lake (PBTTAT 1998b). The extent and type of bull trout utilization is partially documented.

DISTRIBUTION AND ABUNDANCE

Status of Bull Trout at the Time of Listing

In the status summary prepared for the final listing rule (USFWS 1998), a total of 65 subpopulations of bull trout were recognized within the Clark Fork River basin. In the Upper Clark Fork Recovery Subunit, bull trout subpopulations were identified for the upper Clark Fork River (including Rock Creek), 27 separate streams in the Bitterroot River basin, and the Blackfoot River. In the Lower Clark Fork Recovery Subunit, the subpopulations were identified as Lake Pend Oreille and the Pend Oreille River (downstream of the lake to Albeni Falls Dam), Cabinet Gorge Reservoir, Noxon Reservoir, and the lower Clark Fork River. In the Flathead Recovery Subunit, 29 lakes were identified, Flathead Lake being the largest. Each lake was considered to hold a separate bull trout subpopulation. Because of the degree of physical isolation, most of these disconnected lake-based local populations were referred to as "disjunct" by the Montana Bull Trout Scientific Group (MBTSG 1995c, 1995d, 1996b).

The geographic size of the subpopulations that is recognized by the status summary prepared for the listing rule (USFWS 1998) varies greatly, from the large units in the Clark Fork and Flathead Rivers to the very small watersheds associated with the Bitterroot River and some of the disjunct lakes. About two-thirds (43 of the 65 subpopulations) were considered to be depressed; 3, probably extirpated; 17, of unknown status; and 2, stable (USFWS 1998). Ten of the subpopulations were considered to have a declining trend, including 2 of the largest subpopulations, in Lake Pend Oreille and Flathead Lake. Trend was considered unknown in 53 of the remaining 55 subpopulations, with 1 stable subpopulation in Hungry Horse Reservoir and a single increasing subpopulation in Swan Lake. Over 70 percent (46 of 65) of the bull trout subpopulations in this recovery unit were considered to be at risk of stochastic extirpation due to a single spawning stream and/or small population size. This percentage indicates that fragmentation is a major issue for this recovery unit (USFWS 1998).

The U.S. Fish and Wildlife Service considered introduced species (affecting 48 subpopulations), forestry (47 subpopulations), residential development (32 subpopulations), agriculture (30 subpopulations), grazing (29 subpopulations), water quality impacts (26 subpopulations), dams (14 subpopulations), and mining (6 subpopulations) to be the greatest threats to bull trout in the Clark Fork Recovery Unit (USFWS 1998). The magnitude of threats was rated high for 46 of the 65 subpopulations, and in 50 subpopulations (77 percent) the threats were considered imminent.

The best scientific evidence available indicates that the subpopulation groups that the U.S. Fish and Wildlife Service described in the listing rule are each comprised of one to many local populations. The rest of this recovery chapter addresses recovery actions and analysis of core areas and their local populations, rather than refer to subpopulation groups.

Current Distribution and Abundance

With the probable exception of the upper end of the Clark Fork River drainage (upstream of Rock Creek), which has been severely degraded by contamination by heavy metals, bull trout continue to be present (albeit sometimes in low numbers) in nearly all major watersheds where they likely occurred historically in this recovery unit. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), the fish are not expected to simultaneously occupy all available habitats (Rieman *et al.* 1997). This patchiness is evident in some drainages in western Montana, where bull trout are prevalent in tributaries on one side of a watershed, but absent or nearly so on the other. Examples are the Blackfoot River drainage, where bull trout are seldom found in tributaries south of the river, and the North Fork Flathead River, where bull trout are generally absent from the lower ends of Glacier National Park tributaries, most of which drain relatively large glacial lakes that have headwaters containing bull trout. These distribution gaps often reflect natural conditions as bull trout distribution is strongly correlated with habitat suitability (see Chapter 1). It is important to recognize that in some watersheds, or portions of them, bull trout were probably never numerous because of natural habitat limitations.

However, significant local populations of bull trout have been extirpated in recent times. Examples include the migratory form in the Bitterroot River drainage and in portions of the severely degraded upper Clark Fork River drainage. Bull trout numbers have been reduced to remnant status in several lakes in Glacier National Park and elsewhere in lakes in the Flathead River basin, that have been stocked with (or invaded by) lake trout; such lakes include Whitefish, Tally, and Upper and Lower Stillwater Lakes (Fredenberg 2000).

Population trend data is unavailable for bull trout in the lower Clark Fork River drainage prior to construction of Thompson Falls, Noxon Rapids, and Cabinet Gorge Dams. Since construction of the dams, the catch of bull trout during gill net surveys in the reservoirs (between 1960 and 1985) indicates that bull trout declined in Noxon Reservoir but remained somewhat stable in Cabinet Gorge Reservoir (Huston 1985). When Pratt and Huston (1993) evaluated the past and current bull trout population status of the Lower Clark Fork River drainage, they concluded that local bull trout populations in Cabinet Gorge and Noxon Reservoirs are currently stable, but fragile. More recently, Washington Water Power (now Avista) conducted extensive gill net surveys (in preparation for Federal Energy Regulatory Commission relicensing) and documented few bull trout in the catch (Washington Water Power Company 1998). While these local populations persist at this time, they are susceptible to extirpation from events that could cause further declines.

The strongest remaining bull trout population in the Priest River basin is found in Upper Priest Lake (PBTTAT 1998b). These adfluvial fish spawn in tributaries to the Upper Priest River and Trapper Creek. About 100 adults have been estimated (Fredericks 1999).

In recent years, in the Clark Fork River basin, emphasis has been placed on documenting distribution and determining abundance of bull trout by using redd counts (LPOWAG 1999). Because of the large size of the migratory fish and because of the geology of the streams that generally makes redds easy to recognize, redd counts (Spalding 1997) have been shown to provide a repeatable method of indexing spawner escapement in many streams in this recovery unit (Rieman and McIntyre 1996). However, several authors have cautioned that redd counts should not be relied upon as the sole method of population monitoring (Maxell 1999, Rieman and Myers 1997) and that redd counts may, in fact, lead to erroneous conclusions about population status and trend.

Table 1 summarizes the status of redd count information for the core areas designated in this recovery unit. Thirteen core areas have a history of redd count information for at least 3 consecutive years. The most complete database has been accumulated for the Flathead Lake, Swan Lake, and Lake Pend Oreille core areas, with redd counts conducted annually in multiple index streams for most of the past 20 years. Similar trend data has been accumulated for Rock Creek, the Blackfoot River, Priest Lakes and Upper Priest River, and several of the Flathead basin lakes, but the period of record generally goes back 5, or fewer, years. Only sporadic redd counts have been conducted in the majority of the remaining core areas. In some cases, the numbers of bull trout are too low to accurately identify primary spawning reaches of tributary streams.

Additional effort has been focused in some basins on monitoring juvenile abundance in primary spawning and rearing habitat. The basins with such monitoring data tend to be the same as those with extensive redd count information. In the Flathead River basin, a composite index of juvenile (age 1 and older) abundance has varied from a high of about 7.8 fish per 100 square meters (1,000 square feet) in 1985 to a low of about 0.9 fish per 100 square meters (1,000 square feet) in 1996 (Deleray *et al*. 1999). Assessing trends in bull trout abundance from a single parameter is difficult, given the relatively complex life cycle of the migratory fish. Until sufficient site-specific data has been accumulated to develop more information about natural variability, the interrelationships between juvenile abundance and adult return and between redd counts and juvenile abundance will remain largely speculative. Some of these issues are currently being explored by research projects in the Flathead and Pend Oreille River watersheds. Intensive monitoring of the Flathead, Swan, Hungry Horse, and Pend Oreille Lakes populations is critical to further develop this information. It is also important that these data sets be continually evaluated and methods upgraded for the purpose of developing models and predictive tools.

Table 1. Summary of redd count information for Clark Fork Recovery Unit core areas during the period 1996–2000. Table includes only counts for those local populations that were monitored at least three times during the five-year period.

Recovery Subunit	Core Area	No. of Local Populations Monitored	Mean Total No. Redds Counted per Year (1996–2000)
Upper Clark Fork	Clark Fork Rive Section 1 (Upstream of Milltown Dam)	1	36
	Rock Creek	5	165
	Blackfoot River	5	233
	Clearwater River	0	---
	Clark Fork River Section 2 (Milltown Dam to Flathead River), including Jocko River and Mission Creek	0	---
	West Fork Bitterroot River	1	3
	Bitterroot River	2	60
Lower Clark Fork	Lower Flathead River (including Jocko River and Mission Creek)	0	---
	Clark Fork River Section 3 (Flathead River to Thompson Falls Dam)	0	---
	Noxon Reservoir	0	---
	Cabinet Gorge Reservoir	0	---
	Lake Pend Oreille	17	620
Priest	Priest Lake(s) and Upper Priest River	11	39
Flathead	Frozen Lake	0	---
	Upper Kintla Lake	0	---
	Kintla Lake	0	---
	Akokala Lake	0	---
	Bowman Lake	0	---
	Cerulean, Quartz, and Middle Quartz Lakes	0	---
	Lower Quartz Lake	0	---
	Cyclone Lake	1	1

Recovery Subunit	Core Area	No. of Local Populations Monitored	Mean Total No. Redds Counted per Year (1996–2000)
	Logging Lake	0	---
	Arrow Lake	0	---
	Trout Lake	0	---
	Lake Isabel	0	---
	Harrison Lake	0	---
	Lincoln Lake	0	---
	Lake McDonald	0	---
	Upper Stillwater Lake	1	26
	Upper Whitefish Lake	1	11
	Whitefish Lake	0	---
	Flathead Lake	8	170
	Doctor Lake	0	---
	Big Salmon Lake	1	58
	Hungry Horse Reservoir	7	400
	Lindbergh Lake	0	---
	Holland Lake	1	16
	Swan Lake	10	1,161

REASONS FOR BULL TROUT DECLINE

Ecological processes or conditions that regulate or limit bull trout production are known as limiting factors. In the Clark Fork Recovery Unit, limiting factors are not equally distributed across the basin—what may be a limiting factor for bull trout in one recovery subunit or stream may not be significantly influencing bull trout in another. Therefore, discussion of limiting factors is presented, in context, on a subunit-by-subunit basis.

Water Quality

Upper Clark Fork Recovery Subunit

Water quality in the Clark Fork River is improved downstream of Missoula by dilution from large tributaries such as the Blackfoot and Bitterroot Rivers. However, due to warm summer water temperatures and other habitat limitations, the mainstem Clark Fork River supports lower populations of coldwater salmonids than would be expected. A major water quality issue in this portion of the Clark Fork River mainstem is the addition of nutrients and other pollutants to the river from sources such as the Missoula Municipal Sewage Plant and the Stone Container Corporation Kraft Mill. The primary nonpoint sources of sediments and nutrients are the Bitterroot River and the Blackfoot River (MDHES 1994). There has been a growing concern over increases in algae levels in the river, increases that are stimulated by nutrients and that result in depressed concentrations of dissolved oxygen in mid-summer (Watson 1985).

Many water quality studies have been done, or are underway, in the Clark Fork River. For more detailed information about water quality issues in this river, see, among others, Watson (1985 and 1991), Ingman (1992a, 1992b), and Knudson (1992).

Excessive concentrations of nutrients (phosphorus and nitrogen) also cause water quality problems in the Upper Clark Fork Recovery Subunit. High concentrations of nutrients have led to blooms of filamentous algae in the Clark Fork River upstream of Missoula, impairing beneficial uses of river water (USEPA 1993). The main nutrient point sources are the sewage effluent from the towns of Butte and Deer Lodge.

Dams

Upper Clark Fork Recovery Subunit

Milltown Dam was constructed on the Clark Fork River in 1906 and 1907 just downstream of the confluence with the Blackfoot River (Periman 1985). Milltown Dam is a run-of-the-river facility with no water storage capacity, so the impact on bull trout is related to fish passage and not to dam operations. Each spring, concentrations of several fish species are observed at the base of Milltown Dam. These fish are assumed to be attempting an upstream migration past the dam. Radio transmitters implanted in bull trout that had migrated to the face of the dam revealed that, when these fish were passed upstream, they migrated to streams presumed to be spawning streams in the Blackfoot River and Rock Creek drainages (Swanberg 1997).

Pennsylvania Power and Light of Montana (formerly Montana Power Company), which owns and operates Milltown Dam, is currently operating under a license extension from the Federal Energy Regulatory Commission. The company had earlier announced plans to drop the hydroelectric license and discontinue generating power at the facility. Deliberations are occurring over whether to implement a fisheries mitigation plan that includes provisions for providing selective fish passage at this facility or remove the dam altogether. The decision is complicated immensely by the presence of an accumulation of millions of cubic yards of toxic sediment in the forebay of the dam, a result of the mining legacy upstream in Butte and Anaconda. The entire area is part of a Superfund project of the U.S. Environmental Protection Agency. A number of advocacy groups are pushing for sediment and dam removal, primarily because of the problems with potential pollution of the Missoula aquifer. Fish passage is also a major issue in the deliberations. In addition, northern pike have recently proliferated in the reservoir behind the dam and have been documented to eat bull trout among their prey species (Missoulian, *in litt.*, 2000).

East Fork Dam on the East Fork Rock Creek (southwest of Georgetown Lake) is also a barrier to upstream fish passage. Operation of East Fork Reservoir results in seasonal dewatering of the downstream reaches of East Fork Rock Creek. Trout Creek and Flint Creek are used as a conveyance channel for East Fork Reservoir water and are impacted by excess stream flow.

A small dam at the mouth of the Blackfoot River (at the Stimpson Lumber Mill) may be a seasonal fish passage barrier. The Nevada Creek Dam and dams on the Clearwater Lakes (Seely Lake and Placid Lake) are also fish passage barriers in the Blackfoot River drainage. Fish passage barriers were installed at the outlets of Rainy Lake and Lake Inez in the 1960's in an attempt to control the reintroduction of nongame fish into these lakes, following chemical rehabilitation. Montana Fish, Wildlife and Parks is researching the feasibility of removing these barriers.

There are no hydroelectric facilities in the Bitterroot drainage, but there are several irrigation storage reservoirs in the valley. These dams probably alter nutrient and sediment balance and downstream flow patterns, temperature regimes, and habitat. Fred Burr Dam washed out years ago, and the downstream area is still suffering from the effects of high bedload (sediment not in suspension, dragged or rolled along the river bottom) movement.

Several dams in the Bitterroot River drainage are high in the mountains, generally upstream of local populations of bull trout. Lake Como Dam (on Rock Creek, a Bitterroot River tributary) is a barrier to fish migration. However, the drainage does not support bull trout.

Painted Rocks Reservoir on the West Fork Bitterroot River supports a bull trout core area that includes inflowing tributaries for spawning and rearing. The reservoir is annually drawn down by releases for downstream flow and irrigation purposes. Little water remains in the reservoir during fall and winter months. A minimum pool reservation is needed for bull trout since Painted Rocks has been identified as foraging, migrating, and overwintering habitat. Painted Rocks Dam is a barrier to bull trout migration. However, it is also a barrier to upstream dispersal of brown and rainbow trout and could protect bull trout from possible competition and predation by introduced species.

The Mountain Water Company Dam on lower Rattlesnake Creek blocks fish passage from the Clark Fork River into the upper watershed. It is doubtful that Clark Fork River bull trout successfully spawn in the reaches of Rattlesnake Creek below the dam, although adult bull trout congregate annually below the dam in an attempt to migrate upstream (MBTSG 1996e). Above the dam, Rattlesnake Creek supports bull trout, and the migrants at the dam are probably a fluvial component of that local population. Rattlesnake Creek is the first major watershed downstream of Milltown Dam, which is approximately 10 kilometers (6 miles) upstream on the Clark Fork River from the confluence of Rattlesnake Creek. Montana Fish, Wildlife and Parks biologists are implementing fish passage at this dam, and because the watershed has been protected as a municipal water supply, it has potential to provide significant benefits to bull trout recovery.

Lower Clark Fork Recovery Subunit

Three dams on the lower Clark Fork River have significantly reduced the amount of spawning and rearing habitat available to Lake Pend Oreille bull trout. Other effects of these dams and of other tributary diversions to bull trout habitat include changes in water quality (temperature, sediment, and nutrients) and quantity, lake drawdowns, a reduction in shoreline food sources, and direct losses of fish into water conveyance systems (turbines, spillways, or water delivery systems).

Built in 1913 on the Clark Fork River, Thompson Falls Hydroelectric Development eliminated migration and spawning access from Lake Pend Oreille to 86 percent of the Clark Fork River basin, though not all of that basin was historically used by bull trout (Pratt and Huston 1993). Between 1913 and 1951, only 108 kilometers (67 miles) of the Clark Fork River remained barrier free between Lake Pend Oreille and Thompson Falls Dam, providing access to spawning tributaries in Montana. Cabinet Gorge Dam, completed in 1952, further isolated Lake Pend Oreille bull trout from important spawning habitat downstream of Thompson Falls. Before Cabinet Gorge Dam was constructed, bull trout used at least 10 tributary streams in the 93 kilometers (58 river miles) between Thompson Falls and the present site of Cabinet Gorge Dam (PBTTAT 1998a). Noxon Rapids Dam was constructed in the mid 1950's and lies between the other two major dams, creating a series of three impoundments over 113 kilometers (70 miles) of the Clark Fork River.

Thompson Falls Dam is operated by Pennsylvania Power and Light of Montana as a run-of-the-river facility. It has very limited storage capacity. Cabinet Gorge and Noxon Rapids Dams are owned and operated by Avista Corporation. The operational agreement for Noxon Reservoir allows for a 3-meter (10-foot) maximum seasonal drawdown, which may be exceeded under special circumstances. Cabinet Gorge currently functions as a re-regulating facility[1] for Noxon Rapids Dam. Cabinet Gorge drawdowns rarely exceed 1.5

[1] "Re-regulating facility" refers to a secondary dam located downstream of a major hydro dam. The purpose of these types of facilities is to smooth out peaking flows from the larger dam upstream. Water levels in the re-regulating facility show

meters (5 feet) (Huston 1985). The aquatic environment has benefitted to some extent from the water level stability provided by the current Noxon Rapids operational agreement. However, there is some concern that this operational scenario benefits other fish species (*e.g.*, largemouth and smallmouth bass, northern pike) to the detriment of bull trout.

Noxon Rapids Reservoir has a surface area of 3,240 hectares (8,000 acres) at full pool and 2,228 hectares (5,500 acres) at minimum pool (Huston 1985). Discharge from Noxon Dam varies daily and seasonally depending on the river inflow and the demand for electrical power (Huston 1988). Noxon Rapids Reservoir is divided into two distinct habitat types with a broad transition zone that varies depending on river flow and project operation. The upstream end of the reservoir, generally between Beaver Creek Bay and Thompson Falls Dam, is characterized by visible current at almost all times of the year. The portion of the reservoir downstream of Beaver Creek Bay has visible water currents only during spring high water or during severe reservoir drafting (Huston 1985).

Noxon Rapids Reservoir exhibits varying degrees of stratification, depending on river flow and ambient conditions, and occasionally has a weak thermocline (documented in late July 1994 at about 7.5 meters [25 feet] [MBTSG 1996a]). Surface temperatures average about 22 degrees Celsius (72 degrees Fahrenheit) during the hottest days, but uncommonly reach or exceed 24 degrees Celsius (75 degrees Fahrenheit). Generally, oxygen concentrations remain within the tolerance level for salmonids (Huston 1985).

Cabinet Gorge Reservoir is 32 kilometers (20 miles) long and has a surface area of 1,296 hectares (3,200 acres) at full pool and 992 hectares (2,450 acres) at minimum pool (Huston 1988). The reservoir currently has typical daily water level fluctuations of 0.6 to 1.2 meters (2 to 4 feet). The temperature of the reservoir is nearly isothermal, and there is limited coldwater habitat in the reservoir during the warm summer months. However, tributary and groundwater inflows may provide some areas of coldwater refuge for bull trout. Maximum temperature rarely exceeds 22 degrees Celsius (72 degrees Fahrenheit), except in backwater shallows outside the main current pattern. Dissolved oxygen levels in the reservoir are adequate for fish at all depths.

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extremes in water fluctuations, but presence of the facility tends to stabilize flows downstream.

Downstream of Cabinet Gorge Dam, bull trout from Lake Pend Oreille are known to take refuge and spawn in coldwater spring areas that are found on the south shore of the Clark Fork River near the State of Idaho's Cabinet Gorge Fish Hatchery. Spawning surveys since 1992 show a high of 18 redds in 1995 and a low of 2 in 1992 (LPOWAG 1999). It is unknown whether these fish are progeny of bull trout spawning successfully in the channel or are fish which have dropped down from upriver tributaries and are unable to return because of Cabinet Gorge Dam. Recent genetic evidence appears to support the latter hypothesis as bull trout sampled from below the dam are genetically similar to upriver stocks (Neraas and Spruell 2000). Juvenile habitat usage in the river is unknown, and no life history information is available for juvenile bull trout that may recruit from the river. The genetic evaluation provided support for passing a limited number of fish upstream above the dam to test the potential benefits to upstream populations, and that passage is currently occurring.

During high flow events, Cabinet Gorge Dam may spill up to 2,832 cubic meters per second (100,000 cubic feet per second) or more in addition to the power plant's generating capacity of approximately 1,062 cubic meters per second (37,500 cubic feet per second). When significant volumes of water are passed over the spillway, atmospheric gases become entrained in the water column. During 1997, gas supersaturation levels, or total dissolved gas, exceeded 140 percent of saturation. The State of Idaho's water quality standard is 110 percent. In 1997, the supersaturated gas plume extended all the way down the Clark Fork River and across the northern end of Lake Pend Oreille. Fish exposed to high total dissolved gas levels for periods of time can be harmed or killed. At this time, the population effects of these high dissolved gas levels are unknown in the lake or river. Studies conducted in the next few years as part of the Settlement Agreement between Avista and the Federal Energy Regulatory Commission are intended to identify impacts resulting from high total dissolved gas levels below Cabinet Gorge Dam and to develop and implement abatement strategies.

Peaking power flows downstream of Noxon and Cabinet Gorge Dams can fluctuate on an hourly basis. Avista maintains a required minimum flow of at least 141.6 cubic meters per second (5,000 cubic feet per second), below Cabinet Gorge Dam in the 11 to 14 kilometers (7 to 9 miles) of river upstream of Lake Pend Oreille (PBTTAT 1998a).

While none of these hydroelectric projects provides upstream fish passage, downstream movement has been demonstrated. Marked hatchery fish planted in Noxon Reservoir have been caught in Cabinet Gorge Reservoir and Lake Pend Oreille (Huston 1985). The turbine intakes on these dams are currently not screened, and evaluation is occurring to determine the effects of unscreened turbine intakes on downstream migrants.

Additional studies funded by Avista during the next 45 years (the term of the Federal Energy Regulatory Commission license) will explore and implement options for upstream passage of adult fish and safe passage for juveniles downstream, experiment with control of nonnative species in selected waters, monitor fish abundance and distribution, and research other elements that emphasize native species restoration (Washington Water Power Company 1998).

Kerr Dam, constructed in 1938 on the Flathead River near Buffalo Rapids (just downstream of Flathead Lake), is operated by Pennsylvania Power and Light of Montana. Formerly operated as a “load-following” or “peaking” facility, it has recently been converted to base load, meaning that flows from the dam no longer fluctuate dramatically and rapidly. Fluctuating flows are known to have reduced the food base (aquatic macroinvertebrates) in the lower Flathead River, a reduction that, in turn, has reduced the carrying capacity of the river for fish (Cross and DosSantos 1988). Pennsylvania Power and Light of Montana recently concluded negotiations with the Federal Energy Regulatory Commission for relicensing of Kerr Dam. The December 2000 relicensing terms include Kerr Dam flow modifications for the protection, mitigation, and enhancement of fisheries in the lower Flathead River, though the extent to which bull trout will benefit is unknown. Further discussion of Kerr Dam impacts is included in the following section (Flathead Recovery Subunit).

Albeni Falls Dam on the Pend Oreille River near the Idaho–Washington border interrupts habitat connectivity with the lower portion of the basin and also regulates water levels in Lake Pend Oreille and at the delta of the Clark Fork River. Gilbert and Evermann (1895) described Albeni Falls as “scarcely more than pretty steep rapids [that] would not interfere at all with the ascent of salmon.” Albeni Falls Dam was built in 1952, about 42 kilometers (26 miles) downstream of the outlet of the lake on the Pend Oreille River. This dam significantly influences water levels in the lake and the Pend Oreille River. During the summer months, the dam holds the lake level artificially high, and the Pend Oreille River downstream of the natural lake outlet essentially becomes a shallow arm of the lake. During the fall, the gates are opened at Albeni Falls, and water level is drawn down for flood control storage. Although this dam restricts upstream movement and functionally removes any downstream migrants from the Pend Oreille population, these effects are probably much less significant than other effects of this dam, such as those of lake level fluctuations on access to tributary streams and on the prey base (primarily impacts on kokanee salmon). Low winter water levels are thought to be the primary cause for the decline of kokanee salmon in the lake since the late 1960's because the lower lake levels forced kokanee salmon to spawn in shoreline gravels that had high levels of fine sediments (PBTTAT 1998a).

The December 2000 Biological Opinion, emanating from Endangered Species Act formal consultation between the U.S. Fish and Wildlife Service and Federal water project managers (U.S. Army Corps of Engineers, Bonneville Power Administration, and U.S. Bureau of Reclamation), contained reasonable and prudent measures prescribed for fish passage at Albeni Falls Dam (USFWS 2000): "... evaluate the feasibility of reestablishing bull trout passage at Albeni Falls Dam. If the information from these studies warrants consideration of modifications to the Albeni Falls facility, then the U.S. Fish and Wildlife Service will work with the action agencies to implement these measures, as appropriate, or to reinitiate consultation, if necessary." As it pertains to lake levels in Lake Pend Oreille, the Biological Opinion stated that "... action agencies shall continue the lake winter elevations study to promote kokanee spawning/recruitment along the shoreline of Lake Pend Oreille."

Albeni Falls Dam and its operations may have negatively influenced overwintering habitat for bull trout. The dam fragments habitat believed to have been historically occupied (Pratt and Huston 1993). Lake Pend Oreille winter drawdown generally begins after Labor Day. Minimum pool (625 meters [2,051 feet] mean sea level) is normally reached between November 15 and December 1, with a target date of November 15 to facilitate kokanee salmon spawning. The Corps of Engineers is participating in the study mentioned above, initiated by the Idaho Department of Fish and Game in 1996, to evaluate benefits of leaving the winter lake level 1.2 meters (4 feet) higher to enhance kokanee salmon spawning on the lake shoreline (PBTTAT 1998a).

Migration by post-spawning bull trout out of Gold Creek may be hindered as an indirect result of lake level fluctuations caused by Albeni Falls Dam. Peak runoff flows in Lake Pend Oreille tributaries generally occur before the Clark Fork River peaks and fills the lake to its summer elevation (629 meters [2,062 feet] mean sea level). Consequently, coarse bedload material carried downstream by Gold Creek during high flow is deposited in an alluvial fan that has formed near the winter lake level elevation. In the summer, when Albeni Falls Dam brings the lake up to full pool, the alluvial fan is underwater and so cannot armor with silt (and other fine material) and grow vegetation. This water level change leaves a coarse and porous alluvial fan. In years with substantial runoff, when considerable bedload material is deposited at the mouth of the stream, late-season flow cannot maintain itself on top of the porous substrate and goes subsurface, creating difficult downstream migration conditions (PBTTAT 1998a). This scenario also occurs to some extent on several other tributaries.

Flathead Recovery Subunit

The Bigfork Dam on the Swan River, built after the power plant was first installed in 1902 and then later improved, probably blocked some bull trout migration from Flathead Lake into the Swan River. Hungry Horse Dam completely blocked the migration of bull trout from Flathead Lake into the South Fork Flathead River, beginning in 1953. Together, these two facilities reduced by nearly 50 percent the potential spawning and rearing habitat available to Flathead Lake bull trout (Fraley *et al.* 1989), although not all of that habitat was necessarily occupied.

Bigfork Dam blocked the Swan River drainage from Flathead Lake, but the ramifications of this loss to either system are not well understood. Anecdotal evidence from newspaper accounts around 1900 indicates that the mouth of the Swan River (or Big Fork as it was called then) was a very popular fishing spot in the spring (April to May), with apparent concentrations of bull trout and westslope cutthroat, and again in the fall (November), for mountain whitefish (Inter Lake, *in litt.*, 1900). It is not clear whether those fish migrated up the Swan River, were simply drawn there because of proximity to the mouth of the Flathead River, or were drawn there for foraging opportunities or other reasons. The Flathead Recovery Subunit Team presumes that limited genetic interchange between the Swan and Flathead River drainages probably occurred naturally because of thermal regimes. Bigfork Dam currently prevents introduced fish species, especially lake trout present in the Flathead River drainage, from migrating upstream into the Swan River drainage. This isolation is now an overall benefit to Swan Lake, which is treated as a separate bull trout core area.

Bigfork Dam operation has little direct influence on habitat occupied by bull trout. Fish are known to enter the diversion canal and may become trapped when flows are reduced during maintenance activities. PacifiCorp, the current owner of Bigfork Dam, alerts the Montana Fish, Wildlife and Parks before total dewatering of the canal so that fish can be captured and moved back into the river. The Federal Energy Regulatory Commission license for the dam expires in 2002, and the review process for relicensing is underway.

Although Bigfork Dam has eliminated connectivity of the Swan River drainage with the Flathead River drainage, the remainder of the Swan River drainage upstream of Flathead Lake remains intact. A large number of license applications for small hydropower projects in the Swan River drainage during the early 1980's stimulated a major study of their potential effects on fisheries. Had the construction of the 20 proposed microhydro projects proceeded, the estimated total losses of juvenile bull trout was calculated to be 11 to 84 percent in individual streams, or 1 to 8 percent of the drainagewide migratory bull trout production (Leathe and Enk 1985). Although none of the proposed projects has been built to date, future activity may occur at these sites.

Kerr Dam, constructed downstream of the natural outlet of Flathead Lake in 1938, blocked upstream fish passage from the lower Flathead River into Flathead Lake. In early biological surveys, surveyors noted that the falls downstream of Flathead Lake were not fish barriers but "... consist simply of a series of rapids, which do not interfere in the least with the free movement of fish. From this point down Flathead river possesses no falls or obstructions of any kind, and there is none in Clarke Fork until near Lake Pend d'Oreille" (Gilbert and Evermann 1895).

However, because of thermal conditions, routine bull trout migration probably did not occur historically between large lakes, such as Flathead Lake and upstream or downstream lakes. Bull trout are believed to be deterred from migrating upstream into relatively warm effluent waters from lakes during the fall. To date, only casual observation and genetic information support this hypothesis, but research with radio transmitters should be invaluable in further defining these migratory patterns. Regardless, historical habitat connectivity between lakes, which facilitated straying of fish, may have been important for providing genetic exchange and reestablishing extirpated populations. Downstream movement of fish through Kerr Dam, into the lower Flathead River, has been demonstrated.

Kerr Dam has substantially modified the hydrograph of Flathead Lake, resulting in a longer full pool period in the summer months followed by a more rapid drawdown in winter. This water level scenario has impacted fisheries in the lake, in part by increasing shoreline erosion, both in the lake and in the lower end of the mainstem Flathead River where it enters the lake.

Hungry Horse Dam, completed in 1953, disconnected the South Fork Flathead River drainage from the main Flathead River system. The full ramifications of this loss to Flathead Lake, as well as to the South Fork Flathead River drainage, are not currently known. Preliminary genetic information suggests that, to a great extent, local bull trout populations using the three forks of the Flathead River segregated themselves naturally (Kanda *et al.* 1994). Therefore, the genetic diversity of Flathead Lake bull trout may have been reduced as a result of the dam construction. The bull trout core areas remaining upstream of the dam (Hungry Horse, Big Salmon, and Doctor Lakes) probably preserved the genes of South Fork Flathead River stocks that existed there historically, though some adaptive changes could occur. Hungry Horse Dam has benefitted the South Fork Flathead River in one way, creating an isolation barrier that has kept most of the South Fork Flathead River drainage free from nonnative fish species.

During recent decades, operation of Hungry Horse Dam has resulted in excessive drawdowns. Montana Fish, Wildlife and Parks has recommended a maximum drawdown of 26 meters (85 feet) based on biological considerations. Since 1988, this recommendation has been frequently exceeded, as the U.S. Bureau of Reclamation released water as required to meet the Pacific Northwest Coordinated Agreements for critical water years. Research has shown that reduced reservoir volume directly impacts the size of the aquatic environment for all organisms in the food web. Production of phytoplankton, zooplankton, and aquatic insects is reduced. And reduction in the food base reduces the prey available for predator species like bull trout. Reservoir volume can also be greatly reduced, forcing bull trout and other fish species into riverine habitats. Because of the steep slopes in the reservoir, volume is reduced by approximately 80 percent for drawdowns of 55 meters (180 feet). Biologists at the Montana Fish, Wildlife and Parks are concerned that some local bull trout populations in Hungry Horse

Reservoir may be damaged by continuing deep drawdowns (MFWP 1997a), though to date the overall population appears to have been stable.

Downstream of Hungry Horse Dam, summer releases of cold water may have historically impacted the behavioral patterns and food resources of native bull trout and cutthroat, as well as influenced behavior and distribution of lake trout that invaded the lower river in substantial numbers, beginning in the late 1980's. However, there is limited documentation on the nature of these complex interactions. In 1996, a selective withdrawal system was installed on Hungry Horse Dam. This selective withdrawal system now allows water to be drawn from different levels of the reservoir, allowing for some control of downstream water temperatures and a more natural thermal regime in the summer.

The December 2000 Biological Opinion contained reasonable and prudent measures for operations of Hungry Horse Dam (USFWS 2000): "[i]mplement operational measures at Hungry Horse Dam intended to minimize adverse effects of rapid and severe flow fluctuations on bull trout, including year-round minimum flows and ramping rates, and seasonal water management; conduct studies to monitor the adequacy of the constraints; and provide for modification of the operational constraints depending on study results. "

The Biological Opinion includes specific flow targets and ramping rates and mandates implementation of the VARQ (or variable flood control) operations to better balance reservoir refill and downstream flow regimes to benefit bull trout and other native fishes (USFWS 2000).

Priest Recovery Subunit

The outlet control structure at the mouth of Priest Lake was constructed in 1951 by the State of Idaho and rebuilt in 1978 (PBTTAT 1998b). It is currently operated and maintained by the Avista Corporation under contract with the Idaho Department of Water Resources. The purpose of the dam is to hold up the summer water level in Priest Lake and the Thorofare for recreation. It is probably a fish barrier (upstream) during the time that it operates. Water release during the fall supplements downstream hydropower production. In winter, the dam's boards are removed; then there is free flow, and fish passage is not obstructed. The effects of this dam on bull trout in the Priest River system are not currently well understood.

Summary (Dams)

Dams have been one of the most important factors in fragmenting and likely reducing the bull trout population of the Clark Fork Recovery Unit. Large hydroelectric dams permanently interrupted established bull trout migration routes, eliminating access from major portions of the tributary system to the productive waters of Lake Pend Oreille and Flathead Lake. Also, these dams impact the habitat that was left behind by affecting reservoir and lake levels, water temperature, and water quality. Smaller irrigation storage dams have further fragmented some of the previously connected watersheds and made it increasingly difficult for migratory bull trout to thrive. In some locations, most notably in the Swan, Hungry Horse, and Painted Rocks core areas, dams formed isolation barriers that have prevented the movement of nonnative fish.

Forestry Management Practices

Upper Clark Fork Recovery Subunit

Past forestry practices (road construction, log skidding, harvest in riparian areas, clear-cutting, and terracing) were often damaging to watershed conditions and were major contributing causes of bull trout decline (USFWS 1998). The effects of thesepractices included increased sediment in streams, increased peak flows, thermal modifications, loss of instream woody cover, and channel instability.

In the late 19th and early 20th centuries, mining activity and railroad construction resulted in vast amounts of timber being cut from what was to become the Deerlodge National Forest, in the upper Clark Fork River drainage. Between 1880 and 1918, approximately 50 million board feet were harvested annually from lands surrounding Butte, Montana (MBTSG 1995e, Periman 1994).

The crudely designed road system and skid trails from this era had lingering effects in some areas. In addition, a number of roads were built for other purposes, such as recreation and access to mining claims and private lands. Some of these roads need rehabilitation. Impacts from roads can include high sediment loads, channelization, and valley bottom restriction, resulting in loss of stream pool habitat and loss of riparian vegetation. Separating the effects of logging roads from those of roads built for, or eventually used for, other purposes is difficult or impossible. Most of the major access roads across National Forest lands were initially built as logging roads.

On the Lolo and Deerlodge National Forests, percent surface fines (a measure of fine sediment) in streams is positively correlated to, among other variables, road densities (Kramer *et al.* 1991). Amounts of fine sediment measured in relatively undeveloped watersheds on the Lolo and Deerlodge Forests appear to be roughly half of those measured in managed watersheds on the same forests (Kramer *et al.* 1994). In the Swan River drainage, bull trout redd counts in spawning tributary watersheds were shown to be negatively correlated with the density of logging roads (Baxter *et al.* 1999).

Log drives down the Blackfoot and Clearwater Rivers had an unquantifiable, but significant, impact on aquatic habitat (MBTSG 1995b). Evermann (1901) wrote of the Blackfoot River:

> "At Bonner, a mile or so above the mouth, is a very large sawmill, and the river for 3 or 4 miles above the mill is literally filled with logs which have been cut from the heavily timbered country through which the river flows and which were being floated down to the mill. . . . The mountains on either side are of highly metamorphic sandstone, and in most places densely timbered, but at the present rate of destruction it will not be many years until these magnificent forests are wholly destroyed, the mountains made barren, and the volume and beauty of the streams greatly diminished."

Evermann (1901) also wrote about Rattlesnake Creek near Missoula (MBTSG 1996e):

> "The banks are lined with a heavy growth of trees, bushes, and vines, but this promises not to remain very much longer. The larger timber is being cut off rapidly for wood, which is floated down the stream. At the time of our visit, at least 3 miles of the stream was literally filled with an immense jam of cordwood which had been started down, and above this we saw a constant line of sticks floating by to augment the large amount already in the jam. From the best information we could gain, all of this timber is being cut from Government land, and, whether by Government permission or not, it is certainly to be very greatly deplored."

The Clark Fork River and Fish Creek were also used for log drives. Log drives were very damaging to fish and fish habitat at the time they occurred (MBTSG 1996e). Some of the impacts to the stream channel (eroded streambed, gouged banks, straightened channel, blocked side channels, and lost instream cover and woody debris) no doubt persist into the present (Sedell *et al.* 1991). Guth and Cohen (1991), in a caption for a photograph of a log jam at Bonner in 1899, state that sometimes logs being floated down river did not behave and that there were tremendous log jams. Dynamite was usually used to break up the logs that formed a jam, with predictable consequences to bull trout.

Many drainages in the Blackfoot River watershed have been extensively logged and have suffered damage from sedimentation. Silvicultural impairment to water quality has been noted in Belmont, Bear, Chamberlain, Deer, Dunham, Keno, Marcum, McElwain, and Richmond Creeks and in the North Fork Blackfoot and West Fork Clearwater Rivers (MDHES 1994). Pierce and Podner (2000) identify potential restoration projects, including improvements to road crossings and restoration of habitat related to impacts from forestry, on 64 streams or stream reaches throughout the Blackfoot River drainage.

Current forestry practices are more progressive, but the risk to bull trout recovery is still high because of the existing road systems and the lingering results of past activities. The Bitterroot National Forest has classified the condition of most watersheds on the forest into three categories: high risk, sensitive, and healthy. These categories are based on two major effects of management on watershed health: first, sediment yields from road construction and, second, increased water yields and peak flows from timber harvesting (Decker 1991). An analysis of the condition of the Bitterroot National Forest streams indicates that about one-third of the streams within the timber base are in healthy condition, one-third are in sensitive condition, and one-third are in high risk condition. Validation studies have found this model to be accurate 80 percent of the time. When the model is not accurate, the streams are usually in worse condition than predicted (Bitterroot National Forest 1991, 1992). On the Bitterroot National Forest, local bull trout populations with estimable numbers of individuals (10 or more fish larger than 12.7 centimeters per 305 meters; *i.e.*, number greater than 5 inches per 1,000 feet of stream) have been found only in drainages classified as healthy or sensitive. In the high risk drainages, no bull trout have been found at 80 percent of the sites, and the other 20 percent contain very low numbers of bull trout (Clancy 1993).

Studies conducted on the Bitterroot National Forest have found that, based on population estimates, bull trout numbers are negatively correlated with the amount of fine sediment found in the stream (Clancy 1993; MBTSG 1995a). Weaver and Fraley (1993) found that the higher the percentage of the spawning substrate that is less than 0.6 centimeter (0.25 inch) in diameter, the lower the survival to emergence for embryos and fry of bull trout and westslope cutthroat trout. They also found evidence linking disturbance patterns in the preceding 10 years to sediment and water yield. McNeil core samples taken on the Bitterroot National Forest indicated a high average proportion of fine sediment (38 to 41 percent less than 0.6 centimeter) in both developed and undeveloped drainages (Clancy 1991), in large part due to the underlying granitic geological formations. Wolman pebble counts (an alternative method of analysis) in undeveloped watersheds in the Bitterroot National Forest generally indicated less than 25 percent fine sediment that was less than 0.6 centimeter (0.25 inch) in diameter (Decker *et al*. 1993).

Numerous streams are listed as having impaired water quality as a result of silvicultural activities in the middle portion of the Clark Fork River drainage (MDHES 1994). Studying fisheries habitat on the Lolo and Deerlodge National Forests, Kramer *et al.* (1991) found that percent of surface fines in streams is correlated to, among other variables, road densities. Amounts of fine sediment in relatively undeveloped watersheds on the Lolo and Deerlodge Forests appear to be roughly half of those measured in managed watersheds on the same forests (Kramer *et al.* 1994).

Lower Clark Fork Recovery Subunit

The Thompson River has a main logging haul road along one side of the stream and a county road along the other side of the stream for nearly its entire length. Many other streams have logging roads in the riparian zone.

Silviculture has been identified as a source of impaired water quality within the lower Clark Fork River drainage of Montana in Noxon Reservoir, Beaver, Elk, Fish Trap, Graves, Marten, Pilgrim, Prospect, Snake, and Swamp Creeks and in the Middle Fork Bull, Thompson, and Vermillion Rivers, to name some of the major drainages (MDHES

1994). Bull trout in Prospect Creek, the Vermillion River, and the Bull River (all considered local populations of bull trout) have been particularly impacted by past logging activities (Pratt and Huston 1993). Deposited sediment levels in the Bull River and Rock Creek are high enough to significantly reduce bull trout survival to emergence (Huston 1988; Smith 1993). While some of these streams do not currently contain bull trout, they are contributing waters and may prove important in recovery.

A number of stream segments within the Lake Pend Oreille Key Watershed in Idaho are also listed as water quality limited (PBTTAT 1998a). Lightning, East Fork Lightning, Porcupine, Wellington, Grouse, North Fork Grouse, Gold, Granite, Trestle, Cocolalla, and Hoodoo Creeks and the Clark Fork and Pack Rivers are all listed for various "pollutants of concern," including sediment, flow, habitat alteration, thermal modification, metals, and others. Many of these problems are related to past forestry practices.

In both Montana and Idaho, forest managers and regulators have recognized the potential impacts of forest management and have designed practices and rules (such as the Idaho Forest Practices Act and the Montana Streamside Management Zone Law; see Montana Department of State Lands [MDSL 1994]) to reduce impacts resulting from new operations. Best management practices include requiring "leave trees" in riparian areas, prohibiting use of equipment in or near streams, and controlling erosion from roads, trails, and landings.

Unique, unstable, or previously impacted areas may require best management practices that exceed Forest Practices Act minimum standards, up to and including no activity. The current minimum leave tree requirements in the Idaho Forest Practices Act may not adequately protect water temperatures in all cases (PBTTAT 1998a). Forest Practices Act minimum standards may also not be adequate to maintain recruitment of large woody debris. The Panhandle Bull Trout Technical Advisory Team (PBTTAT 1998a) cited Zaroban *et al.* (1997) as finding that forest practices rules were implemented 97 percent of the time in Idaho and that, when applied, they were 99 percent effective at preventing pollutants from reaching a stream. However, half the timber sales reviewed were still delivering sediment to streams. The impact of this sediment delivery was not assessed. These findings, updated recently by Hoelscher *et al.* (2001), illustrate the need to fully implement all applicable rules to prevent misapplication of any one rule from delivering sediment to a stream. Federal land management agencies have adopted management guidelines (Inland Native Fish Strategy [or INFISH]) that exceed Idaho and Montana rules and that were designed to protect native fish populations. Impacts from previous forest activities (legacy effects) may limit current management options.

In lower reaches of Trestle Creek, large cedars have been removed from the stream riparian zone, reducing cover, shade, and recruitment of large woody debris (PBTTAT 1998a). Several small headwater streams on National Forest land were harvested, causing some localized stream channel downcutting and loss of some habitat complexity. Timber harvest on private lands still occurs, but is regulated by site-specific best management practices developed in 1994 by the Trestle Creek Local Working Committee.

Approximately 16 percent of the Granite Creek watershed has been harvested (PBTTAT 1998a). Modeling of flow responses to timber harvest suggests that the Granite Creek drainage is at moderate risk for increased peak flows. Past heavy timber harvesting in riparian areas and in some headwater areas has resulted in downcutting in several headwater reaches and accumulation of excess bedload material in downstream reaches.

Compared with other Pend Oreille watersheds, Lightning Creek has been logged extensively. Over 35 percent of the entire watershed has had timber harvest activity. Poor harvest practices in the past have led to severe bank, bed, and channel instability along most of the mainstem. Bedload deposition, peak flows, stream temperature, and intermittency are exacerbated problems in the Lightning Creek drainage. Lightning Creek (from Quartz Creek to its confluence with the Clark Fork River) is currently listed as a section 303(d) water body, not fully supporting beneficial uses. The listed pollutants of concern are sediment load, flow, and habitat alteration (PBTTAT 1998a). Bull trout redd counts in Lightning Creek have also exhibited a steady decline over the past 20 years (LPOWAG 1999).

The current impaired habitat condition in Grouse Creek is a function of early logging (USDA 1993) and natural geology. In the 1920's, Humbird Lumber Company constructed a logging railroad along the creek to provide easy access for harvesting large cedar and white pine trees in the drainage. By 1934, roughly 70 percent of the main

Grouse Creek drainage had been cleared and/or burned. Much of the mainstem of Grouse Creek (84 percent), including much of the land owned by Humbird, is now National Forest land (USDA 1993). Fifty-four percent of the land in the North Fork Grouse Creek drainage is in private (CPI Forest Products) or State (Idaho) ownership and is contained mostly in large tracts of land in the headwaters. In the lower reaches of North Fork Grouse Creek, much of the stream riparian zone is privately owned, either by individual homeowners or by CPI Forest Products.

In the East River, the only drainage in the lower Priest River watershed with a known bull trout population, 25 percent of the watershed has highly erodible soil types, and 41 percent is in the rain-on-snow sensitive zone. Road densities are high, averaging 5.1 kilometers per square kilometer (2.0 miles per square mile), and there are 2.2 road crossings per kilometer (1.4 road crossings per mile) of stream. The percentage of the watershed that has been logged is high, but has not been quantified (PBTTAT 1998b).

Flathead Recovery Subunit

Past forestry practices (road construction, log skidding, riparian tree harvest, clear-cutting, and splash dams) are also a major contributing cause of the decline of bull trout in the Flathead River drainage. The effects on habitat of these practices include increased sediment in streams, increased peak flows, hydrograph and thermal modifications, loss of instream woody debris and channel stability, and increased accessibility for anglers and poachers. Although the heaviest timber harvest occurred in the 1960's and 1970's, past forest practices will continue to impact bull trout because of the remaining road systems, increased water yields, and increased efficiency of water delivery to the streams that results in changes in the runoff timing. Impaired water quality as a result of silvicultural activities has been identified in 325 kilometers (202 miles) of 17 streams in the Flathead River drainage (MDHES 1994).

Extensive logging and road construction began in the Swan River drainage in the early 1950's (MBTSG 1996b). These activities, conducted on private and on State- and federally owned lands, progressively penetrated nearly all major tributary drainages up to the Bob Marshall and Mission Mountains Wilderness boundaries. The extent of timber harvest and road development varies considerably within and between ownerships in the Swan River drainage. The U.S. Forest Service and the Montana Department of Natural Resources and Conservation estimate that 20 percent and 27 percent of their lands, respectively, have had some degree of timber harvest activity. Plum Creek Timber Company estimates that approximately 70 percent of its land has had some degree of harvest activity.

Riparian and adjacent timber harvest have affected stream channel and streambank cover, stability, and integrity in the Swan River. The Montana Department of Health and Environmental Sciences reports that 79 kilometers (49 miles) of six streams in the Swan River drainage suffer impaired water quality as a result of silvicultural activities (MDHES 1994).

In Swan River basin streams, monitoring of spawning and incubation habitat quality in major spawning tributaries suggests that there are relatively high sediment levels, even under natural conditions (MBTSG 1996b). Slight sediment increases may adversely impact survival of bull trout fry to emergence (Weaver and Fraley 1993). However, in the Swan River drainage, natural variation in sediment levels occurs between streams, largely because of geological and geomorphic differences, and this variation complicates analysis of the effects of human activities on sediment in streams (MBTSG 1996b).

Research conducted by Plum Creek Timber Company suggests that bull trout spawning and distribution in the Swan River is primarily a function of geomorphology and patch size. Bull trout occur mainly in the larger watersheds, that is, those over 2,000 hectares (5,000 acres) (Rieman and McIntyre 1995; Watson and Hillman 1997). Preliminary investigations comparing bull trout spawning locations to riparian land types suggest that bull trout tend to spawn in locations exhibiting specific riparian land types and that the degree of spawning in any tributary may be directly related to availability of specific land types (Watson and Hillman 1997).

Another analysis indicates that Swan River tributaries draining large areas of roadless lands are disproportionally important for the persistence and recovery of westslope cutthroat trout, bull trout, and amphibians (Frissell *et al.* 1995). Road density in other drainages is highly correlated with the proportion of a watershed that has been logged (Hauer and Blum 1991). Baxter *et al.* (1999) found that changes in bull trout redd numbers with time in Swan River tributary streams (1980's and 1990's, as reported by Montana Fish, Wildlife and Parks) was negatively correlated with road density, and they suggested that prior land use (primarily logging and associated road building) may have negatively affected bull trout populations. Frissell *et al.* (1995) and Trombulak and Frissell (2000) also state that habitat deterioration and the introduction of nonnative fishes that threaten native aquatic biota are both associated with roads and the wide range of human activities that roads encourage or allow.

Research by Butler *et al.* (1995) and Spencer (1991a) indicates that a seasonal deficit in dissolved oxygen has occurred in the deeper portions of Swan Lake in recent years, a phenomenon not observed in earlier surveys. Stable isotope analysis was used to trace the source of the oxygen deficit to input of organic carbon from the Swan River into the lake during spring runoff and further suggested that recently logged tributaries are one important source of organic carbon (Butler *et al.* 1995). Given the potential consequences to bull trout habitat, this phenomenon clearly merits close monitoring and further investigation.

Timber harvest in the South Fork Flathead River began during the 1950's and will probably continue into the future (MBTSG 1995d). Differences are obvious when managed lands are compared with the Wilderness Area upstream. Managed lands present higher risk to bull trout, but the percentage of these lands is a relatively small portion of the entire South Fork Flathead River drainage.

Many problems result from road systems around Hungry Horse Reservoir (MBTSG 1995d). Logging access roads up most of the major tributaries on the managed lands are located in the riparian zone. Streams have been impacted by increased water yields from timber harvest and old road systems (Weaver 1993). The U.S. Forest Service and Montana Fish, Wildlife and Parks are constantly evaluating roads, and improvements are being proposed and implemented.

Priest Recovery Subunit

Approximately half of the Upper Priest Lake drainage basin has soil types that are classified as highly erodible, ranging from 15 percent in the Lime Creek drainage to 86 percent in the Rock Creek drainage (PBTTAT 1998b). Half or more of many of the watersheds lie in the rain-on-snow sensitive zone, making them prone to flashy runoff patterns. These characteristics predispose portions of the watershed to habitat degradation when ground-disturbing activities occur. East-side streams are higher gradient, are bedrock controlled, and generally transport fine sediment through their systems. West-side streams are lower gradient and have a greater accumulation of fine sediment. These characteristics are of special concern because the Upper Priest Lake watershed is the most intact habitat remaining for bull trout in the Priest River basin.

In the Lime Creek subwatershed, portions of the Hughes Fork and Trapper Creek have high road densities, exceeding 3.5 kilometers per square kilometer (1.4 miles per square mile) of land, with many of the roads constructed in the riparian zone (PBTTAT 1998b). Lime Creek has 2.2 road crossings per kilometer (1.4 road crossings per mile) of stream, and several other drainages exceed 0.8 crossings per kilometer (0.5 crossings per mile). Logging has occurred in 5 percent of the Upper Priest River watershed, 18 percent of the Hughes Fork, and 55 percent of Trapper Creek (PBTTAT 1998b). Logging in the Trapper Creek drainage in the 1990's was conducted under site-specific best management practices, with primary emphasis on reducing any contribution of fine sediment to stream channels.

In tributaries draining directly into Priest Lake, the portion of the watershed having highly erodible soils ranges from 10 to 30 percent, with half or more of most watersheds in the rain-on-snow sensitive zone (PBTTAT 1998b). Road densities tend to be lower (less than 3.0 kilometers per square kilometer [1.2 miles per square mile]) in the watersheds where bull trout spawning and rearing still occur (Caribou, Lion, Two Mouth, Indian, and Granite Creeks). Major portions of many watersheds have been logged, including 23 percent of Caribou Creek, 35 percent of Lion Creek, 52 percent of Two Mouth Creek, 36 percent of Indian Creek, and 75 percent of Soldier Creek (PBTTAT 1998a).

Five stream segments within the Priest Lake basin were listed as water quality limited segments on Idaho’s 1996 section 303(d) list under the Clean Water Act, including Kalispell, Reeder, Tango, Trapper, and Two Mouth Creeks (PBTTAT 1998b). Streams listed are considered as not fully supporting designated or existing beneficial uses. Many streams in the basin fail to meet temperature standards for salmonid spawning and specific temperature criteria for bull trout protection. The State is currently in the process of determining beneficial uses and support status for water bodies throughout the basin.

Riparian logging historically removed stands of mature cedar in some Priest River drainages. These cedars have often been replaced by early successional species, such as alder in thickets, resulting in decreased recruitment of large woody debris to the stream channels, reduced shading, and lower quality habitat for bull trout. In addition, the Sundance fire, started by accident from a slash burn, burned much of the east side of the drainage.

Culverts on forest roads have been identified as potential fish passage impediments and are found on Hughes Fork, Gold Creek, Granite Creek, South Fork Granite Creek, Kalispell Creek, and the Middle Fork East River (PBTTAT 1998b).

Summary (Forestry Management Practices)

For over 100 years, forestry practices have caused major impacts to bull trout habitat throughout the Clark Fork Recovery Unit. And because forestry is the primary landscape activity in the basin, the impacts have been widespread. Primary effects of timber harvest, such as road construction, log skidding, riparian tree harvest, clear-cutting, splash dams, and others, have been reduced by the more recent development of more progressive practices. However, the legacy effects of the past century have included lasting impacts to bull trout habitat, including increased sediment in streams, increased peak flows, hydrograph and thermal modifications, loss of instream woody debris and of channel stability, and increased accessibility for anglers and poachers. These impacts will continue and are irreversible in some drainages. In addition, insufficient funding to maintain the existing road system has resulted in maintenance deficiencies, even on some well-designed roads. Consequently, impacts of the existing road system are compounded.

Livestock Grazing

Upper Clark Fork Recovery Subunit

The first cattle in this recovery subunit were brought to the Deer Lodge Valley in the 1850's. By the early 1860's, thousands of cattle were grazing in the Deer Lodge and Flint Creek Valleys. Rangelands in the 1880's were commonly overstocked and overgrazed (Periman 1994).

Grazing, both current and historical, causes a major impact on fisheries in some portions of the upper Clark Fork River basin (MBTSG 1995e). Grazing directly affects streams by reducing bank stability and riparian vegetation. These reductions, in turn, increase sediment loads and water temperatures and reduce instream water quality.

Historical grazing use of the Blackfoot River drainage may have been significant in causing the decline of bull trout. Grazing impacts have decreased in recent years as a result of cooperative efforts between landowners and agencies, but that effort needs to continue. Pierce and Podner (2000) identified 30 streams or stream reaches in the Blackfoot River watershed that are still impacted by grazing practices or cattle feedlots that need to be improved.

Lower Clark Fork Recovery Subunit

Some isolated areas in this recovery subunit have been impacted by grazing (particularly in the lower Flathead River portion of the drainage, Thompson River, Elk Creek, Pilgrim Creek, and portions of the Bull River), but overall grazing is not one of the high risk factors (MBTSG 1996a).

Livestock grazing occurs in the Lake Pend Oreille basin but is not prevalent. Following the 1910 fires, sheep grazing was a common use of uplands, but is no longer significant (PBTTAT 1998a). Some negative impacts from livestock are occurring in the lower Priest River and in portions of the mainstem of the East River (Rothrock 2000).

Use of land for agriculture has been ongoing for many years in the Pack River drainage (PBTTAT 1998a). Grazing occurs in the lower two-thirds of the watershed. Much of the Pack River is considered open range. Crop production occurs in the watershed from below the Highway 95 bridge downstream. Large cedar trees and riparian vegetation were removed years ago. Impacts to the stream channel in lower reaches have occurred over a long period of time and continue to be a factor today in degrading habitat condition and decreasing complexity.

Effects of livestock grazing on bull trout recruitment are a significant threat in Twin Creek, a mainstem Clark Fork River tributary just upstream of Lake Pend Oreille (PBTTAT 1998a). In the early 1960's, the lower reach of Twin Creek was channelized, significantly reducing stream length and creating a reach with high width-to-depth ratios and poor habitat. The channel has not recovered, and grazing has continued to negatively impact the stream and riparian area until recently. A restoration project is now underway.

Flathead Recovery Subunit

The overall risk to bull trout from livestock grazing in this area is low (MBTSG 1995c). There are only a limited number of public allotments, and most of the privately grazed livestock is on the valley floor, where spawning and rearing seldom occur. The Stillwater and Whitefish River watersheds are most heavily affected.

Livestock grazing also occurs near the Swan River and the lower portions of some important tributary drainages (MBTSG 1996b). There is some risk to bull trout, but, at present, grazing is not considered to be a significant factor for bull trout conservation in this drainage.

No grazing occurs in the South Fork Flathead River drainage above Hungry Horse Dam, except for stock used by outfitters and recreationists (MBTSG 1995d). In some instances, recreational stock grazing does impact water quality and streambank stability. The trail system in the wilderness is extensive, and grazing problems are created in areas of high use.

Priest Recovery Subunit

Livestock grazing is not a major problem in the Priest River basin, especially in the watersheds where bull trout spawning and rearing occur (PBTTAT 1998b).

Summary (Livestock Grazing)

Livestock grazing is most widespread and has had the greatest impact to bull trout in the upper portion of the Clark Fork Recovery Unit. Grazing is of particular concern where allotments are located along spawning and rearing streams. While severe site-specific problems may occur, livestock impacts are generally being reduced through better management practices on public and, to a lesser extent, private lands. Livestock grazing does not represent a major threat to bull trout recovery in this recovery unit, but where problems exist, they can be severe.

Agricultural Practices

Upper Clark Fork Recovery Subunit

Impacts to bull trout from agriculture include dewatering, irrigation entrainment, reduced water quality, loss of riparian habitat, and increased water temperature. Water diversions significantly threaten the restoration of bull trout in many portions of the upper Clark Fork River drainage (MBTSG 1995e). Diversions may make fish migration upstream impossible unless passage has been incorporated or added to the design, and downstream migrants may be pulled through unscreened irrigation diversions (entrained) and displaced from stream habitat into ditches where they become lost to the system. In addition, many diversions are simply bulldozed gravel dikes that are frequently a major source of stream instability, leading to bank erosion and channel degradation. Diversions are a particular problem in the Little Blackfoot River drainage, in the upper portions of the Clark Fork River drainage, in the Flint Creek drainage, and in the Bitterroot River drainage (MBTSG 1995a 1995e). The Rock Creek drainage contains relatively few diversions. In both Rock Creek and the Blackfoot River drainage, numerous diversion structures have been renovated to provide fish passage and eliminate entrainment (Pierce and Podner 2000). However, more work needs to be done.

Agriculture also impacts bull trout when farming practices encroach on riparian zones. Such encroachment is a widespread problem in the upper Clark Fork River basin (MBTSG 1995e). Loss of riparian vegetation can result in bank destabilization, warmer water temperatures, and increased sediment loads, among other problems. Agriculture can also impact water quality though increased nutrients. For example, feedlots are known to negatively impact water quality. In some areas of the Upper Clark Fork Recovery Subunit, streams have been channelized for agricultural purposes.

Poor water quality, poor habitat, and depressed fisheries in Nevada Creek and, to some degree, the Blackfoot River below Nevada Creek can be attributed to agricultural practices in the Nevada and Ovando Valleys (MBTSG 1995b). Alteration of stream flows below Nevada Creek Reservoir, including dewatering of the stream channel, has negatively impacted the fishery. Irrigation return flows add excessive amounts of nutrients and sediment and increase water temperatures (Pierce and Peters 1990). McGuire (1991) found evidence of persistent nonpoint source pollution (nutrient enrichment, sedimentation, and elevated water temperatures) in the Blackfoot River below the confluence of Nevada Creek. Despite substantial progress in this area, irrigation impacts and instream flow problems continue to plague 23 streams or stream reaches in the Blackfoot River watershed (Pierce and Podner 2000).

Seasonally, there are diversion barriers on the upper mainstem Clark Fork River and a large diversion on Warm Springs Creek. Most of the diversions in the upper basin are at least seasonal barriers to fish passage (MBTSG 1995e).

The Upper Clark Fork River drainage contains approximately 626 kilometers (389 miles) of chronically dewatered streams and 14 kilometers (9 miles) of periodically dewatered streams (MFWP 1991). Most of the water diverted from streams for irrigation in this basin is used for raising feed for cattle. Water is diverted from streams to irrigate over 40,500 hectares (100,000 acres) of land upstream of Turah (USGS 1993). Only a handful of the tributary streams located upstream of Rock Creek contain surface flow on a year-round basis. Some other tributary streams contain only warm irrigation return flows in late summer. Flint Creek, the Little Blackfoot River, and the Clark Fork River are among the most impacted (MBTSG 1995e).

Most of the large tributary streams on both sides of the Bitterroot Valley north of Darby are heavily diverted. Some diversions that may be barriers to fish passage also occur on the mainstem Bitterroot River. Approximately 104 kilometers (65 miles) of rivers and streams are estimated to suffer from chronic dewatering in the Bitterroot River drainage (MBTSG 1995a), including North and South Bear Creeks, Big Creek, the Bitterroot River from Corvallis to Stevensville, and Blodgett, Burnt Fork, Carlton, Kootenai, Lolo, Lost Horse, Mill (tributary to Lolo Creek), O'Brien, Rock, Skalkaho, South Fork Lolo, Sweathouse, Sweeney, and Tin Cup Creeks (MFWP 1991).

Dewatering of streams restricts the distribution and movement of bull trout in tributary streams and is probably one of the primary causes for the decline of migratory bull trout from the mainstem Bitterroot River (Nelson 1999). Dewatering also contributes to thermal problems in the tributaries and the mainstem river. Dewatered areas are a barrier, and the complexity of diversions and over-appropriation of water in the Bitterroot Valley severely complicate the potential for restoring bull trout (MBTSG 1995a).

Agricultural impacts to water quality have been noted in 311 kilometers (193 miles) of tributary streams to the Blackfoot River (MDHES 1994). Chronic dewatering is found in 133 kilometers (82.4 miles) of 18 streams within the Blackfoot River drainage (MFWP 1991).

Passage at an irrigation diversion on Dry Creek, a Clark Fork River tributary near Superior, is currently blocked. The entire reach of stream below the diversion goes dry during the irrigation season (MBTSG 1996e). This condition effectively eliminates any potential for spawning and rearing in Dry Creek. In nearby drainages, such as Fish and Cedar Creeks, some lower stream reaches dry up seasonally. However, during the spring runoff, migratory bull trout move upstream into the perennial reaches and survive there to spawn later in the fall. If the Dry Creek irrigation dam were improved to allow fish passage, the potential exists for migratory bull trout spawning and rearing.

Rieman and McIntyre (1993) concluded that temperature is a critical habitat characteristic for bull trout. Temperatures in excess of 15 degrees Celsius (59 degrees Fahrenheit) are thought to limit bull trout distribution in many systems (Fraley and Shepard 1989; Brown 1992). The causes of the thermal problems include dewatering, lack of riparian vegetation to shade the water, and warm irrigation return flows entering tributary streams and the main river.

The upper mainstem Clark Fork River has elevated water temperatures considered detrimental to bull trout from about Perkins Lane Bridge downstream (MBTSG 1995e). For the 92-day period from June through August 1992, water temperatures exceeded 20 degrees Celsius (68 degrees Fahrenheit) on 61, 36, 49, and 35 days near Warm Springs Creek, Deerlodge, Gold Creek, and Turah, respectively. The maximum temperature was over 25 degrees Celsius (77 degrees Fahrenheit) near Warm Springs Creek, Gold Creek, and Turah (USGS 1993). Long reaches of the river between major tributaries exceed the preference range of bull trout because only a few of the major tributaries maintain sufficient flow of cold water in summer to have a cooling effect on the river. Most of these colder tributaries are located from Rock Creek downstream. How much of this condition is natural is unknown, but land and water use have probably exacerbated the natural condition.

In the Little Blackfoot River and Flint Creek, irrigation diversions and return flows result in elevated water temperatures (MBTSG 1995e). The consensus of the biologists and hydrologists working in the area is that water temperatures probably exceed the tolerance limits for bull trout in portions of many of these streams.

Within the Blackfoot River drainage, elevated temperatures are found in Nevada, Douglas, Nevada Spring, Cottonwood (near Helmville), Willow (near Sauerkraut Creek), Union, and Elk Creeks and in the Clearwater River (MBTSG 1995b). Summer water temperatures in Nevada Creek and the Blackfoot River below Nevada Creek were consistently above levels considered optimal for trout (Pierce and Peters 1990). Probable causes of elevated temperatures are grazing in riparian zones, reduced riparian health, chronically low summer flows, warm water releases from Nevada Reservoir, and irrigation return flows.

Elevated summer temperature appears to be a habitat problem in many tributaries and in portions of the mainstem Blackfoot River, but thermal conditions may not act as a migration barrier. Preliminary data indicate that, in the Blackfoot system, fish migration primarily occurs before warm water temperatures occur (Swanberg 1997). Further research is needed to determine the specific causes of temperature increases and the impact on bull trout.

Temperatures in the lower Bitterroot River and some of the tributaries meet or exceed 21 degrees Celsius (70 degrees Fahrenheit) during the summer months (Spoon 1987). This evidence suggests that there may be thermal problems that limit bull trout distribution in the Bitterroot River and in the lower reaches of some of the tributaries (MBTSG 1995a). The probable causes of the thermal problems include dewatering, lack of riparian vegetation to shade streams, warm irrigation return flows entering the tributary streams and river, and warm water releases from irrigation reservoirs and private fish ponds. Further research is needed to determine the specific causes of temperature increases in the mainstem Bitterroot River and the impact on bull trout.

Lower Clark Fork Recovery Subunit

In portions of the lower Flathead River drainage downstream of Kerr Dam, agricultural impacts may have been the primary cause of the loss of bull trout (MBTSG 1996e). From the 1910's until the mid-1980's, stream dewatering for irrigated agriculture was considered a major fisheries problem in the Flathead River portion of the drainage. In 1985, the Confederated Salish and Kootenai Tribes were able to establish instream flows on streams that are impacted by the Flathead Agency Irrigation District. Although stream dewatering is no longer a major problem in this portion of the drainage, agricultural impacts to water quality remain.

The Flathead Agency Irrigation District, which was constructed beginning about 1910, broke the connection between many of the tributary streams and the lower Flathead River (MBTSG 1996e). Many tributary streams also contain dams, including Crow, Mission, Post, and Dry Creeks. All of these streams, except Crow Creek, are known to have been historical bull trout spawning and rearing streams. The impacts of these tributary dams vary depending on the situation. Some have blocked migratory fish from spawning tributaries, and some have created isolated local populations of bull trout. Each case is unique, and the effects should be evaluated on a case-by-case basis. In total, construction of irrigation diversions, canals, and dams on the tributaries eliminated access to more than 100 kilometers (62 miles) of tributary spawning and rearing habitat in the lower Flathead River watershed (Cross and DosSantos 1988), though some of the watershed may have been unoccupied by bull trout because of natural conditions.

In the lower Flathead River drainage, three irrigation storage reservoirs are now considered to hold isolated fragments of the local bull trout population(s) that once occupied the Mission Creek drainage. Tabor Reservoir (St. Marys Lake) is an irrigation storage facility (approximately 111 surface hectares [274 surface acres] when full); its spawning and rearing habitat is compromised because the only tributary stream (Dry Lake Creek) is completely flooded at full pool and mostly inaccessible due to gradient barriers at minimum pool (MBTSG 1996e). Spawning can only occur when there are suitable lake water levels to inundate passage barriers while still exposing an adequate length of stream. Rearing habitat becomes lentic (without current) during late spring and summer because the entire accessible portion of the stream is inundated at full pool. The lack of spawning and rearing habitat raise concerns about the long-term viability of this local population (Hansen and DosSantos 1993a). Water enters the system from the Upper Jocko canal and may translocate some bull trout from that system. Appropriate dam operations are vital for continued successful reproduction in this local population. The outflow waters are transported through the Dry Creek irrigation ditch system and no longer have a functional connection to Mission Creek. Reconnection of this fragmented population to its historical source (Mission Creek) is unlikely.

In Mission Reservoir (approximately 117 hectares [289 acres] when full), another small natural lake (terminal glacial moraine) that was dammed, the lake environment is a limiting component of bull trout habitat due to extreme drawdowns for irrigation (Hansen and DosSantos 1993b). The greatest risks to bull trout in this system are hybridization with brook trout, washout of adult fish through the dam, overwinter stress from deficiencies in reservoir habitat, and illegal harvesting (Hansen and DosSantos 1993b). A higher minimum pool was recently negotiated in Mission Reservoir, but further research is necessary to determine the extent that drawdown affects the bull trout in this local population (MBTSG 1996e).

McDonald Reservoir (approximately 100 hectares [250 acres] when full) on Post Creek, a Mission Creek tributary, is also used for irrigation storage. It supports a now isolated, local population of migratory bull trout. This local population is believed to be more secure than those at Tabor and Mission Reservoirs because of more adequate pool volume, a higher-quality spawning stream, and the absence of brook trout. Dam operations have a minor negative impact on this local population (MBTSG 1996e).

The water management operations of the Flathead Agency Irrigation District are severely limiting to the potential recovery of the local population(s) of bull trout in the Mission Creek complex and the Jocko River. The isolated populations in the three reservoirs on Mission Creek will probably never become secure, but with better management strategies, drawdown limits, and instream flow protection, the chances of persistence would increase (MBTSG 1996e).

Elevated temperatures appear to limit bull trout habitat in several tributaries and in the lower Flathead River below Flathead Lake. In the lower Flathead River, summer water temperatures approach 24 degrees Celsius (75 degrees Fahrenheit) (DosSantos *et al.* 1988). Further research is needed to determine the specific causes of thermal problems and the resulting impact on bull trout. In the lower Flathead River, warm water temperatures may be a natural occurrence, the result of waters warming in the shallow South Bay of Flathead Lake. In addition, land use practices in the Mission Valley have probably elevated temperatures from historical temperature regimes in the lower Flathead River and its tributaries (MBTSG 1996e).

Almost all streams entering the middle reaches of the Clark Fork River (or reservoirs) from the Bitterroot Mountains (south side of the drainage) have naturally occurring intermittent reaches. This intermittency influences the streams' usefulness to bull trout (Pratt and Huston 1993). Intermittency also occurs in streams entering from the north. Intermittency has been exacerbated by both natural and human-caused events. Historical natural events include a major forest fire in 1910 and periodic drought. Human disturbance is primarily from mining, silviculture, and agriculture practices.

The Clark Fork River drainage in Montana, downstream of Thompson Falls Dam, contains only about 10 kilometers (6 miles) of chronically dewatered streams (MFWP 1991); none of these streams are important for bull trout. While the *1994 Montana 305(b) Report* (MDHES 1994) identifies several streams that suffer from impaired water quality resulting from agricultural activities, overall, agricultural impacts to bull trout are minor in this portion of the drainage.

Agricultural impacts to the lower drainages entering Lake Pend Oreille are minor and mostly confined to the Pack River watershed (PBTTAT 1998a). Some low-level impacts may also be occurring in the lower Priest River and in portions of the East River mainstem.

In Hoodoo Creek and Cocolalla Creek, two large drainages that enter the Pend Oreille River downstream of Lake Pend Oreille, bull trout are believed to have been present historically. Both drainages have been subjected to extensive agricultural impacts, including cropland conversion, dredging and straightening of the streams, draining of wetlands, loss of riparian vegetation, and temperature and sediment impacts (PBTTAT 1998a). On Cocolalla Creek, a manmade barrier downstream of Round Lake eliminates access for migratory fish. The cumulative impacts of these and other human activities have eliminated bull trout from these watersheds.

Flathead Recovery Subunit

Agriculture impacts to water quality in the Flathead Recovery Subunit occur primarily in the lower reaches of the upper Flathead River, Ashley Creek, and the

Stillwater River (MBTSG 1995c). Though the latter two streams are not generally occupied by bull trout, they do contribute to the water quality degradation of the lake and river system. The Montana Department of Health and Environmental Sciences state that 206 kilometers (128 miles) of streams in the Flathead River watershed suffer impaired water quality as a result of agricultural activities (MDHES 1994). Montana Fish, Wildlife and Parks has identified 31 kilometers (19 miles) of streams that are chronically dewatered and 145 kilometers (90 miles) of streams that are periodically dewatered as a result of irrigation withdrawals (MFWP 1991). Not all of these stream segments are occupied by bull trout. The impacts of agriculture on bull trout in this watershed may have been more significant historically than they are at the present time. Current impacts to bull trout from agricultural activities in the Flathead River basin are believed to be low.

Relatively few irrigation diversions occur in this region of Montana. Most of the irrigation water is withdrawn through the use of pumps, so diversions are not a major problem for bull trout.

The outlet streams from the large glacial lakes in Glacier National Park are naturally too warm in the summer to attract bull trout. The valley portions of the Stillwater and Whitefish Rivers also exceed bull trout preference ranges. The extent to which the current thermal regime in these rivers is human-caused is unknown since no data exist prior to 1900.

There is no agricultural development in the South Fork Flathead River drainage upstream of Hungry Horse Dam (MBTSG 1995d) and relatively little in the Swan River drainage (MBTSG 1996b).

Priest Recovery Subunit

Agriculture is not a major land use in the Priest River basin and is not a major problem, especially in the watersheds where bull trout spawn and rear (PBTTAT 1998b).

Summary (Agricultural Practices)

Agricultural impacts to bull trout in the Clark Fork Recovery Unit are primarily a result of water demand. Diversions for irrigation can destabilize stream channels, severely interrupt migratory corridors (blockages and dewatering), and, in some cases, entrain fish, which are then lost down the ditches. A second, and potentially more serious, issue is the increased water temperature regime common to streams that are heavily diverted and/or subject to receiving irrigation return flows. All of these problems occur and are widespread in the Clark Fork Recovery Unit. Some of the worst impacts are in the upper drainages, and these problems are then transmitted to the receiving waters downstream. Overall, agricultural practices represent a significant threat to bull trout recovery in this recovery unit.

Transportation Networks

Upper Clark Fork Recovery Subunit

Two railroads, a secondary highway, and Interstate 90 have been constructed through the Clark Fork River Valley (MBTSG 1995e). These intrusions have adversely affected stream channels that provided habitat for bull trout. Railroad and highway construction have also affected some tributary streams.

Some railroad and highway stream crossings are fish passage barriers. In addition, some streams were channelized during road and railroad construction, resulting in shortening of stream channels, increased erosion, higher water velocities, and loss of fish habitat. These developments probably had a major impact at the time they were constructed, and the impacts continue today.

Beginning in the 1880's, railroads were built all across Montana. By 1940, two rail lines between Butte and Missoula followed the Clark Fork River (MBTSG 1995e). There were also spurs between Drummond and Phillipsburg along Flint Creek, from Butte to Georgetown along Warm Springs Creek, and along the Little Blackfoot River (Periman 1994). Although most of these railroads are no longer operating, they had a significant impact on these rivers because of the modifications that were made to stream channels during railroad construction.

Major road development began in the 1860's with the construction of the Mullan Trail (Periman 1994). At the present time, all of the major drainages have paved roads, and most of the minor drainages have roads of varying types. The Clark Fork River has major transportation corridors on both sides of the river: a four-lane interstate highway and a railroad. A considerable amount of the river has been channelized.

Some culverts in the upper Clark Fork River drainage are barriers to fish passage. However, in some areas, impassable culverts assist in keeping introduced fish out of a watershed. Culvert barriers are not considered a significant threat to bull trout in the Upper Clark Fork Recovery Subunit at this time, except in localized instances. Historically, impassible culverts may have been a major problem for migratory bull trout in the Blackfoot River drainage. However, in recent years, some of the most problematic culverts have been replaced, including culverts in Bear, Belmont, Blanchard, Chamberlain, and Rock Creeks. Problems remain, in particular in the upper Blackfoot River drainage (*e.g.*, North Fork Cottonwood Creek); see Pierce and Podner (2000).

A major highway corridor parallels much of the mainstem Blackfoot River. Potential spills of toxic substances are a concern along all transportation corridors (MBTSG 1995b). Road maintenance may impact bull trout when road sanding or deicing materials enter the stream or when road grading increases stream sediment loads.

Several canyon meanders of the East Fork Bitterroot River were straightened for U.S. Highway 93, and the location of the highway remains problematic along much of the Bitterroot River (MBTSG 1995a). The Skalkaho Highway is located on a major geologic fault, is poorly designed, and drains large sediment loads into the adjacent streams. The St. Regis River has experienced severe impacts from channelization due to interstate highway and railroad construction (MBTSG 1996e).

Lower Clark Fork Recovery Subunit

The mainstem Clark Fork River is a major transportation corridor. Nearly 296 kilometers (184 miles) of 14 streams are reported to suffer water quality impairment because of highway, road, and bridge development in the mid-reaches of the Clark Fork River drainage (MDHES 1994). In the Lower Clark Fork River drainage, two core areas (Prospect Creek and the Bull River) have major roads that parallel the streams (MBTSG 1996a). The railroad along the lower reaches of the Jocko River restricts the floodplain and, in some locations, forms a dike.

Roads and railroads in the Lake Pend Oreille basin have been constructed to provide access for timber harvest, mining, and recreation and to provide infrastructure for urban development, travel, and commerce. Many larger stream drainages within the

Lake Pend Oreille Key Watershed, including the lower Priest River and the East River, have roads of varying quality that run parallel to the channels (PBTTAT 1998a).

On steep or unstable slopes, roads that are poorly planned, constructed, or maintained have washed out or triggered large debris flows that have filled stream channels with sediments and resulted in instability even decades after the roads have been abandoned (PBTTAT 1998a). Such roads will continue to degrade until they are identified and either upgraded or properly abandoned. Many roads were originally built for mining or timber harvest purposes and were subsequently taken over by counties or road districts for public use and residential access. Maintenance is often infrequent and not adequate to limit sediment delivery to streams.

Construction of new roads may result in sedimentation if adequate sediment delivery mechanisms are not considered**.** In Lightning Creek, a 98 percent increase in mass wasting occurred in third-, fourth-, and fifth-order streams after logging roads were constructed (PBTTAT 1998a). New road construction in the Cabinet Mountains portion of the basin poses a threat of mass wasting because altered hydrology can increase the slippage of glacial tills perched on bedrock slip-planes (PBTTAT 1998a).

The Lightning Creek watershed has an extensive forest road system. Road erosion, road failure (slides), and culvert blockage have been large contributors of bedload and sediment to Lightning Creek (PBTTAT 1998a). Poor road location and design (built on wood slash fill) in many areas have resulted in slides, slumps, and increased peak runoff flows; the potential for road failure is compounded by the fact that, geologically, this watershed is already conducive to natural mass wasting. Landslide activity in Lightning Creek is strongly related to both road and road/clear-cutting impacts, and slide erosion rates are 88 times greater for roaded areas and 97 times greater for road/clear-cut areas than for unmanaged forest areas (PBTTAT 1998a). In 1989, of the total amount of slide material volume measured (246,000 cubic meters [22,533 cubic yards]) in Lightning Creek, road and road/clear-cutting impacted slides were 58 percent of all slides and 75.5 percent of the total slide volume (PBTTAT 1998a). Most of these slides (75 percent) originated on road fill slopes or immediately below the road.

Road construction has also resulted in loss of riparian forest canopy and loss of recruitment of large organic debris to the stream. The main Lightning Creek channel is highly impacted and unstable in most reaches (PBTTAT 1998a). Lower reaches of this stream exhibit severe bedload deposition. Bedload deposition creates migration barriers (intermittency) in many locations, barriers that may have shifted timing of bull trout migration in Lightning Creek. The Lightning Creek channel, near its mouth, is overly widened and extensively braided. The channel in this area continues to carve a new course during high spring flows each year. The railroad and highway bridges on lower Lightning Creek may be contributing to the bedload aggradation problem by constricting flows and creating a deposition area. Past road repair/maintenance in Lightning Creek has been troublesome and costly. Repair costs for the 1980 road failure/slide event alone were more than $875,000 (PBTTAT 1998a).

Existing information on watershed conditions in East Fork Lightning Creek indicates that the system is in poor condition as a result of flooding, road construction and the subsequent failures, and logging activity (PBTTAT 1998a). A logging road parallels East Fork Lightning Creek for much of the lower 3 kilometers (2 miles), and there are several stream crossings within the drainage. The Lightning Creek drainage has one of the highest precipitation rates of any location in Idaho, and serious flooding as a result of rain-on-snow events or spring melt has been documented over 12 times since the 1890's (PBTTAT 1998a). Currently, portions of the road have been captured by the creek, and East Fork Lightning Creek is generally considered to be highly unstable, with impaired fish habitat conditions. This creek received significant volumes of landslide debris into the stream channel because of the location of roads in relation to the stream channel (PBTTAT 1998a). During 1994, bull trout juveniles were observed in isolated side channels that were created by excess bedload and failure of the road.

Current watershed conditions in Trestle Creek are closely associated with past road building in the drainage (USDA 1995). Roads built on unstable geology in Cochran Draw and in the headwaters contributed elevated bedload to the stream channel (PBTTAT 1998a). In-channel bedload problems originate from blocked road culverts, past road failures, and subsequent land slides. From 1994 to 1995, the U.S. Forest Service obliterated and recontoured 29 to 32 kilometers (18 to 20 miles) of problem, or potential problem, roads in the Trestle Creek watershed to reduce the risk of mass wasting. Currently, only two short spur roads that can access riparian areas of Trestle Creek exist on National Forest land.

Roads built in the Trestle Creek floodplain have also resulted in loss of instream woody debris and removal of riparian vegetation and tree canopy, both important for stream shading. Approximately 5 kilometers (3 miles) of county road run parallel to Trestle Creek in its lower section, but less than 1 kilometer (0.6 mile) of road is located immediately adjacent to the stream (PBTTAT 1998a). In some locations, the road occupies the floodplain and has reduced the amount of riparian vegetation that provides large woody debris and shade to the stream. Highway 200 acts as a dike that prevents Trestle Creek from using its floodplain and constricts the stream channel, resulting in deposition of bedload material. Consequently, this portion of stream channel requires periodic dredging to keep the stream under the bridge, and the quality of fish habitat is diminished in this area. Channel braiding and water loss to subsurface flow can result from excessive bedload deposition. On National Forest lands, bedload is the most prominent factor affecting the channel and decreasing the pool volume in Trestle Creek (USDA 1995). Excess bedload also contributes to loss of habitat in some lower reaches of Trestle Creek. The current high level of bedload aggradation (build-up) at the railroad trestle and near the stream mouth poses risks for trestle failure and stream intermittency.

The Kickbush Gulch slide has a history of failures that have contributed fine sediment to Gold Creek (PBTTAT 1998a). In 1996, a large road failure in the Kickbush area contributed significant amounts of road and hill-slope material to this stream. Separate Bonneville Power Administration and Avista transmission lines span Gold Creek in the lower reach near Lakeview (PBTTAT 1998a). In the early 1950's, timber and vegetation were cleared in a 76-meter (250-foot) corridor for line construction. The lines cross, then run parallel to, Gold Creek at one location. Loss of woody debris recruitment may affect this portion of stream, and shade is diminished.

Road failures have occurred in upper reaches of the Granite Creek watershed (PBTTAT 1998a). Road density is about 1.2 kilometers per square kilometer (0.46 mile per square mile) of watershed. In the winter of 1995 to 1996, a portion of the Kilroy Bay Road failed during flooding, and the road has been relocated.

There are over 8 kilometers (5 miles) of roads in the Char Creek watershed, and average road density is between 0.6 and 1.2 kilometers per square kilometer (0.23 to 0.46 miles per square mile). Landslide activity was related to roads in the Char Creek portion of the watershed (PBTTAT 1998a). Most of the roads are within a small tributary watershed with four stream crossings. Roads were constructed on steep slopes, and road failures have contributed bedload to Char Creek and East Fork Lightning Creek downstream.

A road parallels Porcupine Creek for most of its length, crossing several headwater channels (PBTTAT 1998a). Evidence of fill slope failures at headwater stream crossings is common, and failed culverts can be seen at the bottom of slides in the Porcupine Creek channel. Landslides from road failures probably occurred recently (within the last 10 years).

Grouse Creek has an extensive road network, including a raised bed road that bisects the floodplain in some locations (PBTTAT 1998a). The drainage was historically railroad logged, and remnants of the rail grade are still evident in the floodplain. More analysis work is needed on roads in the drainage to assess impacts and whether corrective measures need to be taken. Road repair work following the 1995 to 1996 floods resulted in localized channelization near bridges and road corridors.

Pack River has an extensive road system on private, State, and Federal lands. Because of the sandy soils, fine sediment is readily transported from roads to stream channels. Three railroads (Burlington Northern Santa Fe, Union Pacific, and Montana Rail Link) and two highways (U.S. 95 and Idaho 200) cross lower Pack River in the migration corridor, creating a risk to migrating bull trout from toxic spills.

Flathead Recovery Subunit

Overall, stream crossings and culverts are not a significant problem in the Flathead River drainage (MBTSG 1995c, 1995d, 1996b). Highways and railroads have impacted bull trout in a few areas, most significantly on Bear Creek in the Middle Fork Flathead River drainage. This stream has been heavily channelized and often receives foreign substances from train derailments. There is potential for a spill of toxic materials to have a catastrophic impact on this stream and on the Middle Fork and mainstem Flathead River downstream.

State Secondary Road 486 traverses the entire length of the North Fork Flathead River into British Columbia. An interior road in Glacier National Park on the other side of the river also encroaches on the floodplain in some locations. Several landslides have been problematic for the maintenance of this road, and the dust from heavy traffic contributes sediment to the system (MBTSG 1995c). Proposed paving of a portion of the main North Fork Road has been portrayed as a controversy, the press pitting bull trout against grizzly bears. The impacts of dust to bull trout are probably minimal since the river is foraging, migrating, and overwintering habitat. However, paving the road will increase access to the drainage, compounding the problems related to angling, poaching, and development.

Highway 83 parallels the Swan River along its entire length. Analysis of sediment taken from deep within Swan Lake shows a spike corresponding with initial highway construction (Spencer 1991b). A recently completed project to widen this highway, along with installation of telephone and utility systems throughout the region, raised concerns about increased sedimentation, and precautions were taken. To date, the Flathead Recovery Subunit Team is not aware of any documented adverse impacts. Many stream crossings on the east side of the Swan River create the potential for catastrophic impacts resulting from a toxic material spill (MBTSG 1996b). The Swan River drainage has no major tributary to buffer catastrophic impacts. Threats resulting from the transportation system in the drainage will probably become greater in the future as the highway is improved and traffic increases.

Since the time of dam and road construction in the early 1950's, numerous tributaries to Hungry Horse Reservoir (*e.g.,* Felix, Harris, Murray, and Riverside Creeks) in the South Fork Flathead River drainage have been blocked by impassable culverts (MBTSG 1995d). In most instances, the blockages were on streams that are potential spawning habitat for westslope cutthroat trout or mountain whitefish, and use by bull trout, especially for juvenile rearing, is possible. In 1996 and 1997, projects to correct passage barriers to seven streams were successfully completed (Knotek *et al.* 1997), and follow-up monitoring has shown that juvenile bull trout are using streams upstream of former barriers.

Priest Recovery Subunit

As typically occurs in watersheds with an extensive history of timber harvest, many of the major haul roads have encroached on the riparian zone. The close proximity of these roads to the streams makes it difficult to prevent sediment from entering the streams (PBTTAT 1998b). Increased use of these poorly designed and located road systems by recreationists adds to the problem in this watershed. Roads closely parallel the Hughes Fork, the lakeshore of Priest Lake, and Gold, Lion, Two Mouth, Granite, Indian, Kalispell, and Soldier Creeks (PBTTAT 1998b).

Though the streambed of the mainstem Hughes Fork above Hughes Meadows is primarily composed of sand, the stream is hydrologically stable. During the 1940's, a reach of the stream running through Hughes Meadows was channelized for construction of an airstrip, and this reach is now extremely unstable (PBTTAT 1998b). This instability is apparent further downstream in the excessive depositional features and the lack of sufficient large woody debris.

Summary (Transportation Networks)

Transportation systems were a major contributor to the decline of bull trout in this recovery unit. Separating the direct effect of the roads and railroads from the development associated with their construction is difficult. Separating the effects of transportation corridors in forested habitat from the legacy effects of forest management is also difficult. Construction methods during the late 19th and early 20th century, primarily channelization and meander cutoffs, caused major impacts on many of these streams—impacts that are still being manifested. Such impacts seldom occur with new roads. However, significant problems remain and are associated with passage barriers, sediment production, unstable slopes, improper maintenance, and high road densities. All of these problems impact bull trout and can only be addressed on a site-by-site basis.

Mining

Upper Clark Fork Recovery Subunit

Over a century of mining and smelting activity in the Butte and Anaconda areas has resulted in designation of the nation's largest Superfund site with the U.S. Environmental Protection Agency. Descriptions of the river from early researchers clearly indicate that Silver Bow and lower Warm Springs Creeks and the upper Clark Fork River were void of fish prior to 1900 as a result of mining-related pollution (Evermann 1901).

To this day, the entire 40-kilometer (25-mile) length of Silver Bow Creek is fishless due to mining wastes originating in Butte. The bed, banks, and much of the floodplain of Silver Bow Creek and the upper Clark Fork River are contaminated with mine tailings. Some recovery of the upper Clark Fork River has occurred because of improved waste treatment and reductions in the discharge of mining wastes to the river. Still, fish populations in the upper 193 kilometers (120 miles) of the Clark Fork River remain depressed in some reaches because of mining wastes (Phillips and Lipton 1995).

Declines in fish abundance are attributed to copper that originated from eroding tailings that were piled on the riverbanks. The eroding pilings increased copper loading and elevated copper concentrations for a prolonged period in a downstream direction. Copper concentrations are diluted downstream of major tributaries (Phillips and Lipton 1995).

Most other drainages in the upper Clark Fork River basin have also been impacted by mining activity. The first Montana gold discovery was at Gold Creek (tributary to the Clark Fork River) in 1852. In the placer gold rush period of 1859 to 1866, individual prospectors, looking for gold, panned along creeks. If gold was found, the stream banks were sampled to locate the source of the mineral. In the 1870's, hydraulic mining came into heavy use. The large-scale destruction from hydraulic mining is still very much in evidence in the Upper Clark Fork Recovery Subunit (Periman 1994). At least 562 kilometers (349 miles) of streams within the upper Clark Fork River basin have been identified as impaired by mining (MDHES 1994). Further downstream, damage was done by placer mining in the St. Regis River and in Ninemile, Cedar, Trout, and Quartz Creeks (MBTSG 1996e). Other streams that have impaired water quality as a result of mining include Cache, Cedar, Crow, Josephine, Kennedy, Little McCormick, and Trout Creeks, as well as the Clark Fork River and Oregon Gulch (MDHES 1994).

Placer and hardrock mining have occurred in both the Little Blackfoot River and Rock Creek drainages. In the Little Blackfoot River, pollution from historic mines continues to impact fisheries resources (MBTSG 1996e). The Brooklyn mine in the Boulder Creek drainage has been identified as having adverse effects and is scheduled for reclamation. The Rock Creek drainage contains the Gem Mountain Mine, as well as several historic mining districts. Exploration continues today for new hard rock developments. Most Clark Fork River and Flint Creek tributary streams have historic and/or current mines. Mining, both past and present, continues to be a major threat to the restoration of bull trout in the upper Clark Fork River drainage (MBTSG 1996e).

Mining in the headwaters of the Blackfoot River began in approximately 1865. A variety of minerals and commodities, including gold, silver, lead, and copper, were recovered from numerous small placer and hard rock mining operations. Although milling has not been widespread in the drainage, milled tailings were discharged into the headwaters at several sites (Moore *et al.* 1991).

Mining has had an extensive impact on aquatic ecosystems in the Blackfoot River drainage (MBTSG 1995b). Numerous mines have been developed in the southern and western portions of the basin. Impacts include the direct loss of aquatic habitat and, particularly in the upper portions of the drainage, chemical contamination. Overall, the Montana Department of Environmental Quality lists 11 streams in the Blackfoot River drainage that suffer water quality impairment from mining activities, including Day Gulch and Beartrap, Douglas, Elk, Jefferson, Poorman, Sandbar, Washington, Washoe, West Fork Ashby, and Willow Creeks (MDHES 1994). Pierce and Podner (2000) also identify Seven Up Pete and Sauerkraut Creeks as needing restoration from past mining activities.

Mine drainage from adits and waste piles continues to contaminate waters in the headwaters of the Blackfoot River drainage (MBTSG 1995b). Contaminant input from mine effluent in the headwaters of the Blackfoot River is apparent from downstream trends of solute constituents. The pH of effluent in contaminated tributaries that flow into the upper 5 kilometers (3 miles) of the river ranges from 3 to 6.5. Concentrations of sulfate are extremely high in the more acidic tributaries and decrease downstream of those sources (Moore *et al.* 1991). Alkalinity is also depressed for about 32 kilometers (20 miles) because of the effects of acid mine drainage (Ingman *et al.* 1990). Both acidity and sulfate concentration lessen downstream of the headwater sources in the Blackfoot River (Moore *et al.* 1991). Inflows of limestone groundwater or springs below Lincoln enhance the river's buffering capacity against changes in pH and the effects of metals (Ingman *et al.* 1990).

Trace metal contamination originates from a small number of sources on Blackfoot River headwater tributaries, particularly the Mike Horse Mine. Concentrations of solutes decrease rapidly in the upper few kilometers below their sources. However, solute metal contaminants transfer to the particulate phase, and at least some cadmium and zinc remain bioavailable over long stretches of the river (Moore *et al.* 1991).

In 1975, the tailings dam at the Mike Horse Mine washed out, sending tons of metal-contaminated tailings into the upper Blackfoot River (MBTSG 1995b). These tailings continue to impact aquatic life in the Blackfoot River. Studies of fish populations conducted before and after the tailings pond failure indicate acute mortalities of brook and cutthroat trout (Moore *et al.* 1991; Spence 1997), and fish population densities remain reduced (Peters and Spoon 1989; Moore *et al.* 1991).

New mines may be developed in the Blackfoot River drainage in the future. A large open-pit gold mine (the McDonald Gold Project) was proposed near Lincoln. It was the subject of heated public policy debate until development of the mine was blocked by a 1999 State law resulting from a successful citizen-sponsored ballot initiative prohibiting new cyanide heap leach mining projects. Given the presence of valuable ore bodies, new mining will probably continue to be of interest in the basin.

Toxic sediment from tailings on the upper Clark Fork River has been trapped and deposited in the small reservoir behind Milltown Dam on the Clark Fork River just downstream of the confluence of the Blackfoot River (MBTSG 1995e). Recently, Pennsylvania Power and Light of Montana (formerly Montana Power Company), the owners of the dam, announced that it would no longer generate power at this run-of-the-river hydroelectric facility due to economic considerations. However, there continues to be an enormous risk to downstream fish populations and water quality because of the sediment deposits. Pennsylvania Power and Light of Montana, the Federal Energy Regulatory Commission, and the public will probably make a decision on the ultimate fate of this facility over the next few years. Ideally, the dam would be removed and the sediments hauled away from the floodplain for permanent disposal, but the costs associated with this solution are high.

Past or present mining activity has been limited in the Bitterroot River drainage and is not a significant issue in this area (MBTSG 1995a). Hughes Creek, a tributary of the West Fork Bitterroot River, has had extensive placer and dredge mining.

The State of Montana and partners successfully negotiated an out-of-court settlement with Atlantic Richfield Corporation for damages to the ecosystem of the upper Clark Fork River valley from the mining legacy effects at Butte and Anaconda. The settlement totaled approximately $213 million. Separate compensation for damages to the Clark Fork River itself are still being negotiated. A great deal of information has been collected on the upper Clark Fork River in connection with the litigation between the State of Montana and Atlantic Richfield Corporation (MDOJ 1999). This information will be helpful for planning bull trout restoration projects.

Tens of millions of dollars will be available for restoration of aquatic habitat in the 21st century as a result of this settlement. Plans are now being developed for effectively using the money (MDOJ 1999). Though such a remediation effort is unprecedented, the magnitude of the problem is immense. The 1995 remediation plan states: ". . . the most that can be achieved in the way of restoration of the Upper Clark Fork River Basin within the lifetimes of persons alive today is to ameliorate natural resource injuries, enabling the resource and the services provided by the resources to recover substantially" (State of Montana and Rocky Mountain Consultants 1995)

Lower Clark Fork Recovery Subunit

Permits are currently being sought to operate an underground copper/silver mine and mill that could produce 10,000 tons of ore per day in the Rock Creek drainage of the Lower Clark Fork Recovery Subunit near Noxon. The proposed tailings impoundment would store about 100 million tons of tailings near the confluence of Rock Creek and the Clark Fork River. The Rock Creek drainage has been identified as one of two spawning and rearing streams for migratory bull trout living in Cabinet Gorge Reservoir (MBTSG 1996a). Sediment levels in Rock Creek already exceed 40 percent fines (Smith 1993, 1994), which is high enough to significantly reduce bull trout survival to emergence. This mine and mill complex pose a high risk to bull trout in the Rock Creek drainage and, potentially, in downstream waters.

There are areas in the Lake Pend Oreille basin that have been impacted by underground and open-pit mining operations and the resulting effluent from these closed or abandoned mines (PBTTAT 1998a). Many sites are not now being operated or have been abandoned without reclamation. Toxic substances (primarily heavy metals) emanating from abandoned mine sites could block migratory corridors or impact life stages of bull trout, but, to date, heavy metals have not been identified as a significant water quality problem in the direct tributaries to Lake Pend Oreille. Increased sedimentation or release of toxins into surface or groundwater may occur if specified best management practices are not designed and implemented.

On some tributaries to Lake Pend Oreille, mining companies still hold water rights to divert stream water for power and mining operations (PBTTAT 1998a). Thirteen separate water rights for surface water diversion are held in Trestle Creek, totaling 0.74 cubic meters per second (26.17 cubic feet per second) (PBTTAT 1998a). One of these water rights is for 0.71 cubic meters per second (25 cubic feet per second) and was initially granted for a mining claim; the water right does not appear to have been used for well over five years (PBTTAT 1998a).

Past mining operations in the Gold Creek watershed, which drains into the south arm of Lake Pend Oreille, have impacted this stream and continue to affect channel equilibrium. Both Chloride Gulch and Gold Creek, above the confluence with West Gold Creek, exhibit channel disequilibrium and intermittency as a result of excess bedload inputs stemming from mining operations (PBTTAT 1998a). These streams go dry for most of the summer season in areas where width-to-depth ratios, channel confinement, and channel sinuosity are outside normal ranges. All intermittent reaches in Gold Creek are located downstream of areas where extensive mine waste deposits were placed directly in the stream. Waste from the Conjecture Mine has already contributed an estimated 38,000 cubic meters (50,000 cubic yards) of sediment into the channel, with another 84,000 cubic meters (110,000 cubic yards) available with future runoff (USDA 1997). The Weber Mine in Gold Creek and the Idaho Lakeview Mine in Chloride Gulch have introduced and continue to supply the stream channel with large sediment loads.

Flathead Recovery Subunit

At the present time, mining is not known to be impacting bull trout in the Flathead River drainage (MBTSG 1995c). However, there is a large coal deposit in the North Fork Flathead River drainage in British Columbia. If the deposit is mined, as was proposed in the 1970's, a potential loss of 10 percent of the spawning stock of Flathead Lake migratory bull trout was estimated (Fraley *et al.* 1989). Also water quality impacts could be experienced downstream. Because the coal is in Canada, the United States has relatively little control over mine plans, except under the authority of the International Joint Commission.

Exploratory oil and gas development has been sporadic in the Flathead River basin, but has continued for nearly a century without any fields being developed. Location and full development of a large deposit would be a major concern because of the fragile and pristine nature of much of this ecosystem.

Current and historical mining does not threaten the Swan Lake or South Fork Flathead River bull trout populations (MBTSG 1996b, 1995d). No existing mining operations occur other than recreational gold panning. However, a few mining claims are scattered in the South Fork Flathead River drainage (*e.g.*, Baptiste), but none are currently active.

Priest Recovery Subunit

Mining is not a common activity in this drainage, and impacts to bull trout from previous mine exploration have been low to nonexistent. The Continental Mine in the Boundary Creek watershed of the Kootenai River drainage was often accessed from the Upper Priest River side, causing some road-related impacts (PBTTAT 1998b).

Summary (Mining)

The legacy effect of mining, particularly in the upper Clark Fork River drainage, will continue to impact bull trout for many decades to come. Because of extreme water quality degradation in the upper watershed, dating back to the 19th century, continued vigilance and purposeful improvement will be required for many decades before the full potential of the aquatic resources can be restored. Some major portions of the Clark Fork River watershed have never been materially impacted by mining. Meanwhile, existing mines and new mine proposals continue to develop and have the potential to negatively impact some core areas and local bull trout populations.

<u>Residential Development</u>

Upper Clark Fork Recovery Subunit

The impacts of residential development in the upper Clark Fork River watershed vary by location, but where impacts occur, they can be severe. Some impacts may be partially mitigated by an active program to acquire conservation easements to protect fragile lands in riparian zones. Newly adopted rules, such as those by Missoula County to require protection of riparian zones, have been difficult to enforce and represent the exception, and not the norm.

For many years, excessive nutrients have been reported throughout the mainstem Clark Fork River. The communities of Butte and Deer Lodge discharge municipal sewage effluent into the Clark Fork River and are the main point sources for nutrients in the upper Clark Fork River (MDHES 1994).

The human population is growing in the Blackfoot River drainage, particularly in the area around Lincoln. Lewis and Clark County grew 17.3 percent in the decade of the 1990's, according to U.S. Census Bureau statistics (Inter Lake, *in litt.*, 2001). Alteration of riparian zones is often a major impact associated with residential and commercial development. Some areas in the upper portions of Rock Creek, the Ninemile Creek Valley, and the lower portions of Rattlesnake Creek are under development pressure. Many other areas have potential for future development.

The lower Bitterroot River has been determined to be a major nonpoint source of nutrient pollution in the upper Clark Fork River basin, primarily from sewage effluent from towns and also from land development along the river (USEPA 1993). About 628 kilometers (390 miles) of stream in the Bitterroot, including the entire mainstem, are impaired or partially impaired for beneficial uses of the water (MDHES 1994). Sources of impairment are primarily from agriculture (siltation and flow modification), silviculture (siltation and habitat modification), and resource extraction. However, land development, road and highway modifications, and wastewater effluent also contribute to impairment (MDHES 1994).

Since the 1930's, there has been rapid growth of home building along riparian zones in the Bitterroot Valley (Javorsky 1994). In the 1990 to 1994 time period, Ravalli County had the highest population growth (22.8 percent) in Montana, and that rapid pace has not abated (MBTSG 1995a). Streambank modification and destabilization and municipal point source pollution have been identified as sources of impairment of water quality in the Bitterroot River (MDHES 1994). Rural residential development is a high risk to long-term aquatic ecosystem health in the Bitterroot River drainage. Development exacerbates temperature problems, increases nutrient loads, decreases bank stability, and increases pressures to alter stream and riparian habitats.

Bull trout in headwater streams in the Bitterroot River drainage are not currently being directly impacted because many of the remaining local bull trout populations are on lands owned by the U.S. Forest Service. However, the potential to restore migratory fish in the Bitterroot River is being severely compromised by uncontrolled urban sprawl in the Bitterroot Valley.

Lower Clark Fork Recovery Subunit

The northwest corner of Montana remains sparsely populated. However, in recent years, the human population has been increasing, and in the future, rural residential development may be a high risk to the restoration of bull trout (MBTSG 1996a). In the decade of the 1990's, Lincoln, Sanders, Lake, and Mineral Counties grew 7.8 percent, 18.0 percent, 26.0 percent, and 17.2 percent, respectively (Inter Lake, *in litt.*, 2001). Growth is particularly evident in watersheds bordered by private lands, such as along the Bull and the Jocko Rivers.

In some watersheds in the Pend Oreille portion of the lower Clark Fork River basin, housing subdivisions and urban development are expanding. Trestle Creek has considerable residential development along 5.6 kilometers (3.5 miles) of its lower reach (PBTTAT 1998a). Some residents have cleared riparian zone areas and removed canopy cover to increase views and to plant lawns and gardens. Homeowners in riparian areas sometimes remove large woody debris from the channel to reduce the perceived risk of floods. Removal of these pool-forming features (*i.e.*, trees and wood) from the stream has reduced pool frequency and volume in the lower 5 kilometers (3 miles) of stream running through private land. Homes exist in the natural floodplain now, and further subdivision is occurring for new homes. Surface erosion occurs because of roads and driveways. Urban encroachment in Trestle Creek has contributed to stream channel instability and disequilibrium, bedload and sediment input, increased stream temperatures in lower reaches, and other streambed damage. Although not verified, other threats may include septic system leakage and associated impacts to water quality (PBTTAT 1998a).

Granite Creek was reportedly dredged in the reach below the Kilroy Bay Road after a large flood in the early 1970's (PBTTAT 1998a). A significant portion of the floodplain downstream of the Kilroy Bay Road has been subdivided and developed. Removing timber and constructing roads for access to lots have also impaired floodplain function. Restoration efforts are underway to partially mitigate these problems.

The lower reach of Strong Creek runs within the city limits of East Hope. This stream runs between houses and lawns that have replaced riparian vegetation on both sides of the channel. Septic systems may also affect the stream but have not been evaluated. The channel is diked on its northwest bank between the highway and the mouth, resulting in a confined channel.

Flathead Recovery Subunit

The impact of residential development will become increasingly important to bull trout recovery in the Flathead Recovery Subunit. An increasing human population has led to increased lake eutrophication because of nutrient enrichment in Flathead Lake and other large natural lakes within the basin (Flathead Basin Commission 1999). During the 1990's, the human population in Flathead County grew by 25.8 percent, the sixth highest rate of growth among Montana's 56 counties (Inter Lake, *in litt.*, 2001). Recent evidence indicates that the downward trend in water quality in Flathead Lake may be leveling off, in part because of an aggressive campaign by the Flathead Basin Commission and other private and public interests. Unmanaged growth and increased development pose a serious threat to water quality in many of the lakes in the basin (MDHES 1994).

Some residential development is also ongoing in the tributaries used by spawning bull trout in the North and Middle Fork Flathead River drainages (MBTSG 1995c). Domestic sewage from these developments and changes to stream morphology caused by building in the floodplain could reduce habitat quality in the tributaries.

Golf courses often impact riparian areas, causing bank erosion and reduced water quality. Ski area development is expanding into the headwater areas of Big Creek, an important bull trout spawning stream in the North Fork Flathead River drainage (MBTSG 1995c). Downhill ski areas create permanent clear-cuts that have the potential to increase sediment loads and water yields and to change hydrologic patterns.

The human population in the Swan River Valley is also growing rapidly (MBTSG 1996b). The Swan Valley is in Lake and Missoula Counties, which grew in human population by 26.0 percent and 21.8 percent, respectively, during the decade of the 1990's (Inter Lake, *in litt.*, 2001). Requests for State 310 permits to alter the bed and/or immediate banks of streams in the drainage are increasing. Private land in the drainage is concentrated along the Swan River and the lower portions of the tributary drainages. These reaches provide critical migratory corridors and rearing habitat. It is likely that some corporate timber holdings in the drainage may be sold in the future. Such a sale could allow development adjacent to major spawning and rearing areas, though the recent development of a Habitat Conservation Plan with Plum Creek Timber Company is designed, in part, to minimize such impacts (USFWS *et al.* 2000).

Only a few small tracts of private land and scattered mining claims occur in the South Fork Flathead River drainage. Therefore, limited rural residential development is possible upstream of Hungry Horse Dam (MBTSG 1995d).

Priest Recovery Subunit

A study conducted by the Idaho Department of Environmental Quality in 1993 to 1995 examined several components of the lake system, including trophic status indicators of the limnetic zone (open waters), the bathymetry (shape and depth of the basin), plant growth in littoral (near-shore) zones, quantity and quality of inflow waters, characteristics of selected groundwater aquifers, and watershed characterization using a geographical information system (PBTTAT 1998b). Conclusions developed from the three-year water quality study include the following: 1) open waters of Priest and Upper Priest Lakes can be classified as oligotrophic; 2) lake waters of shallow near-shore sampling sites showed no indication of nutrient enrichment linked to onshore human development; 3) both lakes do exhibit a marked decline in water clarity during spring runoff in tributaries; 4) phytoplankton growth in Priest Lake may be co-limited by phosphorus and nitrogen, at least during summer months; 5) attached algae growth in the littoral zone of many Priest Lake shoreline areas appears excessive given the low nutrient content of ambient near-shore waters; 6) the primary nutrient fueling sources relating to attached algae biomass were not determined; 7) phosphorus, nitrogen, and sediment loading from various sources into Priest Lake was determined as low to moderate, except that loading per area of runoff from some residential areas can be high; 8) some isolated areas of groundwater sampling indicate an altering of back-groundwater quality by sewage effluent plumes; and 9) project consultants consider human-induced nutrients and sediments as a potential threat for deterioration of Priest Lake water quality (Rothrock and Mosier 1997).

Most of the residential development in this watershed is seasonal and is related to the growing recreational demands from the expanding urban areas in northern Idaho and eastern Washington. Impacts are particularly acute on the shore of Priest Lake (PBTTAT 1998b). Most of the drainages that contribute to Priest Lake have experienced growing recreational and urban use, with impacts most pronounced in the watersheds of Two Mouth, Granite, and Kalispell Creeks. Urbanization increases the demand for flood control, stream crossings, water diversion or withdrawal, and other stream channel alterations that are potentially harmful to bull trout. These impacts will be expected to increase as the popularity of this area for recreational activities continues to grow.

Summary (Residential Development)

Ultimately, unmanaged growth and residential sprawl may be among the biggest threats to the recovery of bull trout in this recovery unit. The entire recovery unit holds many of the attributes that are increasingly attractive to people seeking relief from the urban environment, and human population growth in western Montana and northern Idaho has accelerated. The way in which this growth is managed and our ability to limit the impacts of growth, in particular on bull trout spawning and rearing streams, are pivotal to the success of the bull trout recovery effort. Increasing human populations have a direct impact on all of the other categories of risk that affect bull trout.

Fisheries Management

Upper Clark Fork Recovery Subunit

The introduced sport fish species found in the upper Clark Fork River drainage in Montana include brook trout, brown trout, rainbow trout, lake trout, Yellowstone cutthroat trout, kokanee salmon, Arctic grayling, largemouth bass, northern pike, yellow perch, pumpkinseed sunfish, and fathead minnow. Walleye, apparently from illegal transplants, have been found in several waters. To date, however, walleye are not known to have established reproducing populations in this headwaters portion of the Columbia River.

Brook trout and lake trout, the two common species most closely related to bull trout, are believed to represent the greatest threat to bull trout in the Clark Fork River basin as a whole. Brook trout are present in nearly all mainstem Clark Fork River tributaries. Bull trout hybridize with brook trout, and the offspring are generally sterile. The available data indicate that brook trout presence can create an unstable situation, resulting in a dramatic decline or replacement of bull trout (Leary *et al.* 1983).

Brook trout are widely distributed in the Blackfoot River drainage (MBTSG 1995b). Belmont Creek, Landers Fork, and Copper Creek are the only significant bull trout watersheds in the drainage where brook trout are not found. Brook trout are also common in tributary streams of the Bitterroot River(MBTSG 1995a). Approximately 75 percent of the bull trout streams within the Bitterroot River drainage contain brook trout, although not necessarily in the same stream reaches as the bull trout. Some genetic analysis has been done. Streams that are known to contain bull trout x brook trout hybrids in the Bitterroot River drainage include Bear, Gold, Slate, Woods, Nez Perce, Tin Cup, Trapper, Watchtower, and South Fork Lolo Creeks (Leary, *in litt.*, 1991, 1993). Data from the South Fork Lolo Creek and Tolan Creek indicate that brook trout may be expanding their range and numbers at a relatively rapid rate in some habitats.

Brown trout are also suspected to adversely affect bull trout (Nelson 1965; Moyle 1976; Pratt and Huston 1993). At this point, the nature of the negative interaction between bull trout and brown trout, interaction thought to include elements of competition and predation, is not well understood. However, the result of the species' interaction is suspected to be detrimental to bull trout, given the apparent overlap in niches for the two species.

The greatest numbers of brown trout in the upper Clark Fork River occur in the upstream reaches near the town of Warm Springs, where numbers of catchable brown trout consistently exceed 1,600 fish per kilometer (1,000 fish per mile) (MBTSG

1995e). Numbers of brown trout decline rapidly in downstream progression to only about 80 fish per kilometer (50 fish per mile) near Bearmouth. Further downstream, below the confluence with Rock Creek, brown trout numbers increase again (MBTSG 1995e).

Hatchery plants of 10,000 hatchery-reared juvenile brown trout were made in the Huson study section of the Clark Fork River for three successive years from 1986 through 1988 (Berg 1989). Saturation plants of the fish were made to evaluate the potential of using juvenile hatchery brown trout to enhance the existing population of brown trout for the sport fishery. Enhancement of catchable brown trout was not observed in subsequent years, and the plants were discontinued (MBTSG 1995e).

The density of brown trout is relatively even within the mainstem of the Blackfoot River from the mouth upstream to Monture Creek (MBTSG 1995b). But because of differing densities of rainbow trout, the percentage of the overall trout population that is comprised of brown trout varies. In the Johnsrud area, brown trout comprise approximately 5 to 10 percent of the total trout population, and the brown trout numbers appear to be increasing. Further upstream, near the Monture Creek confluence with the Blackfoot River, overall trout densities are lower and brown trout comprise approximately 30 to 40 percent of the trout population. In recent years, total trout densities of all species appear to be increasing in this portion of the Blackfoot River drainage (MBTSG 1995b).

In the section of the Blackfoot River above Monture Creek and below the town of Lincoln, trout numbers (dominated by brown trout) are higher than in the section immediately downstream. The lower portions of Monture Creek and the associated spring creek system are important spawning areas for brown trout. Above the town of Lincoln, brown trout numbers decline (Pierce and Podner 2000).

Brown trout are common in the lower reaches of several tributary streams of the Blackfoot River, as well as in the mainstem river (Pierce and Podner 2000). The Blackfoot River drainage would be a good location for research on brown trout–bull trout interactions because the ranges of the two species overlaps and because historical baseline data are available.

The impact of recent habitat improvement efforts in the Blackfoot River watershed on the relative abundance of brown trout and bull trout is unknown (MBTSG 1995b). If these projects benefit brown trout to a greater extent than they benefit bull trout, they could have the unintended consequence of increasing brown trout numbers at the expense of bull trout. Monitoring is ongoing to determine the specific impacts and to establish general guidelines for habitat improvements to be most beneficial to native species. Fishing regulations in the Blackfoot River have been adjusted to focus angler harvest on brown trout (MFWP, *in litt.*, 2000).

In the past, private ponds have not been a major source of introduced species spreading throughout the upper Clark Fork River drainage (MBTSG 1995e). However, as more people move into the area and build ponds, the risk from fish stocked in private ponds increases. Although private ponds are required to be licensed by Montana Fish, Wildlife and Parks before they are stocked with fish, some people are unaware of the law, or circumvent it. The concern is that brook trout, or other species, may spread from ponds into waters where they do not currently exist. Fish diseases could also potentially be introduced through private fish stocking.

At the present time, the trout species stocked in the headwaters of the Clark Fork River drainage by Montana Fish, Wildlife and Parks are rainbow trout and westslope cutthroat trout. Westslope cutthroat trout are native throughout the Clark Fork River drainage and are stocked into some of the high mountain lakes in the Clark Fork, Blackfoot, and Bitterroot River basins (MBTSG 1995a, 1995b, 1995e). Rainbow trout are stocked into other lowland lakes. This stocking program is not believed to be detrimental to bull trout.

Additional fish species currently stocked in the Blackfoot River drainage by Montana Fish, Wildlife and Parks are largemouth bass, Arctic grayling, and kokanee salmon. Largemouth bass are stocked in Placid and Seeley Lakes. Interactions between largemouth bass and bull trout are unknown, and the agency stocking policy in these waters should be reviewed (MBTSG 1995b).

In the past, Montana Fish, Wildlife and Parks; other agencies; and individuals stocked a wider variety of nonnative species, including brook trout and brown trout.

Brook trout are no longer stocked west of the continental divide. Fish from past stocking have established self-sustaining populations in many waters of the Clark Fork River valley. Legacy effects of these past stocking practices pose a significant threat to the survival of bull trout today (MBTSG 1995a, 1995b, 1995e).

The illegal introduction of nonnative species by private parties is a growing problem in western Montana (Vashro, *in litt.*, 2000). In addition to the risks posed by spreading introduced species, there is also a risk of introducing fish pathogens. In the upper Clark Fork River drainage, most of the identified risk is from illegal stocking of brook trout. Brook trout may be placed in an important bull trout drainage where they do not currently exist or have been removed (MBTSG 1996c).

Illegal stocking of warmwater or coolwater species such as the northern pike, largemouth bass, or walleye also poses a significant risk to native species. The presence of illegally introduced walleye and northern pike in the Clearwater River drainage is of concern (MBTSG 1995b). And northern pike are present in low numbers in the Clark Fork River in the Superior and St. Regis areas (MBTSG 1996e). Predicting what species might be illegally introduced or what impact those fish may have on the native fauna is impossible. But continued illegal fish introductions will complicate restoration efforts for bull trout.

Efforts of fisheries managers in the upper Clark Fork River watersheds have concentrated on addressing the water quality and habitat problems that affect the river. Much of the recreational fishing in the drainage occurs in the lakes and tributary streams.

In 1999, the mainstem Clark Fork River, upstream of the Bitterroot River, received approximately 40,000 angler days of fishing pressure, and use has been up sharply in recent years (MFWP 2000a). The Blackfoot River is one of the most popular fisheries in the region, and use has increased dramatically with the advent of the movie *A River Runs Through It*. In 1999, angling pressure on the Blackfoot River was estimated at 46,385 angler days (MFWP 2000a), up from 20,043 angler days in 1991 (MFWP 1992). Fishing pressure in 1999 on the Bitterroot River was estimated at 110,931 angler days (MFWP 2000a), up from 52,776 angler days in 1991 (MFWP

1992). The doubling of angler use on these streams over just an eight-year period is significant and is one of the major challenges facing fisheries managers. Angler bycatch of bull trout, including associated incidental or accidental mortality, is a major concern on these heavily fished streams. Pierce *et al*. (2002) list the upward trend in recreational use of the Blackfoot River combined with "the inability of a growing number of anglers to identify bull trout" as a major challenge to the conservation of wild trout.

The evolution of fisheries management priorities in Montana is demonstrated by a case study of Rock Creek. In 1958 to 1959, a creel survey on Rock Creek determined that bull trout comprised 5 percent of the catch. The total catch from Rock Creek was estimated to be 50,300 game fish, meaning that approximately 2,515 bull trout were caught (Averett and Whitney 1959). In 1959, the creel survey was expanded to include the tributaries. A total of 120 bull trout that were checked were harvested from the tributaries. The majority of these (103 fish) came from Ranch Creek. Bull trout were also harvested from Welcome, Gilbert, Cougar, Stoney, and Wyman Creeks (MBTSG 1995e).

In the 1970's, fisheries management in Rock Creek began to change dramatically with the termination of the stocking program for catchable trout. In 1979, creel limits were greatly reduced, and terminal gear restrictions were imposed. These changes were successful in increasing the number of rainbow trout longer than 28 centimeters (11 inches) in the stream (MBTSG 1995e).

Today, Rock Creek supports a significant sport fishery. In 1993, Rock Creek supported 27,400 angler days (MFWP 1994), and bull trout were 1 percent of the catch, meaning that approximately 203 bull trout were caught and released in the creek. In 1999, angler use on Rock Creek was estimated at 40,108 angler days (MFWP 2000a).

Currently, the management goal of the Montana Fish, Wildlife and Parks for Rock Creek is to maximize the opportunities for catching trout over 36 centimeters (14 inches) long (MFWP 1989). The Rock Creek sport fishery is comprised primarily of rainbow and brown trout. The strategy for obtaining the management goal is to restrict harvest to three brown trout under 30 centimeters (12 inches) per day. Rainbow trout, cutthroat trout, and bull trout must be released. Brook trout are exempt from the special limits and have a limit of 20 fish daily (MFWP, *in litt.*, 2000).

The current bull trout management objective for the Blackfoot River, according to the Montana Fish, Wildlife and Parks' 1990 management plan for the river, is to increase the standing crop of adult bull trout larger than 2.3 kilograms (5 pounds) to one fish per 300 meters (1,000 feet) (MBTSG 1995b). This goal has not been met, but Montana Fish, Wildlife and Parks biologists have stated that they believe this bull trout management objective is conservative.

The Bitterroot River is primarily a rainbow and brown trout fishery and is managed with a complex suite of regulations that emphasize the opportunity to produce larger fish and protect native species from harvest (MBTSG 1995a). If bull trout are to persist in the Bitterroot River over the long term, the focus of fisheries management and regulations may need to continue to evolve toward a goal of further protecting imperiled native species (MBTSG 1995a).

In the past, bull trout harvest (both legal and illegal) may have been a significant risk factor to the species in the upper Clark Fork River portions of the watershed (MBTSG 1995e). The current risk from legal angling is reduced because harvest of bull trout is no longer legal in these drainages. However, misidentification of bull trout and lack of compliance with regulations continue to plague attempts to reduce angler-induced bull trout mortality. A 1999 creel survey on the Blackfoot River determined that bull trout comprised only 2.4 percent of the trout catch but that 8.2 percent of the bull trout caught were kept illegally (Schmetterling and Bohneman 2000). Surprisingly, that proportion (8.2 percent) of bull trout kept was higher than for rainbow trout (7.4 percent) and brown trout (7.5 percent), both of which could be legally harvested if under 30 centimeters (12 inches). Results of the creel survey also showed that anglers reported catching brook trout with much greater frequency than brook trout are known to occur in the mainstem river and that 31 percent of brook trout reportedly caught were kept. If, as suspected, many of those brook trout were in fact juvenile bull trout, the problem of unintentional harvest because of misidentification may be even greater than documented (Pierce and Podner 2000).

Another problem is hooking mortality of bull trout that are caught unintentionally and then released (MBTSG 1995a, 1995b, 1995e). Currently, very little data is available for assessing this issue, but increasing angler participation would be expected to result in an increase in hooking mortality of bull trout. If future data indicate that hooking mortality is a significant problem, additional angling restrictions may be sought on some streams, particularly during spawning season. The drainages that receive higher-than-average fishing pressure (such as Rock Creek, the Bitterroot River, and the Blackfoot River) are more likely to experience hooking mortality problems than more lightly fished waters are.

Accurate information on targeted illegal harvest (poaching) is difficult to obtain. However, there is anecdotal information that concentrations of large bull trout are targeted by poachers (MBTSG 1995a, 1995b, 1995e). In areas where the local population is small, the loss of even a few fish can be significant. Illegal harvest probably continues in the Blackfoot River drainage (MBTSG 1995b). During summer 1994, two of seven bull trout equipped with radio tags disappeared and, because of circumstantial evidence, were suspected to have been illegally harvested.

Lower Clark Fork Recovery Subunit

The introduced fish species found in the lower portions of the Clark Fork River drainage in Montana include Yellowstone cutthroat trout, brook trout, brown trout, rainbow trout, lake trout, lake whitefish, largemouth bass, smallmouth bass, black crappie, northern pike, yellow perch, pumpkinseed, burbot, yellow bullhead, black bullhead, fathead minnow, and central mudminnow. Individual walleye, apparently from illegal transplants, have been found in several waters. To date, however, walleye are not known to have established reproducing populations.

Brook trout are believed to be a particularly high risk in lentic environments and are present in most streams in the lower Clark Fork River drainage that are currently used by bull trout. Brook trout are known to be extensively hybridized with bull trout in Mission Creek (Hansen and DosSantos 1993b).

Brown trout also use most of the waters inhabited by bull trout in the drainage (MBTSG 1996a). Brown and bull trout are known to spawn in the same area of the

Bull River. Brown trout spawn later in the fall than bull trout and may disturb bull trout redds built earlier in the season (Pratt and Huston 1993). Brown trout are common in the Jocko River and also occur in the lower Flathead River (MBTSG 1996a).

Lake trout have been documented to migrate downstream of Flathead Lake through or over Kerr Dam (Carty *et al.* 1997). However, the habitat in Noxon and Cabinet Gorge Reservoirs is probably not suitable for a self-sustaining lake trout population, in part because of warm water temperatures, and many of these fish are suspected to pass through the system into Lake Pend Oreille.

In the mainstem Clark Fork River reservoirs, yellow perch and pumpkinseed are two of the most abundant species present (MBTSG 1996a). Although the interactions between these introduced species and bull trout are not clear, the possibility of adverse interspecies interactions are considered a high risk to bull trout (MBTSG 1996a). Evaluations of the species complex and interactions in the reservoir fish fauna are a high priority under the Avista mitigation program (Washington Water Power Company 1998).

Northern pike are also present in the mainstem reservoirs of the Clark Fork River. Northern pike have been in the lower Clark Fork River drainage since at least the 1950's and are reproducing and well established (MBTSG 1996a). Given the predacious behavior of the northern pike, predation and/or competition between this species and bull trout may occur. The presence of walleye probably resulted from at least two separate illegal introductions into the lower Clark Fork River drainage, but reproduction has not been documented.

Northern pike and largemouth bass have become established in the Flathead River. More recently, smallmouth bass have begun to provide an increasingly popular sport fishery, with trophy class specimens and a new State record caught. The source of these fish is suspected to have been a stocking error by the U.S. Fish and Wildlife Service, with smallmouth bass included with a plant of largemouth bass in Lower Crow Reservoir (L. Evarts, Confederated Salish and Kootenai Tribes, pers. comm., 2000).

In recent times, the fish species stocked in this portion of the Clark Fork River drainage by Montana Fish, Wildlife and Parks are brown trout, westslope cutthroat trout, Kamloops rainbow trout, and largemouth bass (MBTSG 1996a). Westslope cutthroat trout are native throughout the drainage and are stocked into some of the high mountain lakes in the basin. Brown trout were stocked in the Clark Fork River in the 1980's and in lakes in the upper Thompson River drainage in the 1990's. Kamloops rainbow trout are stocked into Noxon Rapids Reservoir under an informal agreement with Idaho Department of Fish and Game.

The portions of the lower Clark Fork River drainage that received the most significant angling pressure in 1999 were the Clark Fork River (22,525 angler days), Thompson River (11,189 angler days), lower Flathead River (3,180 angler days), and Noxon Reservoir (11,330 angler days) (MFWP 2000a). Fishing pressure in Cabinet Gorge Reservoir is quite low (estimated 608 angler days in 1999; MFWP 2000a) because of the historically poor fishery. Fishing pressure is growing on most of these waters.

Immediately prior to closure of Noxon Rapids Dam in August 1958, Thompson Falls Reservoir and the Clark Fork River downstream to Cabinet Gorge Reservoir were chemically treated with rotenone to remove the existing fish populations (Huston 1985). During that era, such treatment was a common management strategy prior to filling a new reservoir. The hope was that poisoning, followed by stocking of rainbow trout, would result in an improved sport fishery for rainbow. Huston (1985) summarized fishery management activities in Noxon and Cabinet Gorge Reservoirs between the early 1950's and the mid-1980's. Montana Fish, Wildlife and Parks stocked a variety of species, strains, and sizes of introduced fish in an attempt to establish a sport fishery. These efforts were largely unsuccessful.

In the early 1980's, management emphasis in the mainstem reservoirs of the Clark Fork River shifted away from coldwater salmonids and toward a warmwater bass fishery (MBTSG 1996a). Largemouth bass had persisted in the reservoirs, even following the chemical treatment of the late 1950's, and smallmouth bass were stocked into Noxon Reservoir several times, beginning in 1982. At about the same time, reservoir operations were modified to reduce drawdown. Since that time, bass numbers have increased, along with numbers of northern pike, yellow perch and pumpkinseed, and the bass fishery is currently providing a sought-after sport fishery in Noxon Reservoir (Huston 1985). The management goal of maintaining a viable sport fishery for introduced species may prove to be in conflict with the goal of restoring bull trout in this drainage, so further evaluation is underway (MBTSG 1996a).

Accurate information on illegal harvest is difficult to obtain. Pratt and Huston (1993) describe poaching techniques and locations in the lower Clark Fork River. Dynamiting, spearing, snagging, and shooting were all historically used by poachers in this area. Heavy snagging harvest is know to have once occurred in the Bull River. Also, hooking mortality in snag fisheries tends to be high (Long 1997). In areas where the population is small, the loss of even a few fish can be significant.

Lake Pend Oreille

Lake Pend Oreille represents a critical sanctuary for the remaining stock of adfluvial bull trout in the Clark Fork River basin. Like the waters upstream, the lake supports a wide variety of introduced species (see description in the subsection on the Lower Clark Fork Recovery Subunit). Bull trout across their range often appear restricted to waters upstream of the waters used by introduced rainbow trout and brown trout (PBTTAT 1998a). However, in some key watersheds, bull trout and rainbow trout evolved together. Bull trout and rainbow trout are found together in many Lake Pend Oreille tributary stream reaches, and they have coexisted in the lake since rainbows were introduced there in 1919. In 1941, the Gerrard strain of rainbow trout, which is predaceous and grows to large sizes, was introduced. Gerrard rainbows use the same prey base (kokanee salmon) as large bull trout, and the potential for competition exists. Vidergar (2000) analyzed stomach contents from 180 Kamloops rainbow trout taken from Lake Pend Oreille and found that 76.8 percent of the diet was kokanee salmon; 11.4 percent, other rainbow trout; and 5.3 percent, bull trout. Vidergar estimated the number of Kamloops rainbow trout in Lake Pend Oreille at about 15,000 fish with fork length greater than 40 centimeters (16 inches).

Competitive interaction may occur between rainbow and bull trout juveniles for limited food and space, but potential impacts are not known. Watson and Hillman (1997) found that bull trout distribution is negatively correlated with rainbow trout distribution, even in drainages where rainbow trout are native. Pratt and Huston

(1993) report that rainbow trout in the Clark Fork/Pend Oreille drainage seem to use lower reaches of streams occupied by bull trout, while bull trout nursery areas generally lie higher in the watershed. Because bull trout and rainbow trout have coexisted in Lake Pend Oreille tributaries for many decades and because changes in bull trout abundance in the Lightning Creek basin appear to be independent of rainbow trout abundance, the Panhandle Bull Trout Technical Advisory Team (PBTTAT 1998a) did not consider rainbow trout to be a significant threat to bull trout in the Lightning Creek complex. In February 2000, the Idaho Fish and Game Commission took the unusual step of issuing emergency regulation changes for Lake Pend Oreille and the lower Clark Fork River to conserve kokanee salmon and encourage harvest of Kamloops rainbow trout, with the intent to prevent a collapse of the weak kokanee salmon population (IDFG, *in litt*., 2000). This action, if successful in reducing the Kamloops rainbow trout, could benefit bull trout.

In 1925, the U.S. Fish Commission stocked 100,000 lake trout into Lake Pend Oreille and its tributaries (Pratt and Huston 1993), and lake trout may also have migrated downstream of Flathead Lake, where they were introduced 20 years earlier. Lake trout are firmly established in Lake Pend Oreille, but impacts on bull trout populations are not known. A 1997 to 1998 study by the University of Idaho to assess population size of lake trout and other salmonid predators in Lake Pend Oreille indicated that approximately 2,000 lake trout with fork length over 30 centimeters (16 inches) were in Lake Pend Oreille (Vidergar 2000). However, estimates for lake trout harvested from Lake Pend Oreille in 2000, based on more recent creel survey data, were over 4,000, and managers are concerned that lake trout populations are rapidly expanding (Corsi, *in litt.*, 2001). The fisheries managers of the Idaho Department of Fish and Game have proposed experimental lake trout suppression through liberal angler harvest (bag limits on lake trout in Lake Pend Oreille were recently removed) and have also proposed trap netting as one way to protect bull trout and restore the kokanee salmon forage base (Corsi, *in litt.*, 2001). Lake trout may prey opportunistically on juvenile bull trout, but bull trout were found to make up only 1.5 percent of the diet in a sample of 242 lake trout stomachs examined (Vidergar 2000). Kokanee salmon made up 87.4 percent of the lake trout diet, and rainbow trout made up 5.5 percent in that study.

Replacement of bull trout by lake trout has occurred in other lakes where lake trout have been introduced (Donald and Alger 1993). In Lake Pend Oreille, as in Flathead and Priest Lakes, the presence of *Mysis* shrimp (*Mysis relicta*), an important forage item for lake trout, may provide lake trout with an additional competitive advantage.

It is possible that the relative abundance of kokanee salmon in Lake Pend Oreille previously enabled bull trout to compete with lake trout and, therefore, that kokanee abundance helps prevent a rapid decline in the bull trout populations (PBTTAT 1998a). Most lakes where bull trout are declining do not have an abundance of prey species such as kokanee salmon (Bowles *et al.* 1991; Donald and Alger 1993). An introduced species, kokanee salmon are important prey for bull trout, lake trout, and the lake's other top-level predator, Gerrard rainbow trout. Kokanee salmon populations have been in decline since the 1960's, following the construction of Albeni Falls and Cabinet Gorge Dams and the introduction of *Mysis* shrimp. Ongoing investigations by the University of Idaho and the Idaho Department of Fish and Game are examining the impacts of winter drawdown of the lake by Albeni Falls Dam. Currently, the lake is being held at a higher level through the winter to provide more suitable spawning habitat for kokanee salmon. Continued decline of the kokanee salmon population could lead to competition, or more intense competition, among bull trout and other predators and causes concern for the bull trout population, as well for the fishery in general.

The Pack River supports spawning, rearing, and multiple age classes of brook trout. Densities of brook trout are expected to be high in some reaches, but this expectation needs to be verified with updated information. Snorkelers observed large brook trout, up to 46 centimeters (18 inches) long, in middle reaches of the Pack River mainstem (PBTTAT 1998a). Although no genetic work has been done, the presence of larger brook trout could increase the potential for hybridization. Degraded habitat conditions in this stream may give brook trout a competitive advantage over other salmonid species, an advantage described by Fausch (1988) for other streams. Genetics work in the Pend Oreille watershed so far has identified brook trout x bull trout hybrids in Porcupine Creek, and fish believed to be brook trout x bull trout hybrids have been noted in North Fork Grouse Creek (PBTTAT 1998a).

Lake whitefish and Arctic grayling were also stocked into Lake Pend Oreille. Grayling were never documented in catch records, but lake whitefish became established and are still present today. *Mysis* shrimp were planted in Lake Pend Oreille in 1966 by the Idaho Department of Fish and Game to provide additional forage for kokanee salmon in Lake Pend Oreille. *Mysis* shrimp were stocked after fishery managers received favorable reports from British Columbia that kokanee salmon grew rapidly and attained large size in Kootenay Lake by feeding on introduced *Mysis* shrimp. In Lake Pend Oreille, *Mysis* shrimp negatively impact survival of fry of kokanee salmon (PBTTAT 1998a) and may aid the growth and survival of lake trout.

Pratt and Huston (1993) summarized the use of artificially propagated bull trout in the lower Clark Fork/Pend Oreille system. During 1949 and 1950, bull trout eggs were collected from tributaries to the lower Clark Fork River in Montana. The Idaho Department of Fish and Game raised a portion of these eggs in hatcheries at Clark Fork, Montana, and McCall, Idaho. In 1952, approximately 9,700 juvenile fish from the program were released into Spring Creek and the lower Clark Fork River in Idaho. Spring Creek does not currently support bull trout, and the introduction does not appear to have been successful.

In 1966, hatchery-reared Dolly Varden from Alaska were introduced in some tributaries to Lake Pend Oreille (J. Mallet, Idaho Department of Fish and Game, as cited in Pratt and Huston 1993, p. 65–66), but this introduction was not believed to be successful (PBTTAT 1998a). Additional introductions from brood stock originating from the Alaska fish probably occurred into the mid-1970's. To date, genetic evaluations have not shown a Dolly Varden influence on pure bull trout stocks in Lake Pend Oreille (Pratt and Huston 1993; Spruell and Allendorf 1998). More recently (1991), a limited number of bull trout from the lower Clark Fork River and Gold Creek were artificially spawned. Progeny from these fish were marked with a fin clip and released in 1993 into mountain lakes in the Pend Oreille basin and into Lake Pend Oreille (PBTTAT 1998a). The success of these programs is unknown because no marked fish have been recovered, though not all assessments have been completed. Currently, there is no stocking of hatchery-reared bull trout in the Pend Oreille drainage.

A kokanee salmon trap on Sullivan Springs is operated by the Idaho Department of Fish and Game as an egg collection station for kokanee salmon. The trap consists of two picket weirs isolating a section of stream about 14 meters (45 feet) long. In some years, bull trout spawn in this area before the weir is installed (in 1997, three redds were counted in the trap area). In November and December, thousands of kokanee salmon enter the trap, where they are collected and spawned. Disturbance or loss of bull trout redds in the trap area may occur as a result of activity associated with kokanee salmon spawning (PBTTAT 1998a). In 1999, the Idaho Department of Fish and Game began implementing corrective measures.

Lake Pend Oreille supports a significant fishery. In 1991, anglers expended an estimated 465,000 hours fishing the lake, with approximately 65 percent of the effort targeting trout and 35 percent targeting kokanee salmon (PBTTAT 1998a). Bull trout comprised a relatively small percentage of the trout harvest, but provided trophy-sized fish. The world record bull trout, weighing 14.5 kilograms (32 pounds) was taken from Lake Pend Oreille in 1949. The portions of the lake that are within a 91-meter (100-yard) radius of the mouths of tributary streams have the same seasons and regulations as the streams to provide additional protection to bull trout. On January 1, 1996, the Idaho Department of Fish and Game closed Lake Pend Oreille and the Clark Fork River to harvest of bull trout (PBTTAT 1998a). Harvest of bull trout had been closed in all other tributary streams in Lake Pend Oreille in 1964. Although seasons for harvest have been closed, misidentification of bull trout, often as brook trout or lake trout, can result in incidental harvest (Schmetterling and Long 1999).

Poaching has long been recognized as a problem in the lower Clark Fork/Pend Oreille basin and remains a problem in some watersheds, with peak activity occurring in July, August, and September when large fish are in tributaries and are easily taken (Long 1997). Bull trout spawners from Lake Pend Oreille are particularly vulnerable to poaching because they often enter small tributary streams several months prior to spawning and congregate in pools. In some watersheds, such as Pack River and Lightning Creek, extensive road systems provide easy access to prime spawning areas (PBTTAT 1998a). Poaching is known to occur in Gold Creek as individuals generally target the same pools each year.

Hooking mortality from catch-and-release fishing is most likely to occur in Lake Pend Oreille during the summer, when surface temperatures are warm and fish are caught from deeper water. Past creel surveys have shown that catch rates and catch of bull trout are typically highest in late spring and early fall, with declines during mid-summer. Increased interest in lake trout fishing during mid-summer may increase the number of bull trout that are caught and subjected to potential hooking mortality. Currently, there is no estimate of hooking mortality for bull trout caught from the lake.

Flathead Recovery Subunit

In Flathead Lake, bull trout coexist with 23 other fish species, only 10 of which are native (MBTSG 1995c). The introduced fish species found in the Flathead River basin include Yellowstone cutthroat trout, brook trout, brown trout, rainbow trout, lake trout, Arctic grayling, kokanee salmon, lake whitefish, largemouth bass, northern pike, yellow perch, pumpkinseed, brook stickleback, central mudminnow, and black bullhead. Individual walleye, apparently from illegal transplants, have been found in the Flathead River drainage. To date, however, walleye are not known to have established reproducing populations. *Mysis relicta* occurs, as an introduced species, throughout the drainage.

Brook trout pose a threat to bull trout in some tributaries of the Middle Fork Flathead River, although hybridization has not been documented to date. Brook trout have not been found in tributaries of North Fork Flathead River (MBTSG 1995c).

Because of competition and hybridization, the introduced species that presents the greatest existing risk to bull trout in the Swan River drainage is the brook trout (MBTSG 1996b). Recent genetic data (Kanda *et al.* 1994) and observations from Squeezer Creek within the Swan River drainage (Kitano *et al.* 1994) indicate that large, spawning, migratory bull trout mate with smaller brook trout, producing hybrid offspring. Hybrids have been observed in several of the primary bull trout nursery streams. Hybridized offspring are typically sterile (Leary *et al.* 1983).

Brook trout are widely dispersed throughout the Swan River drainage. Leathe and Enk (1985) reported brook trout presence in 40 of 74 tributary stream reaches surveyed. Brook trout were the most abundant species in low-gradient reaches.

Degraded habitat conditions appear to favor brook trout over westslope cutthroat trout in stream reaches where channel gradient is 6 percent or less (Leathe and Enk 1985). There are no bull trout streams in the Swan River drainage that do not contain resident brook trout populations.

In 1999, a reproducing population of brown trout was documented in the Flathead River basin upstream of Kerr Dam for the first time. At least two year classes of naturally produced juvenile fish and several large adults were electrofished from a short reach of Mill Creek, a spring-fed tributary to the Flathead River just upstream of Flathead Lake. Since Creston National Fish Hatchery is located on the upper end of Mill Creek, the likely source of the brown trout is escapement from a population held at the hatchery in the early 1980's (Leary 2000). State and Federal fishery managers are attempting control actions to eradicate this population before it spreads.

Lake trout were introduced into Flathead Lake in 1905 (Spencer *et al.* 1991) and produced a limited, but trophy fishery for most of the 20th century. However, with the establishment of *Mysis* shrimp in Flathead Lake, first discovered in 1981, lake trout populations underwent a dramatic expansion. Estimated angler harvest of lake trout currently exceeds 40,000 fish annually (MFWP/CSKT 2000), and the population number is much higher, though not currently quantified.

With the increase in the lake trout population, subadult lake trout became common in the river systems connected to Flathead Lake. Their presence has been documented as far upstream as Bear Creek on the Middle Fork Flathead River (160 kilometers [100 miles] upstream of the lake) and beyond the Canadian border on the North Fork Flathead River (183 kilometers [114 miles] upstream of the lake). One lake trout with a radio tag traveled up and down the North Fork Flathead River, forayed into the Middle Fork Flathead River drainage, and then swam down the mainstem Flathead River toward Flathead Lake before being caught by an angler, all within a period of a few months (Muhlfeld *et al.* 2000). In an assessment of the seasonal distribution and movement of native and nonnative fishes in the Flathead River system upstream of Flathead Lake, Muhlfeld *et al.* (2000) documented spatial and temporal overlap of juvenile bull trout and westslope cutthroat trout with nonnative lake trout and northern pike. They concluded that this overlap may increase the probability of predation on the native salmonids migrating downstream to Flathead Lake. Muhlfeld *et al.* (2000) also suggest that lake trout migration in the Flathead River system is at least partially a temperature-induced response, with the river habitat not preferred as water temperatures exceed 10 degrees Celsius (50 degrees Fahrenheit) and probably unsuitable as temperatures approach 15 dgrees Celsius (59 degrees Fahrenheit).

Lake trout have been documented as preying on young bull trout and cutthroat in Flathead Lake. Deleray *et al.* (1999) examined 449 lake trout stomachs collected in 1996. Combined diet information indicated that 99 percent of the diet (by weight) was fish and that over three-fourths of the biomass consumed was lake whitefish. Insects, *Mysis* shrimp, and other noninvertebrates comprised only 1 percent of the diet, but made up a higher percentage of the diet in small lake trout (under 500 millimeters [20 inches]). Information on predator food habits was also collected for lake trout (and northern pikeminnow) in the Flathead River (Zollweg 1998). All of these studies indicate a low incidence of trout and char in lake trout diets. However, because of their high abundance, predator populations probably impose a significant source of mortality for species such as bull trout and westslope cutthroat trout (Deleray *et al.* 1999). Additional lake trout food habits data are being analyzed.

Of 27 natural lakes in the Flathead Recovery Subunit known to have contained native populations of bull trout, 11 (41 percent) now contain lake trout (Fredenberg 2000). Three of these lake trout populations resulted from government stocking programs (Flathead Lake in 1905, Whitefish Lake in 1941, Tally Lake in 1985), but the rest apparently resulted from unauthorized stocking or natural invasion. Lake trout have now been detected or reported in each of the watershed's 8 natural lakes that cover more than 404 surface hectares (1,000 surface acres); lake trout inhabit lentic habitat that covers over 57,500 total surface hectares (142,000 acres) (Fredenberg 2000). The remaining lakes, or the bull trout lakes that are not believed to contain lake trout, together occupy only 1,800 surface hectares (4,500 surface acres).

The introduction of lake trout is suspected as the primary factor contributing to the decline of bull trout in several lakes in Glacier National Park (*e.g.*, McDonald, Kintla, Bowman, and Logging Lakes) (Fredenberg 2000). Similarly, the introduction of lake trout and/or brook trout is suspected of playing a role in the extirpation of bull trout from seven lakes in southern Canada (Donald and Stelfox 1997).

Donald and Alger (1993), in their study of 34 Rocky Mountain lakes in Montana, Alberta, and British Columbia, concluded that lake trout can limit the distribution and abundance of bull trout in mountain lakes. They stated that lacustrine populations of bull trout usually cannot be maintained if lake trout are introduced. Evidence that lake trout is the dominant species include 1) displacement of indigenous bull trout populations by introduced lake trout, 2) unsuccessful "natural" colonization by bull trout of suitable low-elevation lakes that support lake trout, and 3) relatively high mortality of sympatric bull trout populations. Bull trout and lake trout exhibited substantial niche overlap with respect to food utilization and their growth, an overlap suggesting that competition may contribute to the disjunct distribution of these species (Donald and Alger 1993).

A scientific advisory team that was convened in 1997 by Montana Fish, Wildlife and Parks and the Confederated Salish and Kootenai Tribes concluded that "Lake trout have come to dominate the fish community of Flathead Lake since the introduction of the opossum shrimp, and now represent the greatest obstacle to restoring the bull trout population. The panel concluded that the lake trout population has to be reduced by 70 to 90 percent from present levels if bull trout are to return to population levels of the 1980's " (McIntyre 1998). In spring 2000, a citizens' advisory committee was convened by Montana Fish, Wildlife and Parks and the Confederated Salish and Kootenai Tribes to recommend management alternatives for Flathead Lake and the Flathead River system. Using that panel's recommendations and other input, the management agencies adopted a Flathead Lake and River Fisheries Co-Management Plan in November 2000. The goals of the 10-year plan are to 1) increase and protect native trout populations, 2) maintain a viable recreational/subsistence fishery, and 3) protect habitat and water quality (MFWP/CSKT 2000). Implementation of strategies identified in the plan is now underway.

Mysis shrimp were stocked by Montana Fish, Wildlife and Parks in Whitefish, Tally, and Ashley Lakes in the Flathead drainage in 1968 and in Swan and Holland Lakes in the Swan drainage in 1975 (Rumsey 1988). The shrimp apparently drifted downstream into Flathead Lake from one or more of these sources and were first collected there in fall 1981 (Leathe and Graham 1982). The inadvertent introduction of these shrimp into Flathead Lake resulted in major changes in the lake's food web, including the abrupt loss of kokanee salmon, and is believed to have facilitated the increase in lake trout numbers (Spencer *et al.* 1991).

The presence of *Mysis* shrimp generally benefits deep-dwelling fish species by providing a food source, but the shrimp may impact planktivorous fish by reducing the available crustacean zooplankton (Nesler and Bergersen 1991). Many lakes with established *Mysis* shrimp populations have experienced a decline or, in some cases, complete loss of kokanee salmon. However, kokanee salmon have persisted in Swan Lake in spite of the presence of *Mysis* shrimp. Some kokanee salmon use *Mysis* shrimp as a food source, particularly during winter months (MBTSG 1996b). Bull trout in Swan Lake also use *Mysis* shrimp as a significant source of food, and the shrimp may result in improved growth and survival of subadults. Stomach samples from bull trout collected by gill-netting in 1988 and 1995 showed that, in both years, 67 percent of samples with food present contained *Mysis* shrimp (MBTSG 1996b). At this time, the presence of *Mysis* shrimp in Swan Lake does not appear to be detrimental to bull trout and may, in fact, benefit bull trout by providing an important source of food.

It is noteworthy that Swan Lake does not have an established lake trout population, although a single specimen was caught from the river upstream of Swan Lake in 1998 and two more adult-sized fish were verified from the lake in 1999 (Fredenberg, *in litt*., 1999). Additional specimens have since been caught. The Montana Bull Trout Scientific Group reported that the greatest future threat to maintaining the bull trout populations of Swan Lake was the potential introduction of lake trout (MBTSG 1996b). Swan Lake appears to have suitable habitat for lake trout, and the food web, including abundant *Mysis* shrimp and kokanee salmon food sources, may provide the opportunity for the lake trout population to expand rapidly. Swan Lake already contains populations of illegally introduced northern pike, yellow perch, largemouth bass, brook stickleback, and central mudminnow. The threat of lake trout to the integrity of the strongest remaining natural bull trout population in Montana should not be underestimated.

Of the other introduced species established in the Flathead Recovery Subunit, the northern pike is the one of most concern, and it is now widely distributed. A single illegal introduction of pike into Echo Lake in the late 1960's led to widespread illegal introductions throughout northwest Montana. An evaluation of the ecology and food habits of pike in the Flathead River upstream of Flathead Lake is currently underway (Muhlfeld *et al.* 2000). Preliminary results show that pike are fairly mobile, with some individuals moving seasonally and temporally between sloughs and throughout the system (MFWP/CSKT 2000). Biologists are attempting to collect a representative set of stomach samples to further assess the potential interaction of this species with salmonids. Preliminary analysis of pike stomachs from the Flathead River and associated sloughs has found that bull trout may be seasonally significant in the diet, comprising as much as 84 percent of the biomass in one sample period (Muhlfeld, *in litt.*, 2001). Pike and lake trout have both become well established in the Stillwater Lakes, providing little hope for bull trout recovery in those lakes, although a bull trout population is hanging on in the river upstream. Pike are established in Flathead, Tally, Whitefish, and Swan Lakes. Impacts of pike in these systems are unknown.

Hatchery stocking with nonnative fish has been extensive in lakes throughout the Swan River drainage (MBTSG 1996b). From the mid-1920's through the mid-1980's, "undesignated" cutthroat trout (probably Yellowstone cutthroat) were planted in Swan, Holland, and Lindbergh Lakes. Rainbow trout were also introduced in these three lakes, beginning in the mid-1920's. After 1966, Montana Fish, Wildlife and Parks discontinued these plants. Beginning in the late 1980's, Montana Fish, Wildlife and Parks stocked pure-strain westslope cutthroat trout in these three large lakes. Although not known to directly threaten bull trout, the plants of Yellowstone cutthroat and rainbow trout have adversely affected native cutthroat trout and may have had indirect or unknown impacts on bull trout (MBTSG 1996b).

Similar stocking practices occurred in the lakes of Glacier National Park. The emphasis on producing a fishery to attract anglers was a driving force of the park management in the early days. And, in fact, Creston National Fish Hatchery, built in 1939 and 1940, was originally a National Park Service facility, and the enabling legislation for the hatchery required that all fish reared there be stocked in waters of

Glacier National Park (Fredenberg 1997). In 1944, the hatchery was transferred to the U.S. Fish and Wildlife Service.

Kokanee salmon stocking in Lindbergh Lake began in 1944, and this program continues today (MBTSG 1996b). Coho salmon were planted in Lindbergh Lake in 1948. Kokanee salmon were first planted in Holland Lake in 1951. Because natural reproduction of kokanee salmon in the lake is limited, this fishery is still maintained by stocking of the salmon. Swan Lake never received kokanee salmon plants, but a substantial shoreline spawning population developed, probably due to downstream drift from Lindbergh and/or Holland Lakes. Also, kokanee salmon from Flathead Lake may have moved upstream to Swan Lake over the Bigfork Dam fish ladder after 1959.

Nearly 80 high mountain lakes exist in the Swan River drainage (MBTSG 1996b). Many of these lakes have been stocked with rainbow and/or cutthroat trout, both Yellowstone and westslope. Currently, only westslope cutthroat trout are stocked. Twenty-five other valley floor lakes in the Swan River drainage are managed fisheries, with most being stocked. In lakes with outlets to the river, management emphasis is directed to native westslope cutthroat trout. In some isolated water bodies or closed basins, rainbow trout have been, and may continue to be, stocked.

Stocking of fish in the Swan River and its tributaries has also been extensive (MBTSG 1996b). Brook trout were the earliest introductions, beginning in 1926 and extending until 1950. Although only six tributaries were known to have been stocked during that period, brook trout are now widely distributed. Cutthroat and rainbow trout were also stocked into tributary streams, and rainbow trout stocking also occurred directly in the Swan River. After 1968, the stocking of tributaries was largely discontinued.

Hungry Horse Dam, which is an isolating mechanism for the watershed upstream of it, could be considered a positive contribution to the fishery resource because of preventing the natural spread of introduced species upstream (MBTSG 1995d). At the present time, only a few small populations of rainbow trout, Yellowstone cutthroat trout, hybrid cutthroat trout, and Arctic grayling exist in the

South Fork Flathead River watershed. In the future, this barrier could become even more valuable as introduced species of fish continue to disperse throughout the mainstem Flathead River drainage. Montana Fish, Wildlife and Parks has made a commitment to manage the South Fork Flathead River and Hungry Horse Reservoir for native species (MFWP 1997b)

The problems created for native species by illegal fish introductions in the Flathead River basin are increasingly severe (MBTSG 1995c). These illegal introductions are not subjected to any environmental analysis, are almost always detrimental to native species, generally involve warmwater species (bass, perch, pike, and walleye) and/or nongame species (*e.g.*, minnows and bullheads), and are usually irreversible. In part, agency stocking efforts of the past have contributed to this problem of introduced species by providing closer sources of many of these species for transplant stock. This problem has been manifested mainly in lakes, perhaps because introductions in lakes have been more successful than those elsewhere, and is currently out of control in the Flathead River basin. Montana Fish, Wildlife and Parks has documented 220 illegal introductions in the northwest portion of the State that involve 122 different waters, with most of the introductions occurring in the past 20 years. Despite stepped-up educational and enforcement efforts, the problem has only worsened (Vashro, *in litt.*, 2000).

Flathead Lake and the Flathead River receive substantial angling pressure. Approximately 47,000 to 53,000 angler days per year are expended on the lake (Evarts *et al.* 1994, MFWP 2000a), and an estimated 31,223 angler days were spent in 1999 on the mainstem Flathead River upstream of the lake (MFWP 2000a). In addition, an estimated 5,352 angler days were spent in 1999 on the Middle Fork Flathead River and 6,590 angler days on the North Fork Flathead River (MFWP 2000a). Recent trends in angler use on the Flathead River system have been relatively stable (MFWP 2000a) as have recent use trends for the Flathead Lake fishery since a decline in use followed the collapse of the kokanee salmon fishery in the late 1980's (Evarts *et al.* 1994).

In 1999, anglers also expended an estimated 7,568 days fishing Hungry Horse Reservoir and 11,488 days fishing the South Fork Flathead River (MFWP 2000a).

Estimated angling pressure on Swan Lake in 1999 was 12,716 angler days (MFWP 2000a). On the Swan River, anglers expended an estimated 16,319 angler days in 1999 (MFWP 2000a).

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

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

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

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

Hungry Horse Reservoir remained open to bull trout harvest until March 1995, when it was closed due to concern about the impact of deep reservoir drawdowns on the fish community. The Montana Bull Trout Scientific Group estimated that roughly 100 to 250 bull trout were harvested annually in Hungry Horse Reservoir between 1985 and 1993 (MBTSG 1995d). The most recent estimate of harvest was that anglers removed less than 10 percent of the adult population of bull trout from the reservoir in 1993 (MBTSG 1995d). Montana Fish, Wildlife and Parks has interpreted the data as indicating a stable trend in bull trout numbers in the South Fork Flathead River since the dam was built in the 1950's, and the agency has opened discussions with the U.S. Fish and Wildlife Service to explore options for reopening the fishery to angling, with the possibility of allowing some controlled harvest (MFWP 2000b). The potential for illegal introduction by anglers wishing to supplement their potential harvest remains a major concern in this drainage (MBTSG 1995d).

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

Risks to bull trout from biological sampling have been minimal in past years, but may increase as more research and management activities occur. The number of research projects is increasing, and some projects involve invasive procedures. Risk due to electrofishing injury is unquantified for bull trout, but evidence suggests that most large trout are susceptible to electrofishing injury. As a result of research by the Montana Fish, Wildlife and Parks on the impact of electrofishing on fish, electrofishing techniques and equipment have been modified to minimize that risk. Also, a Montana Fish, Wildlife and Parks policy limits the use of electrofishing in waters that contain species of concern.

Priest Recovery Subunit

Bull trout are the only char species native to Priest Lake and the Priest River drainage. Brook trout are widely distributed throughout much of the historical range of bull trout in the Priest River watershed, including portions of nearly all spawning and rearing streams (PBTTAT 1998b). Lake trout are dispersed throughout the lakes, the Thorofare, and occasionally in the lower Priest River. Brown trout also occur in the lower Priest River and the East River.

Brook trout populations appear to be increasing in the system, particularly in tributaries on the west side of Priest Lake and the Upper Priest River. The tributaries west of Priest Lake have high sediment loads (due partially to geology) and generally fewer bull trout (PBTTAT 1998b). Finclips from 118 bull trout that were collected during 1997 to 1999 in the Upper Priest River drainage, including the lake and eight tributaries, are awaiting analysis to determine whether hybridization with brook trout is occurring and to assess the genetic attributes of the population(s) (Fredericks and Venard 2000).

Lake trout were introduced into Priest Lake by the U.S. Fish Commission in 1925. With the introduction of *Mysis* shrimp in the 1960's, the population expanded dramatically, all but eliminating kokanee salmon and bull trout from the lake by the early 1980's. Fishery managers attempted a variety of methods to restore a diverse fishery, including stocking nonnative rainbow trout and Yellowstone cutthroat and producing westslope cutthroat in net pens, but none of the efforts yielded adequate returns to the fishery to justify continuing the programs. Lake trout now provide the only significant fishery in Priest Lake, and bull trout have been reduced to remnant status. Regulations for lake trout allow a two-fish limit for any size fish. There is some indication that the lake trout population in Priest Lake is expanding, including the fact that they are pioneering upstream into new waters (PBTTAT 1998b).

Lake trout have been present in Upper Priest Lake for over a decade, but have increased at an alarming rate during recent years (PBTTAT 1998b). *Mysis* shrimp are present in both lakes, having been introduced in the 1960's. In 1997, the Idaho Department of Fish and Game conducted an intensive survey in Upper Priest Lake to assess lake trout population and bull trout abundance and to evaluate the feasibility of removing lake trout (Fredericks 1999). This survey confirmed the presence of a well-established lake trout population. The size distribution of lake trout depicted a relatively young and expanding population. The collection of numerous juvenile lake trout suggested that they are reproducing successfully in Upper Priest Lake (Fredericks 1999). Movement of sonic- and spaghetti-tagged lake trout demonstrated that migration between Upper Priest Lake and Priest Lake is common.

In 1998, the Idaho Department of Fish and Game removed 912 lake trout from Upper Priest Lake by gill-netting (Fredericks and Venard 2000). In 1999, an additional 321 lake trout were removed. Ratios of bull trout to lake trout were similar in both years (about 5:100). However, return rates of tagged fish provided a clear indication that interchange of lake trout between the two lakes is common and that the upper lake cannot be treated as a closed system. Lake trout reduction in Upper Priest Lake is the most viable option for protecting and restoring the Upper Priest Lake bull trout population, but such reduction is unlikely to succeed unless a method can be established to control lake trout immigration through the Thorofare. Initial indications are that lake trout move through the area primarily at night, and mostly in the fall, although winter and spring periods were not sampled. Options to reduce lake trout movement are complicated by the strong public sentiment against obstructing free boat passage between the lakes. Further study will focus on seasonal and 24-hour use patterns of the Thorofare by lake trout and native fish species, with an eye toward developing alternatives to control fish migration (Fredericks and Venard 2000). An alternative strategy of suppressing lake trout in Priest Lake to reduce pioneering migrations into Upper Priest Lake is also being examined.

Upper Priest Lake has been managed as a catch-and-release fishery since 1994, with barbless hooks required and no bait allowed. Much of the fishing in the lake is associated with inexperienced anglers, who may be less able to identify bull trout and therefore more likely to keep bull trout than more experienced fishermen may be. Illegal harvest is an issue in the Priest River watershed, but the impact is largely unquantified.

Current management direction is to continue the existing lake trout fishery in Priest Lake and to attempt to maintain Upper Priest Lake as a refuge for native species. However, the latter lake is being seriously compromised by the increasing brook trout populations and the influx of lake trout. The current adult population of bull trout in Upper Priest Lake is estimated to be fewer than 200 fish (Corsi, *in litt.*, 2001). The existing studies should identify some of the biological factors associated with the feasibility of controlling lake trout, and the Idaho Department of Fish and Game has submitted a proposal to the Bonneville Power Administration for funding of a lake trout removal program, which would be combined with efforts to develop a migration barrier in the Thorofare (Corsi, *in litt.*, 2001).

If bull trout in Upper Priest Lake can be protected and restored, options for eventually restoring bull trout in Priest Lake may remain viable. But if bull trout are extirpated in Upper Priest Lake, successfully restoring the species to this core area is doubtful. The recently approved Idaho Department of Fish and Game five-year fisheries management plan for the Pend Oreille River drainage (including the Priest Lakes system) has an objective of restoring a fishable population of bull trout in Upper Priest Lake, an objective to be accomplished by programs to disrupt lake trout immigration through the Thorofare and to actively suppress lake trout. The Idaho Department of Fish and Game also proposes a significant reduction in lake trout in main Priest Lake with an objective of restoring a "more traditional fishery" based on native species, primarily bull trout and westslope cutthroat trout, with a yield fishery for kokanee salmon (IDFG 2001).

Summary (Fisheries Management)

Of all the threats to bull trout recovery, the expanding presence of nonnative species may prove to be the most intractable. In particular, expansion of congeneric lake trout and brook trout is of greatest concern for bull trout recovery in the Clark Fork Recovery Unit. Scientists currently have limited tools available to deal with these intruders, and, in many cases, there is strong public opposition to controlling or eliminating other salmonids that provide sport fisheries. The impact of introductions of nonnative species, which are essentially “biological pollutants,” in most cases may be permanent. While the status of stream habitat for bull trout in many watersheds throughout the Recovery Unit has had an improving trend, the effects of nonnative species introductions, particularly in large lakes, may permanently reduce the capacity of these waters to support bull trout. This issue ranks as one of the highest priorities for expenditure of research, education, and enforcement dollars. Angling regulations in most waters have gone as far as they can to protect native species, short of completely closing angling to further reduce the take that occurs from hooking mortality and species misidentification. A key to successful bull trout restoration is educating both anglers and the nonangling public about the values of native species. Anglers and the management agencies must be convinced to sacrifice short-term satisfaction for long-term gains to native species populations. Intact native fish ecosystems are increasingly rare, and we must allocate substantial resources to protecting and restoring those that remain.

Isolation and Habitat Fragmentation

Upper Clark Fork Recovery Subunit

Several elements determine the degree of threat that is posed by the isolation and fragmentation of bull trout habitat. One is the likelihood of catastrophic events occurring, along with the relative frequency, intensity, timing, and location of such catastrophes. We must consider natural calamities such as fire, flood, and landslides (which can be exacerbated by mans activities), as well as man-caused catastrophes such as pollution or introduction of exotic diseases or organisms. For example, whirling disease has recently been introduced to numerous waters where bull trout are found. While not believed to pose an immediate threat to bull trout populations, whirling disease is spreading in streams such as the Blackfoot River (Pierce and Podner 2000), with uncertain effects. The population level consequences to bull trout of any catastrophe will depend on the extent and quality of the habitat; the distribution, abundance, and genetic variability of the population (adaptability); and other factors. Therefore, the larger and more interconnected the system is, the more likely that the bull trout population will survive catastrophic events or that it will be able to recolonize from other sources following a catastrophe. For these reasons, this recovery plan places a high level of importance on the interconnectivity of bull trout populations.

In the upper Clark Fork and Bitterroot River drainages, fire, flood and drought are more likely to occur than landslides or rain-on-snow events. The intense fire season of 2000 burned a substantial portion of the upper Bitterroot River drainage. “Rain-on-snow” is a common term used to describe cloudy weather periods when warm winds and rain combine to produce rapid snowmelt. These events generally occur during early to mid-winter periods. Human activities have increased the chances of some of these events occurring. However, these events are of concern to bull trout recovery primarily because local bull trout populations are fragmented. Even Rock Creek and the Blackfoot River, both of which retain habitat connectivity within their tributaries, are disconnected from the mainstem Clark Fork River and Lake Pend Oreille by Milltown Dam and the series of dams downstream. Under current conditions, if a catastrophic event were to cause a localized or widespread extirpation of populations, the opportunity for the fish to naturally recolonize the habitat from downstream or adjacent watersheds is extremely limited.

Disruption of migratory corridors probably leads to the loss of the migratory life history form (Nelson 1999), and resident stocks living upstream of barriers are at an increased risk of extinction (Rieman and McIntyre 1993). Restoration of the migratory life history form is needed for the long-term persistence of bull trout in many portions of the upper Clark Fork River drainage.

If a local population is small enough, random genetic variation among individuals can lead to long-term declines in fitness, and the local population may go extinct. As a local population is restricted in abundance, or as the variation in its birth rate or survival increases, the predicted mean time to extinction will decrease (Rieman and McIntyre 1993).

The Montana Bull Trout Scientific Group judged that the risk of extirpation is high for local populations of bull trout in the core areas of the upper Clark Fork River basin and in the Bitterroot River basin (MBTSG 1995a, 1995e). This high risk is partly because of habitat isolation and fragmentation and low population abundance. The risks to bull trout in the Blackfoot River and Rock Creek are somewhat lower because of greater degree of habitat connectivity and the presence of more robust populations (MBTSG 1995b, 1995e). However, bull trout densities are generally low throughout the upper Blackfoot River tributary system (MBTSG 1995b), with the exception of Copper Creek (Pierce and Podner 2000). Telemetry studies have indicated that bull trout from the lower portion of the Blackfoot River drainage did not migrate to the upper drainage and that separate local populations may occur (Swanberg 1997). Even systems that appear to be functionally connected, such as the Blackfoot River system, may have long reaches where poor water quality, degraded habitat, or other factors result in fragmentation of bull trout populations. In 1999, electrofishing of nearly 6.5 kilometers (4 miles) of the upper Blackfoot River (upstream of the North Fork) resulted in the capture of only three bull trout. The status of bull trout in the upper Blackfoot River remains precarious (Pierce and Podner 2000).

Time series monitoring of local bull trout populations on the Bitterroot National Forest began in 1989, too recently to establish long-term trends. However, available evidence indicates that resident and migratory bull trout are probably continuing to decline from their historical distribution and abundance (MBTSG 1995a). Resident fish are now the predominant life form in the Bitterroot River drainage (Nelson 1999). Migratory fish are rare and are only found in upstream portions of the Bitterroot River and in Painted Rocks Reservoir. For resident fish, the risk varies by location. Some local populations in tributaries on the east side of the valley are at lower risk (adults number in the thousands in some of these tributaries), but in the west-side tributaries local populations are at high risk because of low numbers (MBTSG 1995a).

Lower Clark Fork Recovery Subunit

Prior to hydroelectric development in the lower Clark Fork River drainage, migratory bull trout from the Clark Fork River and Lake Pend Oreille had access to tributary streams both within the lower Clark Fork River drainage and upstream of Thompson Falls Dam (MBTSG 1995e, 1996a, 1996e). Historically, the Clark Fork River was used as a migration corridor between its tributaries and Lake Pend Oreille. Some tributaries within the lower Clark Fork River drainage were used for spawning and rearing. The bull trout biology and life history patterns were probably similar to those currently documented in other tributaries to Lake Pend Oreille or in the Flathead Lake and River system (Fraley and Shepard 1989).

As dams were built, the migratory corridor for spawning bull trout was blocked. Reservoirs upstream of those dams were filled concurrently with chemical treatments being made for rehabilitation, further compounding the loss of bull trout (MBTSG 1996a). Dam construction isolated migratory fish from Lake Pend Oreille from their natal tributaries and created run-of-the-river reservoir habitats behind Cabinet Gorge, Noxon Rapids, and Thompson Falls Dams. The resulting reservoir habitats are not adequate substitutes for Lake Pend Oreille. Currently, the tributary spawning and rearing habitats still exist (although degraded), but foraging, migrating, and overwintering habitats for migratory adult and subadult fish have changed significantly. Over time, the fish expressing the migratory life history pattern were largely replaced by fish that expressed the resident life form in the tributaries. These changes have occurred over a period dating back nearly a century (Thompson Falls Dam was built in 1913).

The shift from larger, more migratory adfluvial populations to smaller, more isolated migratory and resident populations in the lower Clark Fork River has dramatically increased the likelihood of extirpation for a given stock (MBTSG 1996a). Resident bull trout are typically smaller in body size than their migratory counterparts. Because fecundity is related to size, the migratory strategy can confer an adaptive strategy by increasing reproductive potential. In productive environments, migratory forms should dominate resident forms and should be more resilient and more resistant to environmental variation and stressors (Rieman and McIntyre 1993). In addition, migratory fish are more likely to stray between streams than resident fish, a behavior that provides for genetic exchange and higher chances of refounding locally extinct populations. In their study of demographic requirements for bull trout, Rieman and McIntyre (1993) concluded that maintenance of the migratory life history form is necessary for the long-term survival of the species.

The processes of extinction do not operate independently (MBTSG 1996a). For example, habitat changes that stress or isolate population segments, and therefore reduce abundance, may increase the local population’s susceptibility to other risks such as environmental instability or detrimental genetic effects. Low abundance may result in loss of genetic diversity that could reduce fitness and increase sensitivity to environmental variation.

Underlying geology is an important characteristic that influences fish distribution, abundance, and growth (PBTTAT 1998a). Streams on the northern and eastern side of the lower Clark Fork River basin (watersheds in the Cabinet and Bitterroot Mountains) are primarily within the Belt Series bedrock type, meaning that they are underlain by sedimentary deposits of clay, silt, and sand. Streams draining the Selkirk Mountains are in the Kaniksu batholith and are underlain primarily by granite. The basin was substantially altered by major glacial events in the late Pleistocene period. The present Clark Fork River valley was alternately plugged and scoured by dams of ice and deposited debris from glacial Lake Missoula.

As a result of this history, watersheds in the Cabinet Mountains tend to be prone to rapid runoff events, in-channel erosion, and occasional mass wasting (PBTTAT 1998a). Groundwater seeps and springs are also more prevalent in tributaries draining the Cabinet Mountains north of Lake Pend Oreille. These Belt Series streams tend to be more productive and have much less fine sediment than streams draining the granitic soils of the Selkirk Mountains. Granitic soils tend to be nutrient-poor, and fish growth is typically slower in streams flowing from granitic watersheds. Natural waterfalls are found throughout the stream tributaries of the Clark Fork River basin and prevent use of several tributaries, or portions of tributaries, by migratory fish (PBTTAT 1998a).

Forest fires have had a profound impact on vegetation within the Clark Fork River watersheds during the last century. The forest fire of 1910 burned an estimated 1,215,000 hectares (3,000,000 acres) in western Montana and northern Idaho, with the most severely burned areas on the west-southwest flanks of the Clark Fork River valley (PBTTAT 1998a).

Past management activities and successful wildfire control have caused a shift in forest species composition and stocking levels, predisposing forests to large-scale mortality. Drought conditions can further dispose these forests to increased wildfire incidence and intensity, resulting in significant negative impacts on water quality and fish habitat. At least four large wildfires (during 1910, the 1930's, and 1967), and numerous smaller fires, have burned in the lower Clark Fork River watershed in this century (PBTTAT 1998a). Large fires have often left riparian vegetation intact along larger streams, and bull trout have persisted in the basin following large wildfires. However, wildfire may result in short- or longer-term loss of, or reductions in, bull trout use of specific streams or stream reaches. Intense fires may increase natural sediment delivery to streams when hydrophobic soils are created. At the same time, fires can significantly increase recruitment of large woody debris to stream channels. Where post-fire salvage operations have removed woody debris from stream-side areas, or created other disturbances such as roads and fire breaks, impacts to fish may be increased (Rieman and Clayton 1997). Although stream habitat in the most severely burned drainages is recovering from past fires, legacy effects from these fires will continue to lower overall productivity for bull trout in some stream reaches.

Flathead Recovery Subunit

In the Flathead Lake, Swan Lake, and South Fork Flathead River (Hungry Horse Reservoir) core areas, the risk to bull trout from environmental instability is reduced due to the predominance of the migratory life form and the relatively connected habitat remaining for these fish (MBTSG 1995c, 1995d, 1996b). If a natural or human-caused event causes bull trout to be eradicated from a small portion of the basin (local populations), other fish from within the drainage may colonize the vacant habitat. For populations in the core areas centered in smaller lakes, the risks from catastrophic events are higher because the isolation factor and restricted habitat make survival and/or recolonization less likely (MBTSG 1995c). In spite of barriers on the South Fork Flathead and Swan River that have cut off nearly half the watershed, the remaining upper Flathead River (North and Middle Forks) is one of the largest drainages (nearly 200,000 hectares [500,000 acres]) that still maintains good interconnections between spawning and rearing habitat and between the foraging, migrating, and overwintering habitat for migratory fish. There are substantial genetic differences between local populations spawning in the North Fork and Middle Fork Flathead River tributaries that should not be disrupted (Kanda *et al.* 1994).

At present, the Swan River drainage provides habitat for one of the strongest collections of local migratory bull trout populations remaining in the State of Montana (MBTSG 1996b). At least 23 tributaries support some level of juvenile bull trout rearing

(Leathe and Enk 1985). Bull trout spawning occurs in at least 10 tributary drainages. Major spawning and rearing areas in the Swan River drainage are highly groundwater influenced, a condition that reduces the risk from drought conditions.

Evidence of past influence from flooding or rain-on-snow events is seen in several drainages of Flathead River basin tributaries, in large part due to the massive flood in 1964. Problems are particularly evident in the Middle Fork Flathead River watershed (MBTSG 1995c). In the Swan River drainage, channel stability problems have been observed during redd counts of bull trout in Goat, Squeezer, Jim, Piper, Cold, Woodward, and Soup Creeks.

Natural water temperatures over 15.5 degrees Celsius (60 degrees Fahrenheit) occur in the late summer and fall downstream of most lakes in the Flathead River basin; these temperatures deter migratory bull trout spawners from entering these systems from downstream (MBTSG 1995c). These conditions probably serve as natural isolating mechanisms, protecting the genetic adaptations of each core area, but also serving to increase the risk of local extirpation, particularly in some of the smaller systems.

Priest Recovery Subunit

Impact from management activities on the Upper Priest River is relatively low. Natural barriers limit the amount of habitat available to migratory bull trout (PBTTAT 1998b). Malcom Creek has a steep cascade about 0.8 kilometer (0.5 mile) upstream of the mouth that is probably a barrier. Rock Creek has a long rock chute barrier about 1.6 kilometers (1 mile) upstream of the mouth. The upper reaches of Cedar Creek also have bedrock chute barriers. Additional natural barriers occur on Trapper, Caribou, Lion, Two Mouth, Granite, North Fork Granite, and Kalispell Creeks and on the Upper Priest River. Dewatering, due to subsurface flow, occurs with regularity on portions of Kalispell Creek (PBTTAT 1998b).

Summary (Isolation and Habitat Fragmentation)

Rieman and Allendorf (2001) used a generalized, age-structured simulation model to relate the effective population size (N_e) to adult numbers under a range of life histories and other conditions characteristic of bull trout populations. They concluded that “cautious long-term management goals for bull trout populations should include an average of at least 1000 adults spawning each year. Where local populations are too small, managers should seek to conserve a collection of interconnected populations that is at least large enough in total to meet this minimum." This collection of interconnected populations is defined as a core area population. The core area represents our best approximation of a biologically functioning unit.

Rieman and Allendorf (2001) pointed out that few local bull trout populations (indeed, few core areas) support spawner numbers averaging 1,000 or more per year. They noted that populations smaller than 1,000 should not be written off as lost causes, but that those populations should be recognized as facing greater threats associated with small population size and, therefore, as probably requiring more aggressive management and more immediate attention to mitigate those threats (Rieman and Allendorf 2001).

In the Clark Fork Recovery Unit, the risk of core area and local population extirpation from habitat isolation and fragmentation is generally increasing as populations of bull trout decline. Major dams were the catalyst for much of this disruption, and fragmentation has continued at a finer scale because of habitat decline and introductions of nonnative species. While bull trout are present in most historical core areas, there is substantial evidence of extirpation of local populations throughout this recovery unit, and many populations are at levels low enough to seriously reduce the chances of recolonization. The threat from isolation and fragmentation is real, and as more data is gathered, we anticipate gaining a better understanding of how bull trout migrate and interact between patches (Rieman and McIntyre 1995).

CONSERVATION MEASURES

Over the last decade, significant planning efforts to restore and recover bull trout have been initiated, and many on-the-ground activities specifically designed to benefit bull trout and other native salmonids within the Clark Fork Recovery Unit have been implemented. Ultimately, the measure by which these efforts should be judged is the degree to which they have produced positive response in the numbers and security of local bull trout populations. However, because most of these efforts are relatively young and could not be expected to produce measurable population response for several bull trout generations, judging the success of most of those programs at this time is premature. Because most programs have been government-led or funded, and they are most easily summarized by jurisdiction, we depart from the prior format for this section. Following is a brief summary of the existing and ongoing conservation activities.

State of Idaho

The Idaho Department of Fish and Game developed a management plan for bull trout in 1993 (Conley 1993), and the State of Idaho approved a plan for the conservation of bull trout in July 1996 (Batt 1996). The overall approach of the plan is to use existing groups established by Idaho Legislation, that is, watershed advisory groups and basin advisory groups that were formed to strengthen water quality protection and improve compliance with the Clean Water Act through locally developed, site-specific programs.

Lake Pend Oreille was designated as one of 59 key watersheds in the State of Idaho. The Lake Pend Oreille Watershed Advisory Group was one of the first to form, in August 1997. With partial funding provided by Avista Corporation and with the assistance of a consultant, the watershed advisory group progressed rapidly. The Panhandle Bull Trout Technical Advisory Team developed a problem assessment (PBTTAT 1998a), which the watershed advisory group used as the basis for the Lake Pend Oreille Bull Trout Conservation Plan—the first, and only, such plan completed in the State of Idaho (LPOWAG 1999).

The mission statement of the Lake Pend Oreille Bull Trout Conservation Plan is to "[d]evelop and implement a locally accepted conservation plan which will provide for a population of bull trout with long term viability and a harvestable surplus, while minimizing disruption to the lifestyles and industries of the area's population" (LPOWAG 1999). The plan identifies 12 high-priority watersheds for bull trout and describes a series of restoration actions in each of these watersheds. For each action, a coordinating entity (*i.e.*, responsible party) is designated. Actions are categorized as fisheries management, habitat management, education, enforcement, or monitoring needs.

The U.S. Fish and Wildlife Service supports the Lake Pend Oreille Bull Trout Conservation Plan as an excellent road map for the process of bull trout recovery in the greater Lake Pend Oreille watershed and encourages its full implementation. The plan also lists specific measures and activities that have occurred in the various watersheds draining into Lake Pend Oreille to protect and enhance bull trout (LPOWAG 1999). These measures and activities include restrictive angling regulations, scientific studies, educational efforts, riparian and wetland protection, road stabilization and sediment source remediation, and multiple watershed assessments and inventories, to name just a few. It should be noted that these activities are being carried out in a cooperative fashion by a broad group of agencies and private entities, with multiple sources of public and private funding, and not by the State of Idaho alone.

The Priest Lake Bull Trout Watershed Advisory Group also directed the Panhandle Basin Technical Advisory Team to develop a bull trout problem assessment. A draft of that document was prepared in December 1998, but was not completed. The existing draft contains background information but few specific recovery actions (PBTTAT 1998b). The Priest Lake Watershed Advisory Group has not actively met for several years and the entire Basin Advisory Group/Watershed Advisory Group process is currently on hold, pending further direction from the Governor's office.

The Idaho Department of Fish and Game, with section 6 funding from the U.S. Fish and Wildlife Service, is also conducting an evaluation of the threat from nonnative species (*i.e.*, lake trout and brook trout) in Upper Priest Lake. Recommendations for solutions are being pursued through a number of avenues.

The Idaho Department of Lands has been actively graveling roads that parallel bull trout streams to help minimize sediment delivery. The agency has also adopted a more stringent standard for stream shading to insure that timber harvest activities near streams will not increase stream temperatures above the preferred range for bull trout and other coldwater salmonids.

State of Montana

Beginning in 1990, the State of Montana initiated several formal bull trout planning activities, increased enforcement efforts on bull trout streams, and stepped up actions for habitat restoration and habitat monitoring. In 1993, the Governor of Montana appointed the Bull Trout Restoration Team to produce a plan that maintains, protects, and increases bull trout populations. The team appointed a scientific group (Montana Bull Trout Scientific Group) to provide the restoration planning effort with technical expertise.

The scientific group wrote 11 basin-specific status reports and 3 technical, peer-reviewed papers about the role of hatcheries (MBTSG 1996d), the suppression of nonnative fish species (MBTSG 1996c), and land management (MBTSG 1998). A draft restoration plan that defined and identified strategies for ensuring the long-term persistence of bull trout in Montana was released for public comments in September 1998 (MBTRT 1998). In June 2000, the final restoration plan was issued (MBTRT 2000). The plan synthesizes the scientific reports and provides recommendations for achieving bull trout restoration in western Montana. It focuses activities on 12 restoration/conservation areas and was designed to complement and be consistent with this recovery plan. The Montana Restoration Plan relies on voluntary actions, promoted by watershed groups, but has no legislative or legal authority beyond existing State law. Implementation of the Montana Restoration Plan has not officially begun; it is expected to mesh with implementation of this recovery plan.

A multitude of habitat restoration projects, such as removing fish passage barriers, screening irrigation diversions, fencing riparian areas, restoring streams, and monitoring habitat have been completed or are underway in Montana (Graham and Clinch, *in litt.*, 1997). Angling regulations have become more restrictive than in the past, brook trout are no longer stocked, and genetic studies are ongoing. As in Idaho, these activities are being carried out in a cooperative fashion by a broad group of State, Federal, and Tribal agencies and private entities, with multiple sources of public and private funding.

The Blackfoot Challenge is an organization developed by concerned people in the Blackfoot Valley with the purpose of supporting cooperative resource management, helping manage for the future, and keeping the area's desired characteristics. The Challenge is comprised of individuals, landowners, residents, recreationists, special-interest groups, and Federal, State, and local resource management agencies. Participants in the Challenge come together to coordinate efforts, distribute information, and foster open communication. Members of the Challenge have assisted in initiating a number of stream improvement projects. To date, improvement measures for fish habitat, wetlands, and rangeland have been applied, or are in progress, in at least 34 streams. The results of these projects have been substantial localized improvement in water quality and fisheries resources (Pierce and Podner 2000).

In 1999, the State of Montana reached a partial settlement of its Natural Resource Damage Assessment Program lawsuit with Atlantic Richfield Corporation (MDOJ 1999). The settlement decree requires that at least $500,000 of the approximately $130 million settlement be spent on bull trout recovery projects over the next 10 years. In addition, approximately $10 million will be made available annually through competitive grants to restore, replace, rehabilitate, or acquire fish and wildlife habitat that was injured from the mining and smelting activities. An additional allocation of up to $5 million (still under negotiation) will be spent on restoring bull trout habitat. In total, this settlement provides substantial financial resources for restoring bull trout and bull trout habitat in the upper Clark Fork River basin.

The Montana Bull Trout Scientific Group reported that about 724 kilometers (450 miles) of streams in the upper Clark Fork River basin were impaired or partially impaired for beneficial uses (MBTSG 1995e). In April 2000, the Montana Department of Environmental Quality released a revised draft section 303(d) list, which incorporates a different approach to listing impaired water bodies, based upon 1997 legislative amendments to the Montana water quality laws (MDEQ 2000). When finalized, the new section 303(d) list will be more thoroughly documented, but less inclusive, than past lists. The upper Clark Fork River is among the State's highest-priority streams for incorporating into the total maximum daily load process (MDHES 1994). Although algae and metals continue to affect the mainstem and tributaries in the upper basin, the U.S. Environmental Protection Agency (USEPA 1993) reports slightly improving trends because of stricter standards and clean-up measures.

The objectives of the South Fork Flathead Conservation Agreement —signed in 1997 by Montana Fish, Wildlife and Parks, U.S. Fish and Wildlife Service, Bonneville Power Administration, U.S. Bureau of Reclamation, U.S. Forest Service, and Confederated Salish and Kootenai Tribes—are to 1) ensure proactive involvement in addressing factors affecting bull trout, 2) facilitate interagency communication and coordination, and 3) provide a fishable population of bull trout in the South Fork Flathead River drainage. As monitoring of the bull trout population continues, criteria will be developed to determine the conditions under which a fishing season for bull trout may be reestablished.

Several other significant funding sources for bull trout restoration have been developed in Montana. The Montana Future Fisheries Improvement Program awards approximately $750,000 annually for projects that restore or enhance habitat for wild fish, with preference given to projects that emphasize native species. House Bill 647, passed in the 1999 State Legislature, roughly doubled the annual funding for restoring or enhancing fish habitat, with specific directives to benefit bull trout and cutthroat trout. License agreements from the Federal Energy Regulatory Commission for Cabinet Gorge, Noxon Rapids, and Kerr Dams provide tens of millions of dollars for fisheries restoration, much of which is for bull trout, over the decades the licenses are in effect. The State of Montana also receives approximately $1 million annually from the Bonneville Power Administration, through the Northwest Power Planning Council, for native fish restoration. Collectively, these and other funding sources provide a solid foundation for implementing many of the actions described in this recovery plan.

Federal Activities

Aside from the standard Columbia River basin guidelines for land management, water management, and the Endangered Species Act that apply to Federal actions (see Chapter 1), several significant Federal efforts have had specific implications for bull trout in the Clark Fork Recovery Unit. In December, 2000, the U.S. Fish and Wildlife Service issued a Biological Opinion for the Federal Columbia Power System (USFWS 2000) (see Chapter 1 for a discussion of the Biological Opinion). The Biological Opinion requires that issues about dam operation for bull trout at the Albeni Falls Dam be adequately addressed.

The U.S. Fish and Wildlife Service has negotiated a Habitat Conservation Plan with Plum Creek Timber Company. The Habitat Conservation Plan includes bull trout and other native salmonids occurring on over 688,500 hectares (1.7 million acres) of corporate lands, primarily (over 90 percent) within the Clark Fork Recovery Unit. A Final Environmental Impact Statement was published in September 2000, and the Habitat Conservation Plan was signed in December 2000. Successful implementation of the Habitat Conservation Plan is expected to raise standards for private timberland management activities and, therefore, reduce impacts of future actions and remediate existing problems to the benefit of bull trout.

The diverse land uses and economic activities in the Clark Fork River drainage have led to numerous water quality problems. A century of mining and smelting has left the upper Clark Fork River and some of its tributaries polluted by toxic metals and other chemicals. Overall, metals contamination is most prevalent in the headwater tributaries, Silver Bow Creek, and the lower reaches of Warm Springs Creek (MDHES 1994). The Environmental Protection Agency's National Priority List has listed four Superfund sites in the upper Clark Fork River basin, including the mainstem Clark Fork River from Warm Springs Creek to Milltown Dam. Since 1982, the Environmental Protection Agency, together with other State, Federal, and private entities, has worked to investigate and prescribe clean-up procedures (USEPA 1993).

The Federal Energy Regulatory Commission relicensing process has provided a timely Federal nexus to positively influence bull trout recovery at several major private hydroelectric dams, including Cabinet Gorge, Noxon Rapids, Thompson Falls, Milltown, Kerr, and Bigfork. All but one of these dams have recently been, or currently are, subject to relicensing, and substantial changes in operations as well as major sources of money for recovery activities have been, and are, being negotiated. The Avista Settlement Agreement, for example, for relicensing Noxon Rapids and Cabinet Gorge Dams will provide over $1.25 million dollars per year for 45 years to restore and improve habitat and fish passage under Washington Water Power's Native Salmonid Restoration Plan (Washington Water Power Company 1998). Funding for portions of this plan are matched by State and Federal agencies.

The Northwest Power Act, in part requiring mitigation for past and present impacts to fish and wildlife from Federal hydropower projects, has directed tens of millions of dollars of Bonneville Power Administration funds to a series of fisheries recovery actions in western Montana and northern Idaho. With the 1998 Endangered Species Act listing of bull trout, a larger proportion of those funds were directed toward actions directly related to recovery of the species.

The U.S. Fish and Wildlife Service has established several staff positions in western Montana under the Partners for Fish and Wildlife Program, and these new employees have focused on developing funding opportunities and directing U.S. Fish and Wildlife Service funds toward cooperative habitat restoration, water development, and easement programs to benefit native fish. The benefits of these efforts include the successful program guided by the Blackfoot Challenge.

Native American Tribal Activities

The Confederated Salish and Kootenai Tribes have taken an active role in conserving and restoring bull trout habitat, particularly in the Flathead and Jocko River drainages. They have been actively involved in the Montana Restoration Plan development and have applied substantial financial resources, such as from Federal Energy Regulatory Commission relicensing of Kerr Dam and from settlements from Atlantic Richfield Corporation, toward restoration of bull trout.

Canadian Government Activities

The Province of British Columbia has dedicated resources to protecting the North Fork Flathead River drainage, including research and management efforts that were helpful in avoiding proposed coal mine developments in the drainage that would have directly threatened bull trout spawning and rearing habitat for adfluvial fish migrating from Flathead Lake. British Columbia has also implemented and enforced stricter angling regulations to accommodate the United States' concerns and continue to cooperate in recovery planning efforts.