US Fish and Wildlife Service Bull Trout Workshop

Flathead Basin Case History for Bull Trout (*Salvelinus confluentus)*

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Introduction

The following case history for the Flathead Lake and river system (Flathead Complex) has been developed to provide some background and context for exploring bull trout monitoring and evaluation issues. The document provides information on the geography of the Flathead Complex, bull trout biology, historic and current population distribution, and reasons for population decline. The Flathead complex is a recovery subunit of the Clark Fork Recovery Unit of the US Fish and Wildlife Service bull trout Columbia River Distinct Population Segment (Lohr et al. 2000). The Flathead recovery subunit represents a relatively complex and data rich system for bull trout.

The Flathead Complex**,** located in Northwest Montana**,** includes Flathead Lake and its tributary system (North and Middle Fork Flathead, Stillwater, and Whitefish rivers), and the South Fork Flathead watershed upstream from Hungry Horse Dam (Figure 1). 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. The drainage area from Kerr Dam is about 18,400 square kilometers (7,100 miles^2, including 427 miles^2 in British Columbia).

The Swan River is also a major tributary to Flathead Lake. The Swan River drains the Swan Valley and Swan Lake. Fish movement upstream from Flathead Lake into the Swan River, has been blocked by Bigfork Dam since 1902. For the purpose of this case study (and because it is considered a separate recovery subunit), the Swan River drainage is not included in the Flathead Complex.

Historically, bull trout were abundant throughout the North, Middle, and South forks of the Flathead River drainage. All of the major rivers in the drainage were open to migration and interconnected prior to dam construction.

Thirty local populations in the Flathead 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 individual fish may exhibit a primarily fluvial life history. The Flathead Basin has been physically isolated from the rest of the Clark Fork Basin by Kerr Dam since 1938, 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 area.

Geographic Description

The Flathead Basin drains an area of about 18,400 square kilometers, which is underlain by nutrient-poor Precambrian sedimentary rock. The drainage is known for its high water quality (Zackheim 1983).

The North and Middle forks of the Flathead River drainage comprise most of the remaining unblocked portion of the Flathead River system upstream from Flathead Lake. The headwaters of the North Fork Flathead River are in British Columbia. The North Fork Flathead flows south into the United States, bordered by Glacier National Park to the east and the Flathead National Forest to the west. The headwaters of the Middle Fork are in the Bob Marshall and Great Bear Wilderness areas. From the confluence with Bear Creek downstream to its junction with the North Fork, the Middle Fork forms the southern boundary of Glacier National Park. From the confluence of the North and Middle forks, the 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. These three forks of the Flathead River have a combined drainage area of 11,561 square kilometers (4,464 miles^2) and an average annual discharge of 274.7 cubic meters per sec (9,699 cfs) as measured at Columbia Falls (USGS 1999).

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 about 5 kilometers (3 miles) before its confluence with the Flathead River, some 35 kilometers (22 miles) upstream from 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 (USFWS unpublished file data, Kalispell, Montana). Large log drives were conducted down those rivers during that era and several wooden dams were built onstream at sawmills and lake outlets that appear to have obstructed fish passage. Large numbers of migrating trout and whitefish were harvested by anglers at the dam sites, often with snag hooks and even dynamite, and the combined abuses appear to have rapidly depleted the fish runs (USFWS unpublished file data, Kalispell, Montana). Today, these rivers were judged by the Montana Bull Trout Scientific Group to be low priority streams for restoration due to the long-term nature of the decline and existing degraded habitat conditions (MBTSG 1995b). Summer water temperatures are not suitable in these streams for bull trout, and may have also been marginal historically, due to the fact that the rivers flow through large lowland lakes (Stillwater lakes and Whitefish Lake).

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

Flathead Lake has the largest surface area of any natural freshwater lake in the western United States, covering 49,613 ha. (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 South Bay which has a maximum depth of 10 meters(33 feet). Kerr Dam was built in 1938 and is located at the southern end of Flathead Lake, seven km downstream of the natural lake outlet. Kerr Dam regulates the top three meters of water to provide flood control and power.

Construction of Hungry Horse Dam in 1952-53 blocked access to the entire South Fork Flathead River drainage and about 38 percent of the total stream length once available to Flathead Lake bull trout was cut off (Zubik and Fraley 1987). Bull trout upstream from 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 mi^2) and an average annual discharge of 100.5 cubic meters per sec (3,549 cfs), measured 3 kilometers (2 miles) downstream from Hungry Horse Dam (USGS 1999). 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 3,451,000 acre-ft., which allows for substantial flood control storage in the headwaters of the Columbia River system.

Little quantitative information exists regarding historical bull trout distribution and abundance in the South Fork of the Flathead River drainage. Prior to construction of Hungry Horse Dam, 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 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 of the Flathead River. These fish migrate into tributary drainages to spawn and rear. Land ownership in the South Fork Flathead is almost entirely (98 percent) within the Flathead National Forest. Reservoir tributaries and the lower third of the South Fork drainage are managed timberlands, while the upper two-thirds of the South Fork drainage lies within the Bob Marshall Wilderness Area.

Bull Trout Biology

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 there are at least 27 natural lakes with historical evidence of bull trout populations, most of which form their own bull trout core areas. Some lakes are small (including eight less than 100 acres) and may have historically held only low numbers of bull trout. Available fisheries information indicates the migratory life form of bull trout predominates in all these lakes and river systems of the Flathead Lake drainage. Adult bull trout migrate into tributary drainages, usually upstream from each lake, to spawn. The juvenile fish rear in the tributaries for 1-3 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 that is not presently available.

Life History *(from Fraley and Shepard 1989*):

Lake Residence

The Flathead Lake bull trout population includes juveniles arriving from the river systems, subadult fish less than 450mm, and mature fish 5 to 6 years or more in age. Most bull trout in Flathead Lake mature at age 6. The diet of bull trout in the lake is almost exclusively fish (Whitefish species and yellow perch were most important, followed by kokanee and nongame species). Annual growth increments for bull trout in Flathead Lake range from 60-132mm, and growth of lake-resident fish is constant after age 4. Not all mature bull trout spawn annually. It appears that 38 to 69 % of the fish leave the lake each spring and summer to spawn.

Upstream Migration

Bull trout maturing in Flathead Lake began their spawning migration into the river system during April and move upstream, arriving in the North and Middle forks late in June and July. Information indicates that adult bull trout remain at the mouths of spawning tributaries for 2 to 4 weeks, during which time feeding is believed to be limited. Bull trout enter tributary streams at night from July through September; the majority entered in August. These fish hold in tributaries for up to a month in deep holes or log debris cover before spawning. It was observed that most bull trout moved through traps in pairs, it is hypothesized that bull trout formed pairs near the mouth of tributaries. Most bull trout spawners in the North and Middle Forks are 6 or 7 years old, where Swan system spawners are 5 or 6 years old.

Spawning

Bull trout in the Flathead River system predominately spawned during September and early October. Initiation of spawning appears to be largely related to water temperature, although photoperiod and stream flow also are influential. Spawning begins when water temperatures drop below 9-10 ^{o}C. Bull trout select areas to spawn in the stream channel characterized by gravel substrates, low compaction and low gradient. Ground water influences and cover are also important factors influencing spawning site selection. Bull trout from Flathead Lake spawn in only 28% of the 750 km of available stream habitat, given these relatively specific requirements for spawning site selection. After spawning, the spent adults move out of the tributaries and downstream to the lake. Fecundity varies with fish size, averaging about 5,500 eggs per female. The sex ratio of bull trout spawners averages 1.4 females per male in the North Fork drainage, and 1.37 females per male in the Swan drainage.

Incubation and Emergence

After egg deposition in October, bull trout incubate in the redd for several months before hatching in January. The alevins remain in the gravel and first appear as fry in electro fishing samples in mid April (emergence took approximately 200 days from egg deposition. Newly emerged fry average 23-28mm in length. After egg deposition, bull trout require 113 days to 50% hatch (340 temperature units) and 223 days to emergence from gravel (635 temperature units). Survival to emergence in a tributary of the North Fork Flathead averages 50% and the best survival of bull trout embryos was at 2-4 ^{o}C.

Juveniles

Juvenile bull trout are present in many stream reaches that are not used by adults, and the distribution is influenced by temperature. Juvenile bull trout have rarely been observed in streams with summer maximum temperatures exceeding 15 °C. Young of the year bull trout are generally found in side channel areas along stream margins in Flathead tributaries. Densities of bull trout juvenile are greatest in pools. Juvenile bull trout (less than 100mm) are generally found close to substrate material. As juvenile bull trout grew they became less associated with the stream bottom, but remain near cover such as large instream debris. Juvenile bull trout are difficult to observe because of their close association with the stream bottom. Juvenile bull trout mainly ingest aquatic invertebrates, similar in percentage to invertebrate availability. Juvenile bull trout larger than 110 mm also eat small trout and sculpins. Most juvenile bull trout in the Flathead drainage remain in the tributaries 1-3 years before emigrating to the river system. Emigration of the juveniles from the tributaries into the Flathead River system takes place largely from June through August. After juvenile bull trout enter the river system, they appear to move rapidly down into the mainstem Flathead River.

DISTRIBUTION AND ABUNDANCE

In the Flathead Complex there were 29 lakes identified, of which Flathead Lake is the largest. Each was considered to hold a separate bull trout subpopulation. Because of their 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 1995a, 1995b, 1996a, 1996b).

Historic Distribution

Historically, the Flathead Lake bull trout population had access to all three forks of the Flathead River, The Swan River, the Stillwater and Whitefish rivers, and the lower Flathead River downstream of Flathead Lake into the Clark Fork River all the way to Lake Pend Oreille. Bull trout were distributed widely throughout the Flathead River drainage. Some of the smaller streams have waterfalls or other natural barriers that could have prevented bull trout colonization. However, the major river systems were all open and interconnected (see evidence from Montana Bull Trout Restoration Team, 1995a).

The change in historic distribution can be traced through major dam building activities. The interconnectedness of the Flathead System has been disrupted by the construction of the following hydroelectric facilities. Bigfork Dam, constructed in 1902, blocked fish migration from Flathead Lake into the Swan River. Kerr dam, completed in 1938,blocks fish passage from the lower Flathead River into Flathead Lake. Hungry Horse Dam, completed in 1953, blocked fish migration into nearly all of the South Fork of the Flathead River drainage.

Current Distribution and Abundance

With the probable exception of the upper end of the Clark Fork River drainage (upstream from

Rock Creek), which has been severely degraded by heavy metals contamination, bull trout continue to be present (albeit sometimes in very 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 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; or the North Fork Flathead River where bull trout are generally absent from the lower ends of Glacier Park tributaries, most of which drain relatively large glacial lakes with bull trout populations in their headwaters. These distribution gaps often reflect natural conditions, as bull trout distribution is strongly correlated with habitat suitability. It is important to recognize that in some watersheds, or portions of them, bull trout likely were never numerous due to natural habitat limitations.

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

Thirteen core areas in the Clark Fork recovery unit have a history of redd count information for at least three 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. Table 1 summarizes the redd count information for the index areas in the Flathead recovery subunit. These are the index streams, which are annually monitored in the Flathead recovery unit. Flathead basin wide redd surveys, which censuses all habitat that appears suitable for bull trout spawning, are done every 5-7 years (Deleray 1999). The index streams of the North Fork and the Middle Fork of the Flathead exhibit slight negative trends in redd counts (Figures 2 and 3). Rieman and Myers (1997) found that negatives trends in redd counts were more apparent in these Flathead streams, particularly in the pooled streams. Sampling error is a potential factor that may influence the spatial and temporal variation observed in redd counts (Dunham et al. 2001). However, because a significant and widespread decline in bull trout redds has been detected (Riemann and Myers 1997), it is possible that the patterns represent severe population declines. Similar redd data has been accumulated for Rock Creek, the Blackfoot River, Upper Priest, and several of the Flathead Basin lakes, but the period of record generally goes back five or fewer years. Only sporadic redd counts have been conducted in the majority of the 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 of 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 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 in 1985 to a low of about 0.9 fish per 100 square meters in 1996 (Deleray et al. 1999). It is difficult to assess trends in bull trout abundance from a single parameter, 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 watersheds. Intensive monitoring of the Flathead, Swan, Hungry Horse, and Lake Pend Oreille populations is critical in order 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.

Essential Habitat Characteristics for Bull Trout:

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993, 1995; Rich 1996; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide habitat requirements for bull trout to successfully spawn and rear, and that the characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), fish should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997).

Migratory corridors link seasonal habitats for all bull trout life histories. For example, in Montana, migratory bull trout make extensive migrations in the Flathead River system (Fraley and Shepard 1989), and in tributaries of the Bitterroot River resident bull trout move downstream to overwinter in tributary pools (Jakober 1995). The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; M. Gilpin, University of California, in litt. 1997; Rieman *et al.* 1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed, stray, or return to non-natal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants.

Bull trout are found primarily in colder streams, although individual fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Water temperature above 15 degrees Celsius (59 degrees Fahrenheit) is believed to limit bull trout distribution, which may partially explain the patchy distribution within a watershed (Fraley and Shepard 1989; Rieman and McIntyre 1995). Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Rieman et al. 1997; Baxter *et al.* 1999). Goetz (1989) suggested optimum water temperatures for rearing of about 7 to 8 degrees Celsius (44 to 46 degrees Fahrenheit) and optimum water temperatures for egg incubation of 2 to 4 degrees Celsius (35 to 39 degrees Fahrenheit). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 to 9 degrees Celsius

(46 to 48 degrees Fahrenheit) within a temperature gradient of 8 to 15 degrees Celsius (46 to 60 degrees Fahrenheit). In Nevada, adult bull trout have been collected at 17.2 degrees Celsius (63 degrees Fahrenheit) in the West Fork of the Jarbidge River (S. Werdon, Fish and Wildlife Service, pers. comm. 1998); and observed in Dave Creek where maximum daily water temperatures were 17.1 to 17.5 degrees Celsius (62.8 to 63.6 degrees Fahrenheit) (S. Werdon, Fish and Wildlife Service, in litt. 2001). In the Little Lost River, Idaho, bull trout have been collected in water up to 20 degrees Celsius (68 degrees Fahrenheit), however, they made up less than 50 percent of all salmonids when maximum summer water temperature exceeded 15 degrees Celsius (59 degrees Fahrenheit) and less than 10 percent of all salmonids when temperature exceeded 17 degrees Celsius (63 degrees Fahrenheit) (Gamett 1999).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich 1996; Sexauer and James 1997; Watson and Hillman 1997). Jakober (1995) observed bull trout overwintering in deep beaver ponds or pools containing large woody debris in the Bitterroot River drainage, Montana, and suggested that suitable winter habitat may be more restricted than summer habitat. Maintaining bull trout habitat requires stream channel and flow stability (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period and channel instability may decrease survival of eggs and young juveniles in the gravel during winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993).

Preferred spawning habitat consists of low gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989) and water temperatures of 5 to 9 degrees Celsius (41 to 48 degrees Fahrenheit) in late summer to early fall (Goetz 1989). In the Swan River, Montana, abundance of bull trout redds was positively correlated with extent of bounded alluvial valley reaches, which are likely areas of groundwater-surface water exchange (Baxter et al. 1999). Survival of bull trout embryos planted in stream areas of groundwater upwelling used by bull trout for spawning were significantly higher than embryos planted in areas of surface-water recharge not used by bull trout for spawning (Baxter and McPhail 1999). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August to November during periods of decreasing water temperatures. Temperatures during spawning generally range from 4 to 10 degrees Celsius (39 to 51 degrees Fahrenheit), with redds often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Migratory bull trout frequently begin spawning migrations as early as April, and have been known to move upstream as far as 250 kilometers (155 miles) to spawning grounds in Montana (Fraley and Shepard 1989; Swanberg 1997). In Idaho, bull trout moved 109 kilometers (67.5 miles) from Arrowrock Reservoir to spawning areas in the headwaters of the Boise River (Flatter 1998). In the Blackfoot River, Montana, bull trout began spring migrations to spawning areas in response to increasing temperatures (Swanberg 1997). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992), and after hatching, juveniles remain in the substrate. Time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May depending upon water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Growth varies depending upon life-history strategy. Resident adults range from 150 to 300 millimeters (6 to 12 inches) total length and migratory adults commonly reach 600 millimeters (24 inches) or more (Pratt 1985; Goetz 1989). The largest verified bull trout is a 14.6 kilogram (32 pound) specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton and small fish (Boag 1987; Goetz 1989; Donald and Alger 1993). Adult migratory bull trout feed on various fish species (Leathe and Graham 1982; Fraley and Shepard 1989; Donald and Alger 1993; Brown 1992). In coastal areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) in the ocean (WDFW et al. 1997).

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. Thus, discussion of limiting factors is presented, in context, for the Flathead recovery subunit.

DAMS

Dams have been one of the most important factors in reducing the bull trout population of the Clark Fork Basin. Large hydroelectric dams permanently interrupted established bull trout migration routes, eliminating access from portions of the tributary system to the productive waters of Lake Pend Oreille and Flathead Lake. Additionally, these dams impacted the habitat that was left behind, affecting reservoir and lake levels, water temperature and water quality. Smaller irrigation storage dams further fragmented some of the watersheds and made it increasingly difficult for bull trout to migrate. Benefits have accrued from some dams in the form of isolation barriers that have precluded the movement of nonnative fish at a few locations.

The Bigfork Dam on the Swan River, built after the power plant was first installed in 1902 and 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 of the Flathead River, starting in 1953. Together, these two facilities reduced by nearly 50 percent the potential spawning and rearing habitat available to Flathead Lake bull trout (Fraley and Shepard 1989), although not all of that was necessarily occupied.

Bigfork Dam blocked the Swan drainage from Flathead Lake, but the ramifications of this loss to either system are not well understood. Anecdotal evidence from newspaper accounts around 1900 indicate that the mouth of the Swan River (or Big Fork as it was known then) was a very popular fishing spot in the spring of the year (April-May) with apparent concentrations of bull trout and westslope cutthroat and again in the fall (November) for mountain whitefish (USFWS unpublished file reports, Kalispell, Montana). It is not clear if those fish migrated up the Swan River, or were simply drawn there due to its' proximity to the mouth of the Flathead River or for foraging opportunities or other reasons. We presume that limited genetic interchange between the Swan and Flathead drainages probably occurred naturally, due to thermal regimes. Bigfork Dam currently prevents introduced fish species, especially lake trout present in the Flathead drainage, from migrating upstream into the Swan drainage.

Kerr Dam, constructed downstream from the natural outlet of Flathead Lake in 1938, blocked upstream fish passage from the lower Flathead River into Flathead Lake. In early biological surveys it was noted that the falls downstream from Flathead Lake were not fish barriers:

> *". . . 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, due to thermal conditions, it is unlikely that routine bull trout migration occurred 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 supports 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 in 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 the winter. This 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 system. The full ramifications of this loss to Flathead Lake, as well as to the South Fork Flathead River drainage, are not presently known. Preliminary genetic information suggests that, to a great extent, local bull trout populations utilizing the three forks of the Flathead River segregated themselves naturally (Kanda et al. 1997). Thus, 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 from the dam (Hungry Horse, Big Salmon, and Doctor lakes) probably preserved the genes of bull trout of the South Fork that existed there historically, though some adaptive changes could occur. Hungry Horse Dam has benefited the South Fork in one sense, in that it created an isolation barrier that has kept most of the South Fork drainage free from nonnative fish species.

Operation of Hungry Horse Dam has resulted in excessive drawdown during recent years. MFWP 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 (BOR) 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 are all reduced. 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. Due to the steep slopes in the reservoir, a volume reduction of approximately 80 percent occurs at drawdowns of 55 meters (180 feet). MFWP biologists are concerned that some local bull trout populations in Hungry Horse Reservoir may be damaged by continuing deep drawdowns (MFWP 1993); though to date the overall population appears to have been stable.

Downstream from Hungry Horse Dam, cold summer water releases may have historically impacted the behavioral patterns and food resources of native bull trout and cutthroat, as well as influencing 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. A selective withdrawal system was installed on Hungry Horse Dam in 1996, which 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 (BiOp) contained the following “reasonable and prudent measures” prescribed for operations of Hungry Horse Dam (USFWS 2000):

> “Implement 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 (USFWS 2000).”

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

FORESTRY MANAGEMENT PRACTICES

Forestry practices have caused major impacts to bull trout habitat throughout the Clark Fork Basin for over 100 years. Because forestry is the primary landscape activity in the basin, the impacts have been widespread. The negative primary effects of past timber harvest, such as road construction, log skidding, riparian tree harvest, clearcutting, splash dams, etc. have been reduced by the development of more progressive practices. But, the legacy of the past century has resulted in lasting impacts to bull trout habitat. These impacts will continue and are irreversible in some drainages.

Past forestry practices (road construction, log skidding, riparian tree harvest, clearcutting, splash dams) are a major contributing cause of the decline of bull trout in the Flathead drainage. The effects on habitat of these practices include increased sediment in streams, increased peak flows, hydrograph and thermal modifications, loss of in-stream woody debris and channel stability, and increased access to 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 resulting in changes in the timing of the runoff. 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).

Timber harvest in the South Fork Flathead began during the 1950's and will likely continue into the future (MBTSG 1995b). Differences are obvious when comparing managed lands to 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 drainage.

There are many problems resulting from road systems around Hungry Horse Reservoir (MBTSG 1995b). 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 Forest Service and MFWP are constantly evaluating roads and improvements are being proposed and implemented.

LIVESTOCK GRAZING

Livestock grazing has had the greatest impact to bull trout in the upper portion of the Clark Basin. It 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.

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

Livestock grazing also occurs in close proximity to the Swan River and the lower portions of some important tributary drainages (MBTSG 1996a). 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.

There is no grazing in the South Fork Flathead drainage above Hungry Horse Dam with the exception of stock used by outfitters and recreationists (MBTSG 1995b). 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 high use areas.

AGRICULTURAL PRACTICES

Agricultural impacts to bull trout in the Clark Fork Basin are primarily a result of water demand. Diversions for irrigation cause destabilized stream channels, severe interruption of migratory corridors (blockages and dewatering) and, in some cases, entrained fish are 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 much of 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 continue to represent a significant threat to bull trout recovery in this recovery unit.

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 1995a). Though the latter two streams are not generally occupied by bull trout, they do contribute to the lake and river system. The Montana Department of Health and Environmental Sciences state that 206 kilometers (128 miles) of streams in the Flathead 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 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 basin are believed to be low.

There are relatively few irrigation diversions 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. It is unknown to what extent the current thermal regime in these rivers is man-caused, since no data exist prior to 1900.

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

TRANSPORTATION NETWORKS

Transportation systems are also a major contributor to the decline of bull trout in this basin. It is difficult to separate the direct effect of the roads and railroads from the human development associated with their construction. Construction methods during the late 19th and early 20th century, primarily channelization and meander cutoffs, caused major impacts on many of these streams which are still being manifested. These impacts seldom occur with new roads. However, there remain significant problems associated with passage barriers, sediment production, unstable slopes, improper maintenance, and high road densities; all of which impact bull trout. These problems can only be addressed on a site-by-site basis.

Overall, stream crossings and culverts are not a significant problem in the Flathead drainage (MBTSG 1995a, 1995b, 1996a). Highways and railroads have impacted bull trout in a few areas, most significantly on Bear Creek in the Middle Fork. 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. There have been several landslides which have been problematic in the maintenance of this road and the dust from heavy traffic contributes sediment to the system (MBTSG 1995a). Proposed paving of a portion of the main North Fork road has been portrayed as a controversy, pitting bull trout against grizzly bears in the press. 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.

MINING

At the present time, mining is not known to be impacting bull trout in the Flathead River drainage (MBTSG 1995a). However, there is a large coal deposit in the North Fork drainage in British Columbia. If the deposit is mined, as was proposed in the 1970's, a potential loss of ten percent of the Flathead Lake migratory bull trout spawning stock was estimated (Fraley and Shepard 1989). Water quality impacts could be experienced downstream as well. 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 developed fields. Location and full development of a large deposit would be a major concern due to the fragile and pristine nature of much of this ecosystem.

Current and historical mining does not threaten the Swan Lake or South Fork Flathead bull trout populations (MBTSG 1996a, 1995b). There are no existing mining operations other than recreational gold panning. There are, however, a few scattered mining claims in the South Fork Flathead (e.g., Baptiste), none of which are currently active.

RESIDENTIAL DEVELOPMENT

Ultimately, unmanaged growth and residential sprawl may be one of the biggest threats to the recovery of bull trout in this recovery unit. The entire Clark Fork basin holds many of the attributes that increasingly attract people seeking relief from the urban environment. 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, is pivotal to the success of the bull trout recovery effort.

The impact of residential development will become increasingly important to bull trout recovery in the Flathead. An increasing human population has led to increased lake eutrophication due to nutrient enrichment in Flathead Lake and other large natural lakes within the basin (Flathead Basin Commission 1999). The human population grew by 25.8 percent in Flathead County during the decade of the 1990's, the sixth highest rate of growth among Montana's 56 counties (Inter Lake, *in litt.,* 2001). Recent evidence indicates that the downward trend in Flathead Lake water quality may be leveling off, due in part to 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 drainages (MBTSG 1995a). 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 North fork Flathead bull trout spawning stream (MBTSG 1995a). Downhill ski areas create permanent clear cuts which have the potential to increase sediment loads and water yields, and to change hydrologic patterns.

There are only a few small tracts of private land and scattered mining claims in the South Fork. Therefore, very limited rural residential development is possible upstream from Hungry Horse Dam (MBTSG 1995b).

FISHERIES MANAGEMENT

Of all the threats to bull trout recovery, the expanding presence of nonnative fish species may prove to be the most intractable. In particular, expansion of congeneric lake trout and brook trout populations provide concern for bull trout recovery in portions of the Clark Fork Basin. 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. While an improving trend is being realized in the quality of stream habitat for bull trout in many watersheds, the effects of nonnative species introductions, particularly in large lakes, has reduced the carrying capacity for bull trout. A key to successful bull trout restoration will lie in the education of both anglers and the nonangling public to the values of native species. Intact native fish ecosystems are increasingly rare and we must allocate substantial resources to protecting and restoring those that remain.

Bull trout co-exist with 23 other species of fish in Flathead Lake, only ten of which are native (MBTSG 1995a). The introduced fish species found in the Flathead 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 drainage. To date, however, none are known to have established reproducing populations. *Mysis relicta*, an introduced freshwater invertebrate that feeds on zooplankton, is also widespread within the drainage.

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

Brook trout are the introduced species that present the greatest existing risk to bull trout in the Swan because of competition and hybridization (MBTSG 1996a). 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).

In 1999, a reproducing population of brown trout was documented in the Flathead basin upstream from 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 from Flathead Lake. Creston National Fish Hatchery is located on the upper end of Mill Creek and escapement from a brown trout population held at the hatchery in the early 1980's is the likely source (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* 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 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 (100 miles upstream from the lake) and beyond the Canadian border on the North Fork of the Flathead (114 miles upstream from the lake). One lake trout with a radio tag traversed up and down the North Fork Flathead River, took a foray into the Middle Fork 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 their assessment of the seasonal distribution and movement of native and nonnative fishes in the Flathead River system upstream from 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) suggests 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° C and probably unsuitable as temperature approaches 15 degrees Celsius.

Lake trout have been documented to prey on young bull trout and cutthroat in Flathead Lake. Deleray et al. (1999) examined 449 lake trout stomachs collected in 1996. Combined diet information found 99 percent of the diet (by weight) was fish, and over three-fourths of the biomass consumed was lake whitefish. Insects, *Mysis*, and other noninvertebrates comprised only 1 percent of the diet, but were higher in small lake trout (under 500 millimeter). Predator food habits information 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, due to their high abundance, predator populations likely 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 populations resulted from government stocking programs (Flathead Lake in 1905, Whitefish Lake in 1941, Tally Lake in 1985), but the rest were apparently the result of unauthorized stocking or natural invasion. Lake trout have now been detected or reported in all the natural lakes in the watershed larger than 1,000 surface acres, and inhabit over 142,000 total surface acres of lentic habitat (Fredenberg 2000). The remaining bull trout lakes which are not believed to contain lake trout occupy only 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). 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 growth, which suggests that competition may contribute to the disjunct distribution of these species (Donald and Alger 1993).

A scientific advisory team convened in 1997 by MFWP and CSKT 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). A citizens advisory committee was convened by MFWP and CSKT in the spring of 2000 to recommend management alternatives for Flathead Lake and the Flathead River system. Based on that panel’s recommendations, and other input, the management agencies adopted a new 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 were stocked by MFWP in Whitefish, Tally, and Ashley lakes in the Flathead drainage in 1968 (Rumsey 1988). They apparently drifted downstream into Flathead Lake from one or more of these sources and were first collected there in the fall of 1981 (Leathe and Graham 1982). The inadvertent introduction of *Mysis* into Flathead Lake resulted in major changes in the food web of the lake, 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* generally benefits deep-dwelling fish species by providing a food source but may impact planktivorous fish by reducing the available crustacean zooplankton (Nesler and Bergersen 1991). Many lakes with established *Mysis* populations have experienced a decline, or in some cases, complete loss of kokanee salmon.

Of the other introduced species established in the Flathead Recovery Subunit, the one of most concern is the widespread presence of northern pike. 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 from Flathead Lake is currently underway (Muhlfeld 2000). Preliminary results show pike to be 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 with salmonids. Analysis of pike stomachs from the Flathead River and associated sloughs to date has found some rainbow and cutthroat trout, as well as unidentified fish, but no bull trout (C. Muhlfeld, Montana Fish, Wildlife and Parks, Kalispell, *personal communication*, 2001). Pike and lake trout have both become well established in the Stillwater Lakes, providing little hope for bull trout recovery in that lake, although a population is hanging on in the river upstream. Pike are established in Flathead Lake, Tally Lake, Whitefish Lake, and Swan Lake. Impacts of pike in these systems are unknown.

Hatchery stocking practices with nonnative fish in the lakes of Glacier National Park has been extensive. The emphasis on producing a fishery to attract anglers was a driving force of Park management in the early days. Indeed, 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). The hatchery was transferred to the U.S. Fish and Wildlife Service in 1944.

Kokanee salmon stocking in Lindbergh Lake began in 1944 and this program continues today (MBTSG 1996a). Coho salmon were planted in Lindbergh Lake in 1948. Kokanee salmon were first planted in Holland Lake in 1951. This fishery is still maintained by stocking of kokanee salmon because natural reproduction is limited. 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. Kokanee salmon from Flathead Lake also may have moved upstream to Swan Lake over the Bigfork Dam fish ladder after 1959.

Hungry Horse Dam, serving as an isolating mechanism for the watershed upstream from it, could be considered a positive contribution to the fishery resource from the standpoint of precluding the natural spread of introduced species upstream (MBTSG 1995b). 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 watershed. In the future, this barrier could become even more valuable as introduced species of fish continue to disperse throughout the mainstem Flathead drainage. MFWP has made a commitment to manage the South Fork Flathead and Hungry Horse Reservoir for native species (MFWP 1997). The objectives of the South Fork Flathead Conservation Agreement; signed in 1997 by MFWP, USFWS, BPA, BOR, USFS, and CSKT; 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 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.

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

Flathead Lake and the Flathead River receive substantial angling pressure. Approximately 47,000 - 53,000 angler days per year are expended on the lake (Evarts et al. 1994, MFWP 2000aa) and an estimated 31,223 angler days were spent in 1999 on the Flathead River mainstem upstream from the lake (MFWP 2000a). In addition, an estimated 5,352 angler days were spent in 1999 on the Middle Fork 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 has use of 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 of the Flathead River (MFWP 2000a).

Fisheries management programs in the Flathead Basin have attempted to protect native species (bull trout and westslope cutthroat) since at least the 1950's (MBTSG 1995c). Despite those attempts, erosion of native populations has occurred, 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. This 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 very difficult challenge.

In the past, legal angler harvest of bull trout throughout the Flathead Basin was significant. Based on harvest and escapement figures in 1981, 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 have been gradually tightened over the past 45 years (MBTSG 1995a). The earliest regulations allowed an aggregate limit of 15 trout but imposed a 46 centimeter (18 inch) minimum size limit on bull trout. Spawning stream closures first occurred in 1953 in the North Fork and 1962 in the Middle Fork. 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. The one current exception to the no take regulation is in Swan Lake, with a daily limit of one fish.

Hungry Horse Reservoir also 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 roughly estimated a harvest of 100 to 250 bull trout occurred annually in Hungry Horse Reservoir between 1985 and 1993 (MBTSG 1995b). The most recent estimate of harvest concluded less than 10 percent of the adult bull trout population was removed from the Reservoir by anglers in 1993 (MFWP unpublished file data, Kalispell, Montana). MFWP has interpreted the data as indicating a stable trend in bull trout numbers in the South Fork Flathead since the dam was built in the 1950's, and has opened discussions with USFWS 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 1995b).

With increasing fishing pressure, some hooking mortality is inevitable, as are problems with misidentification (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. Long (1997) interviewed poachers in northwest Montana and learned about their fishing habits and success rate. He estimated that, on average, 22 bull trout were killed per week per poacher during three months, July - September. Out of the nine poachers interviewed, seven 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, and pointed out the danger illegal harvest posed to local bull trout populations, especially because of its declining status (Long 1997). In response to this information, MFWP increased enforcement efforts and penalties for illegal harvest of bull trout were raised.

The risks resulting from biological sampling have been minimal in past years but may increase as more research and management activities occur. There is an increasing number of research projects, some involving invasive procedures. Risk due to electrofishing injury is unquantified for bull trout, but there is evidence that most large trout are susceptible to electrofishing injury. As a result of MFWP research into the impact of electrofishing on fish, electrofishing techniques and equipment have been modified to minimize electrofishing risk. There is also a MFWP policy limiting the use of electrofishing in waters containing Species of Special Concern.

ISOLATION AND HABITAT FRAGMENTATION

The risk local population extirpation from isolation and fragmentation of habitat in the Clark Fork Basin is generally increasing, especially where populations of bull trout decline. Major dams were the catalyst for much of this disruption, and fragmentation has continued at a finer scale, caused by habitat decline and nonnative species introductions. While bull trout are present in most historical core areas, there is substantial evidence of extirpation of local populations in major portions of this recovery unit, and many populations are at low enough levels to seriously reduce the chances of recolonization. The threat from isolation and fragmentation is very real and as more data are gathered it is anticipated we will gain a better understanding of how bull trout migrate and interact between patches.

In the Flathead Lake, and the South Fork Flathead River (Hungry Horse Reservoir) areas, the risk to bull trout from environmental instability is reduced due to the predominance of the migratory life form and relatively connected habitat remaining for these fish (MBTSG 1995a, 1995b, 1996a). If a natural or man-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 centered in smaller lakes, the risks from catastrophic events are higher, since the isolation factor and restricted habitat make survival and/or recolonization less likely (MBTSG 1995b). In spite of barriers on the South Fork Flathead and Swan rivers, which have cut off nearly half the watershed, the remaining upper Flathead (North and Middle forks) is one of the largest drainages (nearly one half million acres) that still maintains good interconnected-ness between spawning and rearing habitat and the foraging, migrating, and overwintering habitat for migratory fish. There are substantial genetic differences between local populations spawning in the North Fork and the Middle Fork tributaries, that should not be disrupted (Kanda et al. 1997).

Evidence of past influence from flooding or rain-on-snow events is seen in several Flathead River Basin tributary drainages, in large part due to the massive 1964 flood. These problems are particularly evident in the Middle Fork Flathead River watershed (MBTSG 1995a).

Natural water temperatures over 15.5 degrees Celsius (60 degrees Fahrenheit) occur in the late summer and fall downstream from most lakes in the Flathead Basin, which deter migratory bull trout spawners from entering these systems from downstream (MBTSG 1995a). 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.

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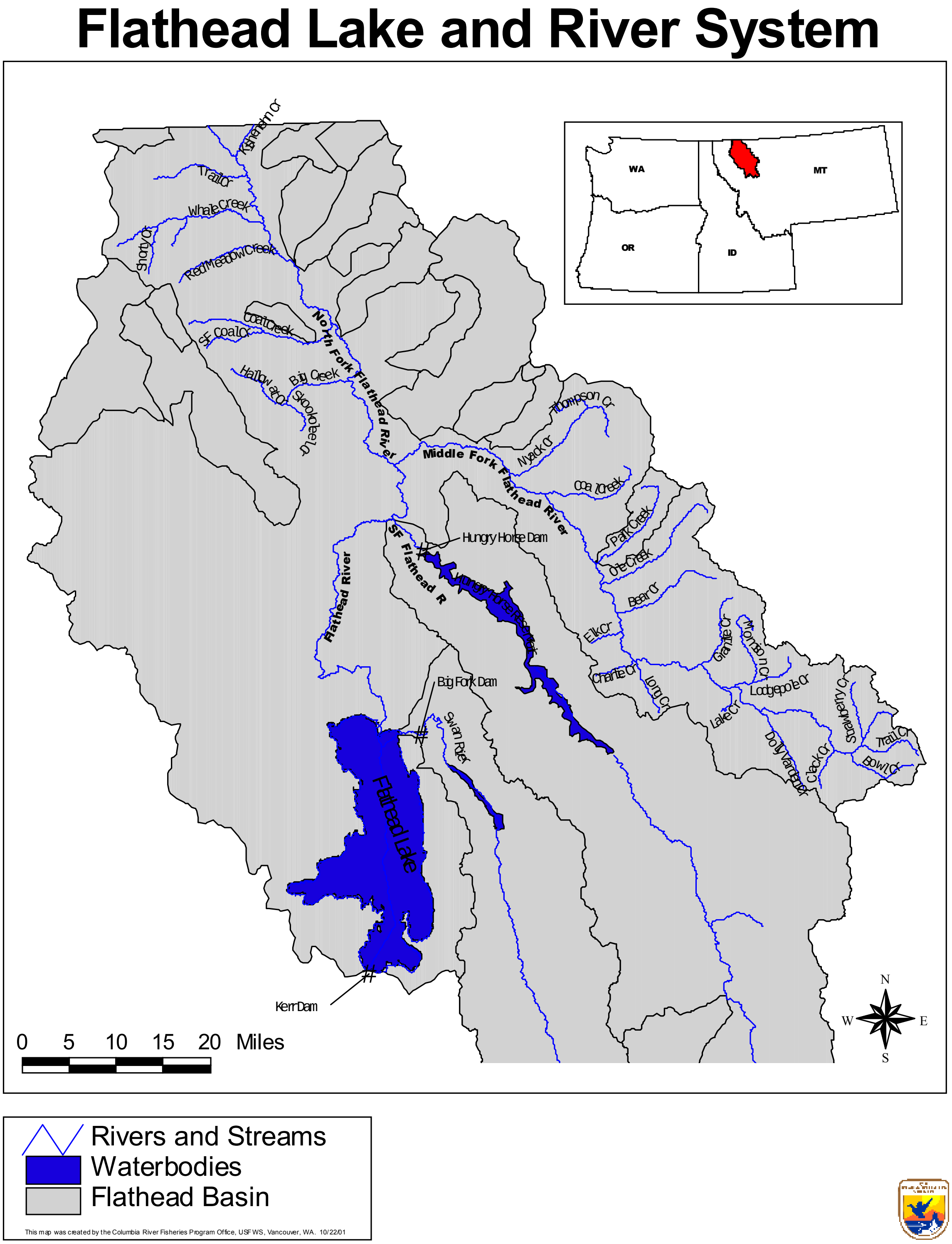

Figure 1. Flathead River System

Table 1. Summary of Flathead Basin bull trout redd counts from 1979-1999 surveys in annual index sections.

DRAINAGE	North Fork FLATHEAD					Middle Fork FLATHEAD				
Index Area	BIG	COAL	WHALE	TRAIL	NF Flathead Total	MORRISON	GRANITE	LODGEPOLE	OLE	MF Flathead Total
1979	10	38	35	34	117	25	14	32		71
1980	20	34	45	31	130	75	34	14	19	142
1981	18	23	98	78	217	32	14	18	19	83
1982	41	60	211	94	406	86	34	23	51	184
1983	22	71	141	56	290	67	31	23	35	156
1984	9	53	133	32	227	38	47	23	26	134
1985	9	40	94	25	168	99	24	20	30	173
1986	12	13	90	69	184	52	37	42	36	167
1987	22	48	143	64	277	49	34	21	45	149
1988	19	52	136	62	269	50	32	19	59	160
1989	24	50	119	51	324	63	31	43	21	158
1990	25	29	109	65	228	24	21	12	20	77
1991	24	34	61	27	146	45	20	9	23	97
1992	16	7	12	26	61	17	16	13	16	62
1993	2	10	46	13	71	14	9	9	19	51
1994	11	6	32	15	64	21	18	6	6	51
1995	14	13	28	28	83	28	25	9	16	78
1996	6	3	35	8	52	9	4	8	10	31
1997	13	5	17	9	44	39	12	5	14	70
1998	30	14	40	17	101	35	22	7	22	86
1999	34	7	49	21	111	30	37	11	26	104
Average	18	29	80	39	170	43	25	17	26	109

Figure 2. Flathead River Basin Index Area Normalized Redd counts (Redds/Average 1979-99 Redds)

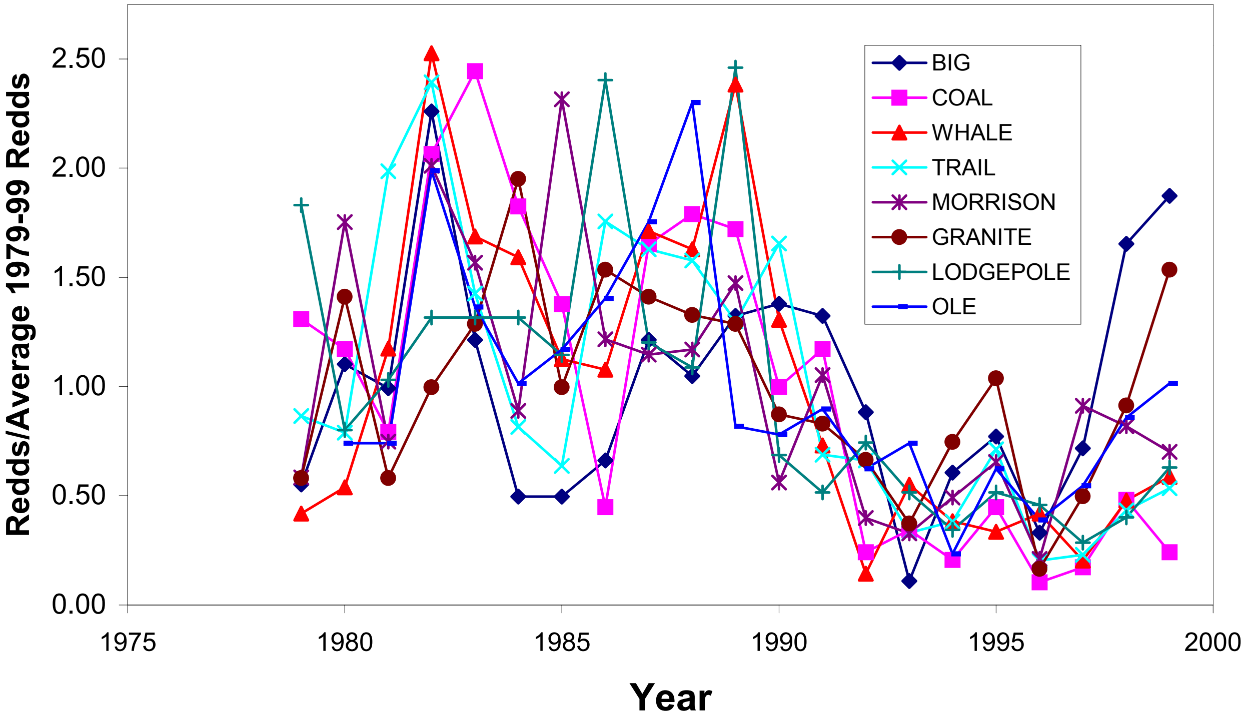

Figure 3. Flathead River Basin Index Area Normalized Redd Counts