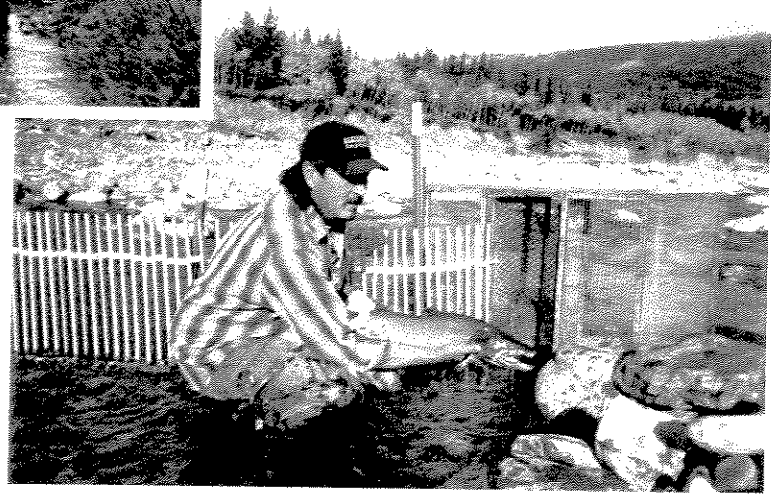
ECOLOGY of BULL TROUT

(*Salvelinus confluentus*)

in the

SAINT MARY RIVER DRAINAGE



A Progress Report

June 2000

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(*Salvelinus confluentus*)

in the

SAINT MARY RIVER DRAINAGE

A Progress Report
Based on Field Investigations Conducted in 1997-1999

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INTRODUCTION

The bull trout (*Salvelinus confluentus*) is a char that inhabits predominantly freshwater environments in western North America. The species is closely related to the Dolly Varden (*S. malma*), which occurs only as an anadromous life-history form (Cavender 1978; Haas and McPhail 1991) that can also be sympatric with bull trout (Leary and Allendorf 1997). The phylogenetic relation between bull trout and Dolly Varden is so close that these fish had been considered a single species until 1980 (Robins et al. 1980).

The historic range of bull trout extends from northern California and Nevada to the Northwest Territories, Canada, and encompasses Puget Sound and the major coastal river systems in Washington, British Columbia, and southeast Alaska. To the east, bull trout primarily inhabit the tributaries and lakes of the Columbia River basin, including headwater regions in Montana and Canada, and the Klamath River basin in Oregon. Periodic connections between headwater streams apparently allowed bull trout west of the Continental Divide to enter some drainages east of the divide until soon after the last glacial period (i.e., the Pleistocene Epoch), 7,000 to 10,000 years ago. Consequently, bull trout also inhabit the upper Saskatchewan River basin, Montana and Alberta, and the MacKenzie River system, Alberta and British Columbia (Cavender 1978; Bond 1992; Brewin and Brewin 1997; Leary and Allendorf 1997; Nelson and Paetz 1992).

Like the young of other inland salmonid species, young bull trout in both streams and lakes are opportunistic feeders that prey primarily on invertebrate organisms. Adult bull trout, however, are notably piscivorous, i.e., they feed almost exclusively on other fishes (Fraley and Shepard 1989; Donald and Alger 1993). Bull trout usually mature at 4 to 7 years of age and spawn entirely in streams, primarily small tributaries. Spawning occurs between late summer and early fall, when seasonal water temperatures decline to between 9 C and 5 C (Fraley and Shepard 1989; Goetz 1989).

Bull trout that live wholly in fresh water exhibit three distinct life-histories forms: resident, adfluvial, and fluvial. *Resident* fish spend their lives entirely in the natal tributaries; *fluvial* fish spawn in small tributaries but their resulting young migrate downstream to larger rivers where they grow and mature; and *adfluvial* fish spawn in streams but their young migrate downstream

to mature in lakes. Whether those life-history forms represent opportunistic behaviors or genetically distinct types of bull trout is unknown. After they spawn in tributaries, both fluvial and adfluvial bull trout migrate back to the rivers or lakes. All three life-history forms may occur in a single drainage. Because lakes and large rivers are often more productive than headwater streams, the adfluvial and fluvial bull trout that use those habitats usually grow more rapidly, attain larger size, and exhibit a higher degree of piscivory than the resident fish in headwaters. An anadromous bull trout life-history form may also occur in coastal streams (McPhail and Baxter 1996).

Today, bull trout are extinct in California, inhabit only one river system in Nevada, and have declined noticeably in many other areas of their historic range in the contiguous United States (*Federal Register* 64: 58909). That decline is generally attributed to adverse, human-caused modifications of the aquatic environment; population fragmentation resulting from the blockage of bull trout migration routes by dams and other barriers; competition or hybridization with introduced, nonnative fish species such as brook trout (*S. fontinalis*); and excessive harvest by anglers. The decline of bull trout led the U.S. Fish and Wildlife Service (Service) to formally list the species throughout its historic range in the contiguous United States as threatened, under the Federal Endangered Species Act, in 1999 (*Federal Register* 64: 58909). In Canada, the status of bull trout has been under review by the Committee on the Status of Endangered Wildlife since 1988 (Groft et al. 1997).

In reaching its decision to list the species as threatened, the Service concluded that bull trout presently occur in five distinct population segments (DPSs) in the contiguous United States (*Federal Register* 64: 58909). One of those DPSs lies east of the Continental Divide, in the St. Mary-Belly River drainage of the upper Saskatchewan River basin, Montana and Alberta. In that drainage, bull trout co-evolved with lake trout (*S. namaycush*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*), another fish that has shown an appreciable decline in population across its historic range. In the listing notice for bull trout, however, the Service also noted that historic information on bull trout in the St. Mary-Belly River DPS was largely anecdotal, and contemporary information was meager.

The primary objectives of the study described here were to: (1) characterize the contemporary bull trout population in the St. Mary drainage of Montana; (2) identify the factors that may be unduly limiting that population; and (3) recommend management actions to eliminate or ameliorate the effects of those factors. Concurrently, the status of westslope cutthroat trout in the drainage was also determined.

STUDY AREA

Aquatic Habitats

The St. Mary River originates at Gunsight Lake, in Glacier National Park, and flows northeast about 10 km before entering St. Mary Lake (Figure 1). Upon leaving the 15-km-long lake, the river flows onto the Blackfeet Reservation and continues northeast for about 2 km before entering Lower St. Mary Lake (9 km long). From that lake, the river meanders northerly about 25 km to the international boundary, then continues north through shrub-grassland habitat about 55 km to St. Mary Reservoir, a large, man-made impoundment. The St. Mary River that flows from the reservoir joins the Oldman River about 8 km upstream from Lethbridge, Alberta.

Several major tributaries, all of which head in Glacier National Park and flow principally through forested habitats, enter the St. Mary River (or its lakes) along its course (Figure 1). Although each of those tributaries differs in physical characteristics that may be important to fish, all have in common the frequent occurrence somewhere along their length of natural year-round or seasonal barriers to the movements of fish.

Red Eagle Creek, the first major tributary, originates from glacial melt near the Continental Divide and flows northeast about 13 km, over a series of waterfalls, to Red Eagle Lake. From the lake, the creek continues northeast about 8 km to the south shore of St. Mary Lake. Red Eagle Creek contains a diversity of habitats for fish.

Divide Creek originates at a cluster of small alpine lakes and flows northeast about 15 km before entering the St. Mary River, between the St. Mary lakes. The creek contains diverse habitat for fish, including much woody debris and substrates dominated by cobble and boulders. About 11 km above the creek's confluence with the river, Divide Creek flows become entirely subsurface for a distance of about 200 m during the seasonal low-flow period. Downstream from that location, Divide Creek emerges as groundwater upwellings along a 1.5-km stretch of gravel-cobble alluvium.

Wild Creek originates as snowmelt and flows east about 7 km, cascading over cobble-boulder substrates and abundant woody debris, before entering the river between the St. Mary lakes. A

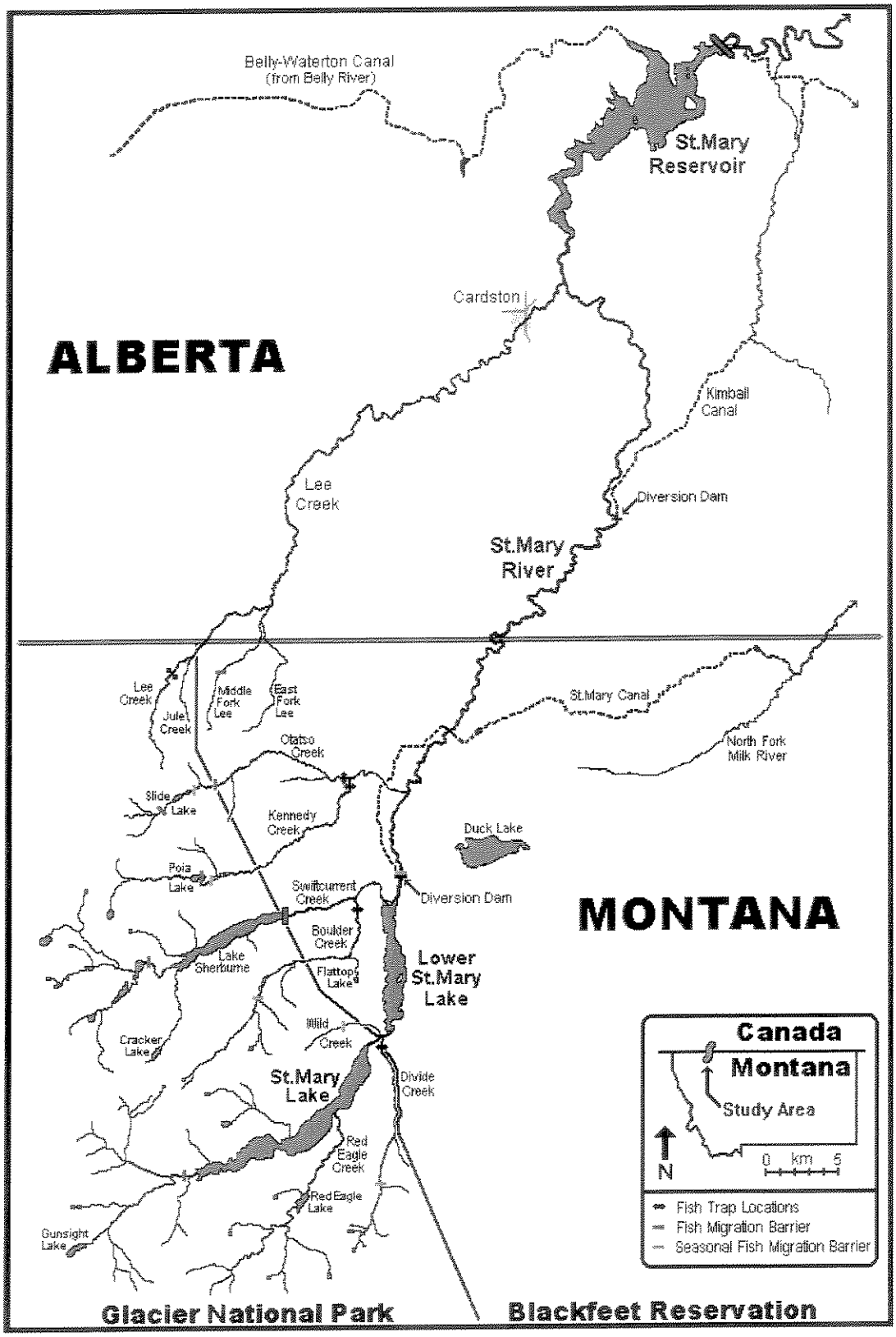

Figure 1. Study area, St. Mary River drainage, U.S. and Canada.

complex of log jams, waterfalls, and cascades, which begins about 3 km upstream from the St. Mary River, probably blocks the upstream movement of fish.

Swiftcurrent Creek originates at a series of lakes near the Continental Divide and enters Lower St. Mary Lake near the lake outlet. About 1920, Swiftcurrent Creek was impounded by placement of a 33-m-high dam at the park boundary, thereby forming Lake Sherburne (Figure 1). That reservoir has a maximum surface area of 648 hectares and storage capacity of nearly 84 million cubic meters. Cracker Lake is drained by Canyon Creek, which flows north about 7 km, over a series of small waterfalls, before entering the upper end of Lake Sherburne.

Boulder Creek originates from snowmelt and flows northeast about 20 km before entering Swiftcurrent Creek, about 5 km above Lower St. Mary Lake. About 6 km upstream from the park boundary, Boulder Creek flows become entirely subsurface as they pass through gravel-cobble alluvium for about 400 m during low-flow periods in late summer. The creek then emerges as groundwater upwellings and flows through a 3-km, low-gradient stretch characterized by braided channels and abundant damming by beavers. Because Boulder Creek has exhibited notably large, seasonal flows, much of the channel in the creek's lower reaches is wide, braided, and has substrates consisting predominantly of boulders and other large materials.

Kennedy Creek originates at Kennedy Lake and flows northeast about 28 km before entering the St. Mary River about 8 km downstream from Lower St. Mary Lake. A 10-m-high waterfall occurs at the outlet of Poia Lake, about 5 km upstream from the park boundary on Kennedy Creek. Immediately downstream from Poia Lake, Kennedy Creek enters a high-gradient, boulder-strewn canyon. At the mouth of that canyon, about 0.7 km below the lake, the valley widens and the creek's gradient declines. In that stretch, Kennedy Creek disappears into the gravel-cobble alluvium during low-flow periods in late summer. About 300 m downstream, however, the creek emerges as groundwater upwellings and flows through a 1.5-km, low-gradient stretch characterized by braided channels and abundant beaver activity.

Otatso Creek originates at Otatso Lake and flows east about 18 km before entering Kennedy Creek, nearly 5 km above the St. Mary River. A large waterfall (50 m high) occurs in upper Otatso Creek, 15 km upstream from the confluence with Kennedy Creek. Two km downstream from the waterfall, Slide Lakes are formed by a large landslide across Otatso Creek. Creek flows

are entirely subsurface for nearly 100 m, i.e., while passing through the landslide, during all but seasonal high-flow periods. From that location, Otatso Creek continues downstream through a 2-km-long, high-gradient, boulder-strewn canyon before flowing over a second waterfall (3 m high) about 12 km above the confluence with Kennedy Creek and near the park boundary. Downstream from that waterfall, Otatso Creek enters a canyon that has exposed, highly erodible, bear-paw shale walls that contribute substantially to the sediment load of the stream. Consequently, instream habitat in this lower reach is less diverse, and most substrates are armored.

Lee Creek and its tributaries--Jule, Middle Fork Lee, and East Fork Lee creeks--drain the northern-most area of the St. Mary drainage in Montana. Lee Creek originates as snowmelt and flows north about 11 km before crossing the international boundary. It then meanders about 50 km through mostly shrub-grassland habitat of southern Alberta, before entering the St. Mary River near the town of Cardston.

The Belly River, which drains the basin northwest of the St. Mary drainage, originates at Helen Lake near the Continental Divide in northeast Glacier National Park. It flows north about 25 km to the international boundary, then continues flowing about 175 km before entering the Oldman River in Alberta, about 35 km upstream from the confluence of the Oldman and St. Mary rivers.

Between 1914 and 1921, the U.S. Bureau of Reclamation (Bureau) built several water-control and delivery structures in the St. Mary River drainage, as part of the Milk River Irrigation Project. Among those structures is a diversion dam 1.2 km downstream from Lower St. Mary Lake. That dam, the St. Mary Diversion, diverts water into the St. Mary Canal, which conveys the water about 50 km–over the watershed divide and into Missouri River drainage–to the North Fork of the Milk River (Figure 1). In addition, Swiftcurrent Creek, which formerly flowed into the St. Mary River downstream from Lower St. Mary Lake, was diverted into the lake itself. That allowed water released from Lake Sherburne to be diverted into the St. Mary Canal.

Similar water-control and delivery structures have been built in Alberta (Figure 1). A diversion dam about 20 km downstream from the international boundary diverts water from the St. Mary River into the Kimball Irrigation Canal. A large and complex canal system transfers water from the Waterton and Belly rivers east to the St. Mary River. Water is conveyed about 10 km to the

Belly River from Waterton Reservoir, an impoundment on the Waterton River. One km downstream, a diversion dam on the Belly River diverts the water into another canal, which transfers the water about 40 km to St. Mary Reservoir.

Fish Species

The occurrence of natural year-round barriers to the movements of fish, along with the stocking of nonnative fish species, have greatly influenced the historic and contemporary distributions of fishes in the St. Mary River drainage. Waters upstream from those year-round barriers that were historically barren of fish include the upper Red Eagle, Swiftcurrent, Kennedy and Otatso Creek watersheds, and the headwaters of the St. Mary River itself.

Among the fish species native to the drainage, bull trout, westslope cutthroat trout, and mountain whitefish (*Prosopium williamsoni*) are believed to have occurred naturally in all the streams and lakes of the St. Mary drainage to which they had access, while lake trout inhabited only the St. Mary and Lower St. Mary lakes. A degree of habitat partitioning between bull trout and lake trout may have resulted from competition between these highly piscivorous species (Fredenberg 1996; Donald and Alger 1993). Also indigenous to the drainage are northern pike (*Esox lucius*) and burbot (*Lota lota),* which inhabit the larger lakes, and white sucker (*Catostomus commersoni*), longnose sucker (*Catostomus catostomus*), lake chub (*Couesius plumbeus*), trout-perch (*Percopsis omiscomaycus*), longnose dace (*Rhinichthys cataractae*), pearl dace (*Semotilus margarita*), mottled sculpins (*Cottus bairdi*), and spoonhead sculpins (*Cottus ricei*), which inhabit many of the streams and lakes of the drainage to which the fish had natural access (Brown 1971).

Stocking of nonnative and native fishes in the St. Mary River drainage began in the late 1890s and continued in the park until the mid-twentieth century. Today, stocking of nonnative species continues in some waters on tribal lands. Nonnative fishes that have established self-sustaining stocks within the St. Mary drainage include Yellowstone cutthroat trout (*O. clarki bouvieri*), rainbow trout (*O. mykiss*), and the hybrids of those two fishes, as well as brook trout, kokanee (*O. nerka*), and lake whitefish (*Coregonus clupeaformis*). Brook, rainbow, and Yellowstone cutthroat trout (and their hybrids) inhabit Gunsight and Red Eagle lakes (Fredenberg 1996; Michels 1996); Yellowstone cutthroat trout occur in Flattop Lake, located at the head of a small

nameless tributary to Boulder Creek (R. Wagner, Service, personal communication), and in Slide Lake, where they have apparently interbred with rainbow trout (Fredenberg 1996; Michels 1996); and rainbow trout, brook trout, and kokanee occur in Lake Sherburne, along with native mountain whitefish, burbot, northern pike, and suckers (Fredenberg 1996; Wagner and Fitzgerald 1995). Upstream from Lake Sherburne, introduced rainbow and brook trout have established reproducing populations in the several small lakes that were formerly barren of fish.

Self-sustaining stocks of native fishes have also been established in formerly fishless waters in the St. Mary River drainage. Around the turn of the century, bull trout are believed to have been introduced to Cracker Lake, where they persist today as an abundant population of slow-growing fish (Fredenberg 1996; Michels 1996).

According to Fitch (1994), bull trout in the entire Oldman River drainage have declined substantially from historic levels and now occupy about 30% of their historic range, and only remnant populations remain in Lee Creek basin and St. Mary River drainage in Montana and Alberta. Electrofishing surveys conducted in the St. Mary River and its tributaries in 1993 and 1994 found no bull trout and few cutthroat trout (Wagner and Fitzgerald 1995). Fredenberg (1996) noted, however, that anglers still reported catching bull trout from the St. Mary River in Canada. Resident bull trout inhabit the Slide Lakes, formed by the landslide, and the stretch of Otatso Creek from the slide downstream to the waterfall.

The westslope cutthroat trout may have never attained widespread abundance in the St. Mary River drainage (Marnell 1988; Marnell, NPS, *pers. comm.* 1999). Westslope cutthroat trout stocks that became established in the Glacier National Park part of the drainage probably maintained viable populations only in streams where they were secure from the highly predacious, native lake trout that subsequently and naturally colonized the St. Mary lakes. Today, westslope cutthroat trout survive only as isolated stocks in a few headwater streams along the park's east boundary (Marnell 1988).

METHODS

Electrofishing (1998-1999)

Electrofishing was used to characterize the fish communities and determine the status and distributions of bull trout and westslope cutthroat trout in representative reaches of Kennedy, Otatso, Boulder, Divide, Lee, and Wild creeks, and their tributaries. Sampling was conducted between mid-July and late August 1998 and 1999, when stream flows were generally low and waters were clear. Tributaries that appeared--upon inspection of their lower reaches--to be too small or to have gradients too high to support fish were not surveyed. Fish were captured using a Smith-Root battery-powered backpack electrofisher (Model 15-B) operated at 500-800 V and 25-30 Hz DC, depending on stream temperature and conductivity. Single electrofishing passes were made through each stream reach, and all cover types were sampled. No estimates of size of fish populations were made.

Captured fish were identified to species, counted, and marked with fin clips. Because cutthroat and rainbow trout coexist in these systems and are likely to interbreed and produce fertile hybrids (CTT × RBT), captured fish of these two species were totaled together. Total length (TL, mm) and weight (g) were measured and recorded for each trout. Scales from each bull trout were taken from an area posterior to the dorsal fin and above the lateral line and used in age and growth analyses. Bull trout longer than 200 mm TL were tagged. In 1997, visual implant (V.I.) tags were injected subcutaneously, immediately posterior to the left eye; in 1998-1999, passive integrated transponder (PIT) tags were injected into the dorsal musculature, directly below the dorsal fin. Samples of fin tissue were collected from most bull trout for subsequent mitochondrial DNA analysis. In streams that had cutthroat trout suspected to be westslope cutthroat trout, five trout were sacrificed for subsequent electrophoretic analysis at the University of Montana Salmon and Trout Genetics Lab. A few samples of rainbow and brook trout were also collected for whirling disease analysis at the USFWS Fish Health Lab in Bozeman, MT.

Fish Trapping (1997-1999)

Between about late August and mid-October, 1997-1999, fish traps and associated weirs were operated near the mouths of Boulder, Kennedy, Otatso, and Divide (1997 and 1998 only)

creeks, and in Lee Creek near the international boundary (1999 only), to collect information on migratory bull trout that spawn in these tributary streams (Appendix A). Trapping on Lee Creek was substituted for that on Divide Creek because few bull trout were found in Divide Creek, whereas many large bull trout were captured during electrofishing surveys in Lee Creek in 1998 and 1999. Throughout the trapping period, all traps were cleaned and checked at least daily according to the protocol described in Appendix A. Traps were removed after the downstream migration of bull trout appeared to have ended or weather and related conditions precluded further sampling. Fish captured in the traps were processed as described earlier for electrofishing.

Traps, designed to capture adult bull trout and other downstream-moving fishes, consisted of boxes with weir wings that spanned the entire stream width (5-12 m). Boxes (1.0 m long, 1.0 m wide, and 1.0 m high) had frames made of steel tubing, 1.3-cm mesh galvanized hardware screen walls and bottoms, and hinged plywood lids secured with padlocks. Vexar mesh funnels were fastened to the trap entrances. Weir wings, attached at the funnel entrances and angled upstream to opposing streambanks, directed fish into the boxes and prevented fish passage around the traps. Wings consisted of 1.2-m lengths of 1.3-cm metal conduit, spaced at 2.5-cm intervals, and cabled together to form a "picket fence." Fence posts driven into the stream bottom supported the wings. The 2.5-cm interval between pickets was chosen to minimize the collection of debris while prohibiting the passage of large fish.

Temperatures of the tributaries were continuously monitored (bi-hourly measurements) from late August to mid-October using Onset Optic StowAway® data-loggers. Those electronic recording thermometers were installed at each of the trap sites (Figure 1), and in Swiftcurrent Creek (West Shore Road Bridge) and the St. Mary River (Bureau's Camp Nine Bridge).

Radio Telemetry (1998-1999)

Twenty adult bull trout (>1250 g) captured in the traps in 1998 (4 fish in Boulder, 6 in Kennedy, and 3 in Otatso creeks) and 1999 (3 fish in Boulder, 3 in Kennedy, and 1 in Otatso creeks) were surgically implanted with radio transmitters that had battery lives rated at 400 d. Tracking of these radiotagged fish will provide definitive information on bull trout home ranges and relations between feeding-wintering and spawning habitats. Radio transmitters had external

whip antennas, emitted unique signals in the 30 MHz range, weighed about 25 g, and did not exceed 2% of recipient fish weight in air. Fish to be radio tagged were anesthetized with MS-222 (tricaine methanesulfonate). Transmitters were then inserted internally through a 20-mm incision made anterior to the left pelvic fin and parallel to and 10-mm from the mid-ventral line. We utilized an angiocath (12GA) and the modified shielded needle technique of Ross and Kleiner (1982) to provide an outlet for the external antennae. The antenna exited the body about 20 mm posterior and slightly caudal to the left pelvic fin. Incisions were closed with four or five sutures (3-0 Ethilon, non-absorbable, nylon monofilament, Ethicon Corp.). Surgical procedures lasted 6-10 minutes (mean, 7 min), during which time the fish's gills were continuously irrigated with water and anesthetic. Beginning about 1 minute prior to surgery completion, water alone was used for irrigation to begin the recovery process.

An ATS Model 2100 programmable receiver, equipped with a directional loop antenna, was used to track radiotagged fish. Tracking in Montana was conducted from the ground and from aircraft. In Montana, much of the St. Mary River is accessible by ground vehicles (truck or ATV). Ground-based tracking consisted of driving along the bank of the stream and stopping periodically to search for signals from deployed transmitters. Because access in Canada was much more limited, only aerial searches were performed. Aerial tracking was conducted from a fixed-wing aircraft (Cessna 185) that had a loop antenna attached to each wing strut and flew 90-120 km/hr, about 100 m above the water surface. Frequencies of deployed transmitters were sequentially scanned at 2-4 s intervals using the programmable receiver. The river corridor was flown in both downstream and upstream directions. The location of maximum signal strength was considered the location of the tagged fish. Locations of radio signals, nearby landmarks, and other notes were marked on topographic maps.

In addition, two ATS Model DCC II data loggers, operated in concert with the aforementioned receiver and antenna, were established as stationary, continuously operated receiving stations on the St. Mary River (Figure 1). The first receiving station was installed in January 1999 at the Bureau Camp Nine Compound, about 17 km downstream from Lower St. Mary Lake. That station's antenna was fastened atop the shop building, about 30 m from and 20 m above the river. The second receiving station was installed in January 2000 at the Cooke Ranch headquarters, on the international border, about 11 km downstream from the first station and 28 km downstream

from Lower St. Mary Lake. That station's antenna was fastened atop a ranch shed, 10 m from and 10 m above the river. Both receiving stations operated constantly and scanned sequentially (10 s per frequency) for each of the deployed radio transmitters.

Redd Surveys (1997-1999)

Estimation of redd abundance has been important in monitoring trends in many salmonid populations. Preliminary redd surveys were conducted in Boulder, Kennedy, Otatso and Divide creeks in 1997 to locate spawning areas and establish a possible baseline of redd numbers for future monitoring of the St. Mary drainage bull trout population. Most surveys were conducted in mid-October, after data obtained from operation of the fish traps suggested most adult migratory bull trout had departed the tributary steams. Because no bull trout were found in Divide Creek, that stream was surveyed in 1997 only.

Redd surveys were conducted in a manner similar to that described by Spalding (1997). In 1997, the initial survey year, surveys were made of all likely spawning habitat to establish index areas for subsequent annual surveys. The survey crew of 2-4 members walked the length of each stream and searched for redds until a barrier to the upstream movement of fish was encountered. Upon discovery of a potential redd, its validity was decided by consensus among crew members. Brief descriptions of redds and spawning areas were recorded, and redd locations were marked on topographic maps. In 1998 and 1999, only known spawning areas (i.e., the index areas determined in 1997) were surveyed for redds.

Saint Mary Canal Gillnetting (1999)

Gillnetting and seining were conducted in the St. Mary Canal in mid-October 1999 to assess fish loss to the canal system. Experimental gill nets were set after the irrigation season had ended and canal flows were substantially reduced. Nets were set in slow-moving water at various locations along the canal between the headgates and the Kennedy Creek crossing, including the pool directly below the headgates, bay-like backwaters, and several straight reaches along the canal. Water depths at sampling locations ranged from 0.5 to 1.5 m. In addition, the two water-release tubes in Sherburne Dam were seined on 28 September, while the dam was closed and the water in the tubes had been drawn down for dam repairs.

RESULTS

Electrofishing Surveys

Electrofishing surveys were conducted in the Boulder Creek drainage during the week of 28 July 1998 and on 23 August 1999. Bull trout (46-648 mm total length), cutthroat × rainbow hybrids (106-458 mm TL), brook trout (87-238 mm TL), and mountain whitefish were captured at several locations 4-8 km upstream from the Glacier National Park boundary (Appendix B, Tables 6 and 7 and Figure 10). Many large (>400 mm) adult bull trout were captured just downstream from the stretch of entirely subsurface flow (about 6 km upstream from the park boundary). One of the 12 (8%) adult bull trout caught in 1998 and 8 of the 10 (80%) adult bull trout caught in 1999 had been captured and marked in previous years. The region of subsurface flow is apparently only a seasonal barrier to fish movement because each species of fish found downstream in Boulder Creek was also captured upstream from the barrier. The tributaries to Boulder Creek appeared too small or too high-gradient to support fish, and were not electrofished.

The Kennedy Creek drainage was surveyed the weeks of 13 July and 27 July 1998 and the weeks of 26 July, 9 August and 25 August 1999, at several locations in Glacier National Park and on the Blackfeet Reservation. No fish were encountered upstream from the waterfall at the Poia Lake outlet. Downstream from the waterfall, bull trout (range, 40-725 mm TL), cutthroat × rainbow trout hybrids (103-411 mm TL), brook trout (92-275 mm TL), and many mountain whitefish were captured (Appendix B, Tables 8 and 9 and Figure 10). In both years, many large (>400 mm TL) adult bull trout were captured from a 3-km stretch of Kennedy Creek, immediately downstream from the park boundary, 4 km downstream from the known bull trout spawning area. Seven of the 22 (32%) adult bull trout caught in 1998 and 9 of the 22 (41%) adult bull trout captured in 1999 had been captured and marked in previous years. About 3 km upstream from the Park boundary, a tributary enters Kennedy Creek from the north and appeared large enough to support fish; however, a large waterfall (20 m high) near the tributary's confluence with Kennedy Creek prohibits fish passage upstream. All other tributaries to Kennedy Creek appeared too small or too high-gradient to support fish, and were not electrofished.

The Otatso Creek drainage was surveyed the week of 20 July 1998 and the weeks of 6 August and 19 August 1999. A few bull trout (218-419 mm TL), cutthroat × rainbow hybrids (80-235 mm TL), and mountain whitefish were captured from lower Otatso Creek, downstream from the waterfall near the park line (Appendix B, Table 10 and Figure 11). In that reach, two tributaries enter Otatso Creek from the south, one near the park boundary and the other near the confluence with Kennedy Creek. Although both streams appeared large enough to support fish, none was encountered during electrofishing surveys. About 3 km upstream from the waterfall, a large landslide across Otatso Creek is a barrier to fish movement during the period of seasonal low flows. In the stretch of Otatso Creek between the waterfall and the landslide, abundant resident bull trout (69-493 mm TL) coexist with small populations of cutthroat × rainbow trout hybrids (105-228 mm TL) and mountain whitefish (Appendix B, Tables 11 and 12 and Figure 11). Slide Lakes, formed upstream from the landslide, support resident populations of bull trout and cutthroat × rainbow hybrids. Otatso Creek is fishless above a large waterfall (50 m high), about 1 km upstream from the lakes. Bull trout (62-572 mm TL) and cutthroat × rainbow hybrids (115-341 mm TL) were captured in the stretch of Otatso Creek between the waterfall and the lakes, and in the 200-m stretch between the two lakes (Appendix B, Table 13 and Figure 11).

The upper Divide Creek drainage was surveyed 8 July 1998 at several locations within Glacier National Park, from its head to the park boundary. No bull trout and only two cutthroat trout (80 and 220 mm TL) were captured. Both cutthroat trout were captured just inside the park boundary. Lower Divide Creek was surveyed at several locations along a stretch from its mouth to the park boundary on 5 August 1999. The few fish (Appendix B, Table 14) encountered were cutthroat × rainbow hybrids (69–186 mm TL) and mountain whitefish. Although no barriers to the upstream movement of fish were encountered in Divide Creek itself, high-gradient cascades probably prohibit fish passage into the few small tributaries of Divide Creek.

Upper Wild Creek was surveyed on 27 July 1998 and 23 July 1999 at several locations along a 2-km stretch near the park boundary. The creek appears to be barren of fish in its upper reach, upstream from a series of temporary barriers (small logjam-waterfall-cascade complexes) about 1 km upstream from the park boundary. The middle reach of Wild Creek (immediately downstream from the barriers) supports a population of small (55-197 mm TL) cutthroat trout (Appendix B, Table 15 and Figure 12). A sample (N=13) of cutthroat trout collected from that

reach in 1998 was subsequently determined to consist of genetically pure westslope cutthroat trout by the Wild Trout and Salmon Genetics Lab in Missoula, Montana. (This was the only sample of cutthroat trout subjected to such laboratory analysis during the study. All other cutthroat trout captured during the study were deemed "hybrids" on the basis of phenotypic characteristics.) Although no other fish species were captured from that middle reach, 1.5 km downstream, near the creek's confluence with the St. Mary River, small rainbow and brook trout were found.

Lee Creek was surveyed at several locations upstream from the Chief Mountain Highway, in northeast Glacier National Park, on 18 August 1998 and 24 July and 24 August 1999. Bull trout (52-592 mm TL), cutthroat × rainbow hybrids (70-382 mm TL), and mountain whitefish were captured (Appendix B Tables 16 and 17 and Figure 10).

Jule, Middle Fork Lee, and East Fork Lee creeks (all small tributaries to Lee Creek) and Roberts Creek (small tributary to the St. Mary River), were surveyed the weeks of 11 August 1998 and 10 August 1999, both upstream and downstream from their crossings with the Chief Mountain International Highway. The lower 4 km of Jule Creek, entirely within Glacier Park, provides summer habitat for juvenile bull trout (89-148 mm TL) and cutthroat × rainbow hybrids (63-195 mm TL) (Appendix B, Table 18 and Figure 12). Middle Fork Lee Creek is highly impacted by human activities. Streamside grazing and logging result in heavy silt loads and turbidities, and the suspended highway culvert constitutes a barrier (2-m waterfall) to the upstream movement of fish. Upstream from the culvert, no fish were captured from a 200-m reach, whereas two bull trout (175-235 mm TL) and several cutthroat × rainbow hybrids (115-234 mm TL) were captured from a 500-m reach downstream from the culvert (Appendix B, Table 19 and Figure 12). Although similarly impacted by grazing and logging, East Fork Lee Creek supports a population of small cutthroat trout (96-217 mm TL) of unknown genetic characteristics (Appendix B, Table 20). Five cutthroat trout (98-177 mm; unknown genetic characteristics) were captured from a pool below the highway culvert on Roberts Creek, a tiny stream too small to shock effectively (Appendix B, Table 20).

Fish Trapping

Stream Temperatures

Stream temperatures during the trapping periods were warmest in 1998 and coolest in 1999 (Figure 2). Although seasonal temperature trends were similar between the five study streams, Kennedy Creek generally exhibited the warmest temperatures in all years, followed by Otatso, Boulder, Divide, and Lee Creek, respectively (Figure 2 and Appendix C Table 21). Mean-daily temperatures in Swiftcurrent Creek and the St. Mary River, however, were significantly higher than those of the other streams throughout most of the trapping periods. Temperature data for Swiftcurrent Creek downstream from Sherburne Dam were not collected after about the first week of October.

Fish Captured in Traps

Throughout most of the annual trapping periods, weather conditions were mild and stream flows were clear, consistent, and manageable, resulting in nearly ideal trapping conditions. An exception occurred during the latter half of the trapping season in 1999, when high winds and frequent rains resulted in high flows and an unusually high load of aspen (*Populus tremuloides*) leaves in the streams. The leaves clogged the weirs, causing daily "blowouts" at all locations and allowing some fish passage around traps. Minor problems included overcrowding of fish in the traps, and mink predation that resulted in the loss of several whitefish, cutthroat trout, and five bull trout. Mink traps set at the sites captured one mink in 1997, seven in 1998, and none in 1999.

Bull trout were captured in each of the traps in each of the years between 1997 and 1999, except in the Divide Creek trap in 1998. Traps captured a total of 691 salmonids in 1997, 787 in 1998, and 548 in 1999 (Table 1 and Appendix D Tables 22-32). Although the traps were designed to capture adult bull trout, appreciable numbers of small bull trout and other small fish were also captured. Native fish species caught were bull trout, cutthroat trout, mountain whitefish, white suckers, mountain suckers, longnose suckers, longnose dace, and sculpins. Nonnative fish included rainbow trout, cutthroat × rainbow hybrids, and brook trout.

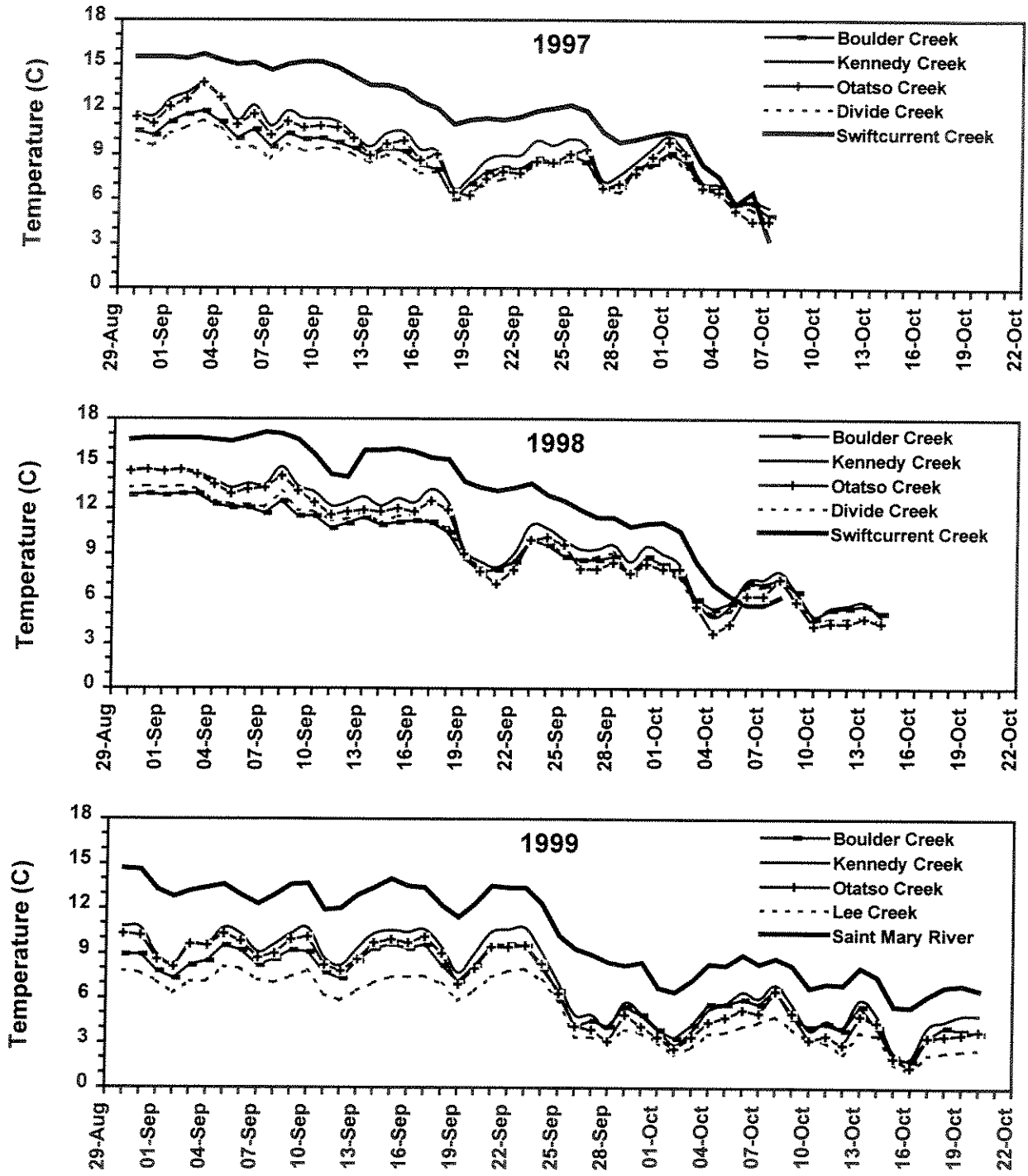

Figure 2. Mean-daily temperatures (°C) of Boulder, Kennedy and Otatso creeks, August-October., 1997-1999; Divide and Swiftcurrent creeks, August-October., 1997-98; and Lee Creek and the St. Mary River near Camp Nine, August-October., 1999, St. Mary drainage, Montana.

Table 1. Total numbers of salmonids captured in fish traps, St. Mary River drainage, Montana, 1997-1999.

Trap Site	Juvenile Bull Trout (<30cm)			Adult Bull Trout (>30 cm)			Cutthroat × Rainbow			Brook Trout			Mountain Whitefish			Totals		
	1997	1998	1999	1997	1998	1999	1997	1998	1999	1997	1998	1999	1997	1998	1999	1997	1998	1999
Boulder	30	23	36	17	64	23	27	15	26	0	2	1	63	132	49	137	236	135
Kennedy	1	6	10	32	38	20	13	6	7	0	0	0	181	147	82	227	197	119
Otatso	1	17	6	16	19	11	16	19	15	0	0	0	220	278	152	253	333	184
Divide	0	0	--	2	0	--	27	3	--	1	0	--	44	18	--	74	21	--
Lee	--	--	69	--	--	19	--	--	19	--	--	0	--	--	3	--	--	110
Totals	32	46	121	67	121	73	83	43	67	1	2	1	508	575	286	691	787	548

Total annual captures of bull trout and other fish species in the Boulder, Kennedy, and Otatso Creek traps declined markedly in 1999. However, with the addition in 1999 of the Lee Creek trap, in which 88 bull trout were captured, overall bull trout captures increased. A total of 194 bull trout (137-695 mm TL) was captured in the fish traps in 1999, compared to 167 (160-690 mm TL) in 1998 and 99 (156-720 mm TL) in 1997. Mountain whitefish dominated the catch at all trap sites except Lee Creek and accounted for over 50% of the total catch in all years, followed by bull trout (15% in 1997, 21% in 1998, and 35% in 1999) and CTT × RBT hybrids (12% in 1997, 6% in 1998 and 12% in 1999). In all years, the Otatso Creek trap yielded the largest overall catch (mainly mountain whitefish); however, most large (>30 cm long) bull trout were captured in the Kennedy trap in 1997 (48%) and in the Boulder trap in 1998 (53%) and 1999 (32%). The largest sample of juvenile (<30 cm) bull trout was captured in the Boulder trap in 1997 and 1998 and in the Lee Creek trap in 1999. Ninety-four percent and 50% of the juvenile bull trout (<30 cm) captured in the fish traps in 1997 and 1998, respectively, were captured in Boulder Creek; however, the Lee Creek trap yielded 57% of all juveniles caught in 1999. Total numbers, and means and ranges in total lengths, weights, and condition factors for all bull trout captured in the fish traps are presented in Table 2. Although outmigrating adult bull trout were captured shortly after the traps were installed in all years, most were captured after mid-September (Figure 3).

Total lengths of all bull trout captured in the fish traps averaged 354 mm (range, 137-720 mm) during the three years of trapping. Adult migrants averaged 495 mm (304-720 mm) in 1997, 470 mm (307-690 mm) in 1998 and 479mm (321-695 mm) in 1999, respectively. Length-frequency distributions for all bull trout captured in the Boulder, Kennedy, Otatso, and Lee Creek fish traps are provided in Figures 4-6.

Age and Growth Analysis (1997-1999)

Results of age and growth analysis of 74 bull trout scale samples collected in 1997 are presented in Appendix G, Tables 34-35. Scales obtained from bull trout captured in 1998 and 1999 are being analyzed as part of a companion study that should be completed in spring 2001. Similarly, genetic and disease analyses have not yet been completed.

Table 2. Total numbers and means and ranges in total lengths, weights, and condition factors for all bull trout captured in the Boulder, Kennedy, Otatso, and Lee Creek fish traps, St. Mary River drainage, Montana, 1997-1999.

Trap Site		Juvenile Bull Trout (<30 cm)			Adult Bull Trout (>30 cm)		
		1997	1998	1999	1997	1998	1999
BOULDER	Total Number	30	23	36	17	64	23
	Mean Length (mm) Range	211 178-255	183 163-235	180 158-216	494 416-586	493 311-690	538 389-695
	Mean Weight (g) Range	81 44-144	47 24-104	47 32-86	1048 654-1650	1121 306-2678	1532 582-3220
	Mean Condition (K) Range	0.83 0.72-0.90	0.73 0.46-0.89	0.79 0.65-0.90	0.86 0.75-1.09	0.86 0.66-1.17	0.92 0.74-1.16
KENNEDY	Total Number	1	6	10	32	38	20
	Mean Length (mm) Range	156 ---	230 190-279	189 145-213	513 356-720	442 316-650	478 361-603
	Mean Weight (g) Range	26 ---	107 52-200	59 26-86	1172 406-2504	808 256-2236	968 430-1700
	Mean Condition (K) Range	0.69 ---	0.83 0.76-0.92	0.83 0.77-0.89	0.82 0.62-1.08	0.84 0.74-1.00	0.85 0.74-0.91
OTATSO	Total Number	1	17	6	16	19	11
	Mean Length (mm) Range	196 ---	203 166-291	207 185-246	463 304-617	448 307-615	441 321-531
	Mean Weight (g) Range	58 ---	75 34-246	72 46-120	840 234-1720	829 298-2108	779 288-1272
	Mean Condition (K) Range	0.77 ---	0.79 0.71-1.00	0.78 0.73-0.88	0.79 0.64-1.04	0.86 0.67-1.08	0.86 0.76-1.06
LEE	Total Number			69			19
	Mean Length (mm) Range			184 137-289			432 358-580
	Mean Weight (g) Range			53 20-190			720 358-1710
	Mean Condition (K) Range			0.80 0.57-0.96			0.84 0.75-0.94

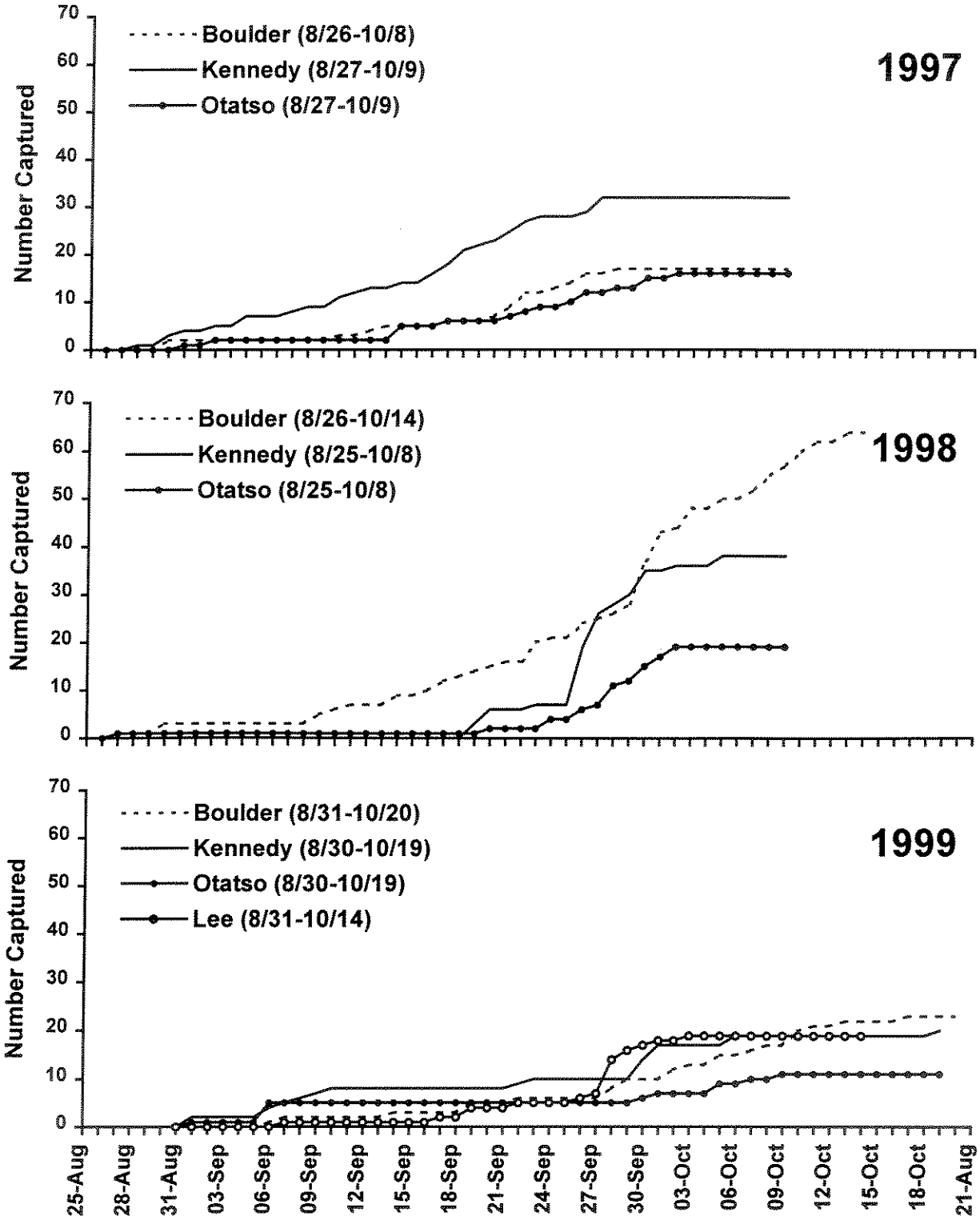

Figure 3. Cumulative catches of downstream-migrating adult bull trout in the Boulder, Kennedy, Otatso, and Lee creek fish traps, St. Mary River drainage, Montana, August-October, 1997-1999.

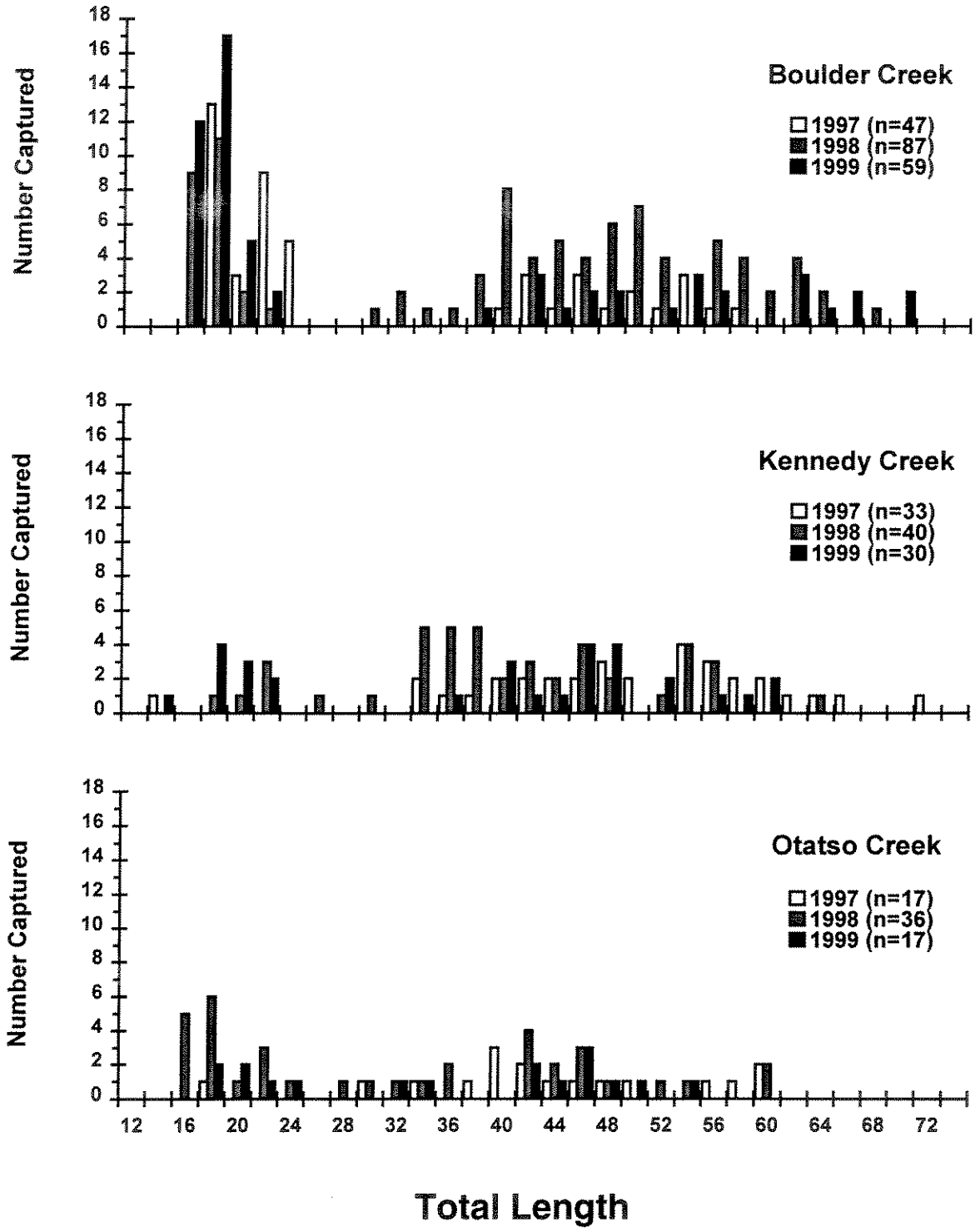

Figure 4. Length-frequency distributions for all bull trout captured in the Boulder, Kennedy and Otatso Creek fish traps, St. Mary River drainage, Montana, 1997-1999.

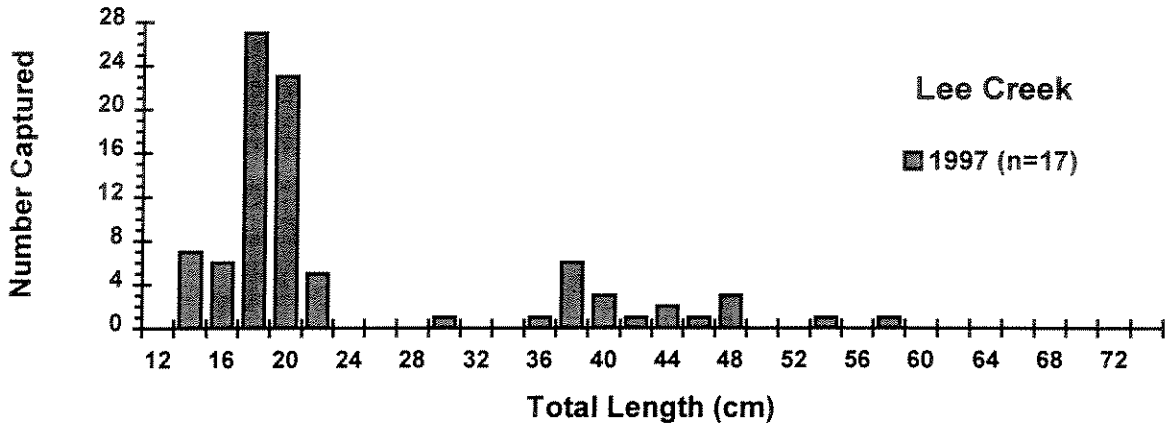

Figure 5. Length-frequency distribution for all bull trout captured in the Lee Creek fish trap, St. Mary River drainage, Montana, 1999.

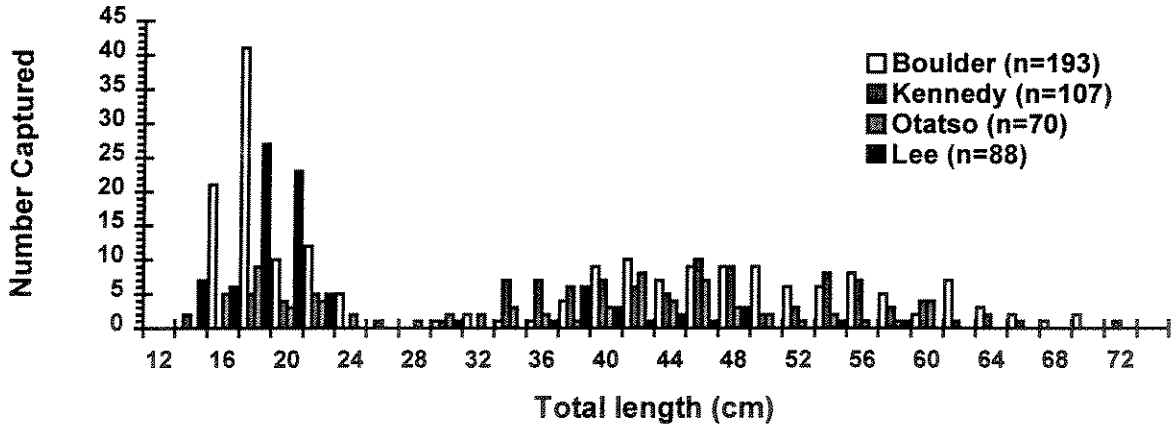

Figure 6. Combined length-frequency distribution for all bull trout captured in fish traps, Saint Mary River drainage, Montana, 1997-1999 (Lee Creek 1999 only).

Movements of Bull Trout

V.I. and PIT Tagged Fish

Altogether, 361 bull trout (> 200 mm TL) received either V.I. or PIT tags over the course of the 3-year study (Table 3). Of the total, 184 bull trout were captured and marked at the fish traps (1997-1999) and 177 were captured and marked during electrofishing surveys (1998-1999). There have been 70 subsequent recaptures of tagged bull trout in traps or by electrofishing. Twenty-three (34%) and 9 (13%) of the 67 bull trout captured in 1997 were recaptured during trapping or electrofishing in 1998 and 1999, respectively. Five (7%) fish were recaptured in both 1998 and 1999. Forty-three (22%) of the 194 bull trout marked in 1998 were recaptured during trapping and/or electrofishing in 1999. Tags, retained in 65 (93%) of the 70 recaptured fish, allowed estimation of individual growth rates for these bull trout (Appendix E, Table 33).

Because the electrofishing surveys were conducted earlier in the season and upstream from the traps, bull trout could be caught multiple times (e.g., by both electrofishing and in traps) in a single season. However, in both 1998 and 1999, few of the bull trout captured by electrofishing were subsequently recaptured at the traps. In 1998, 5 of 12 (42%) and 8 of 29 (28%) bull trout marked while electrofishing in Boulder and Kennedy creeks, respectively, were subsequently recaptured in traps. In 1999, 4 of 9 (44%), 5 of 26 (19%), 0 of 8 (0%), and 3 of 8 (38%) bull trout marked while electrofishing in Boulder, Kennedy, Otatso, and Lee creeks, respectively, were subsequently recaptured in traps. None of the 80 ostensibly resident bull trout that were tagged during electrofishing surveys in upper Otatso Creek was subsequently recaptured downstream in the Otatso Creek trap.

Most (89%) recaptures of tagged bull trout between years occurred in the stream from which the fish was originally captured. However, eight instances occurred of a bull trout marked in one stream being recaptured in another stream. Three bull trout tagged in Kennedy Creek (2 fish) and Otatso Creek (1 fish) in 1998 were recaptured in Boulder Creek in 1999. Three bull trout tagged in Otatso Creek in 1998 were recaptured in Kennedy Creek in 1999, and two bull trout tagged in Kennedy Creek (one in 1997 and one in 1998) were recaptured in Otatso Creek in 1998 and 1999, respectively.

Table 3. Total numbers of bull trout (>200 mm) tagged (V.I. and PIT) in the St. Mary drainage, Montana, 1997-1999 (numbers in parenthesis indicate the proportion of the Otatso Creek totals that were tagged in the upper Otatso/Slide Lake resident bull trout population.

Year and Location		Boulder Creek	Kennedy Creek	Otatso Creek	Lee Creek	Divide Creek	Combined Total
1997 V.I. TAGS	Fish Traps	17	32	16	---	2	67
1998 PIT TAGS	Electrofishing	11	29	39 (39)	25	---	104
	Fish Traps	51	25	14	---	0	90
	Combined	62	54	53	25	0	194
1999 PIT TAGS	Electrofishing	2	17	46 (41)	8	---	73
	Fish Traps	7	6	4	10	---	27
	Combined	10	23	50	18	---	101
Grand Total		88	109	119(80)	43	2	361

Radiotagged Fish

Twenty adult bull trout (13 in 1998 and 7 in 1999) captured in the traps during the post-spawn, downstream migration were implanted with radio transmitters (Table 4, Figure 7). Subsequent contact has been made with 19 of the 20 radio transmitters. The whereabouts of only one bull trout (fish code O2, Table 4), an Otatso Creek fish implanted in 1998, remain unknown.

In 1999, searches for radiotagged fish were limited to ground-based tracking due to poor flying conditions (high winds) throughout most of the winter and spring. Searches were made about monthly from January to May, during which time signals from 7 of 13 radios (3 from Boulder, 2 from Kennedy, and 2 from Otatso creeks) were located in Montana (Figure 8). Except for short movements (< 100 m), all bull trout remained stationary during that period. Distances traveled

Table 4. Total length, weight, and transmitter frequency of all 20 adult bull trout implanted with radio transmitters at the fish traps, St. Mary River drainage, 1998-1999.

Location	Fish Code	Year Implanted	Length (mm)	Weight (g)	Frequency (MHz)
Boulder	B1	1998	566	1532	30.100
	B2	1998	623	1772	30.120 (a)
	B3	1998	585	1638	30.140
	B4	1998	611	1871	30.160
	B5	1999	518	1248	30.110
	B6	1999	662	2152	30.120 (b)
	B7	1999	643	2448	30.130
Kennedy	K1	1998	532	1306	30.020
	K2	1998	542	1396	30.040
	K3	1998	570	1510	30.180
	K4	1998	560	1604	30.200
	K5	1998	577	1602	30.240
	K6	1998	650	2236	30.270
	K7	1999	525	1214	30.150
	K8	1999	580	1666	30.261
	K9	1999	590	1700	30.281
Otatso	O1	1998	606	2108	30.060
	O2	1998	548	1302	30.080
	O3	1998	525	1248	30.220
	O4	1999	531	1272	30.191

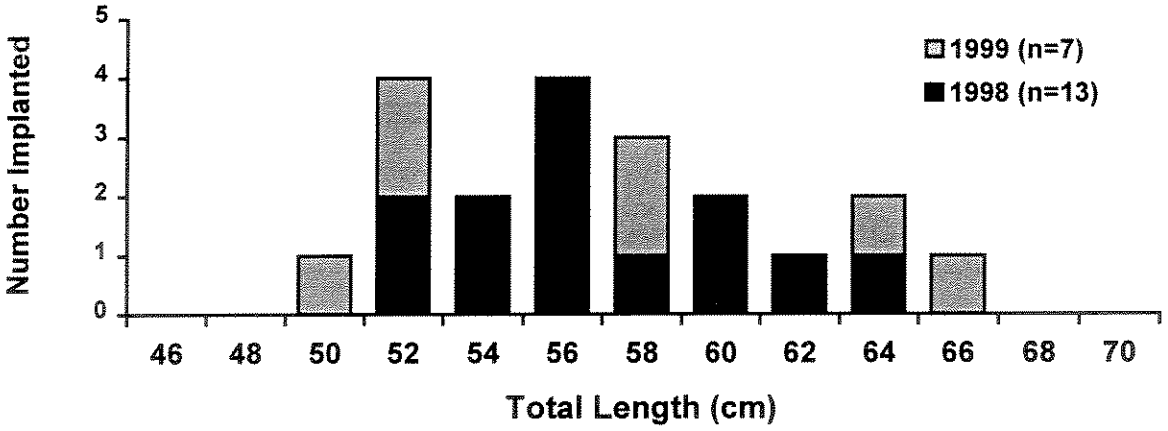

Figure 7. Length-frequency distribution of 20 adult bull trout implanted with radio transmitters, St. Mary River drainage, 1998-1999.

between tagging locations and wintering areas ranged from 0.9 to 23.3 km (mean, 8.9 km) for these seven fish. A bull trout (K3) that wintered near the international border was subsequently recaptured in Kennedy Creek during electrofishing surveys in August 1999, and, subsequently, in the Kennedy Creek trap in October. Bull trout B3 was recaptured at the Boulder Creek trap in October, but had not been located during preceding searches.

At least three radiotagged bull trout died in 1999. Two were Boulder Creek fish (B2 and B4) that swam a short distance up--and may have attempted to over-winter in--Swiftcurrent Creek. Sometime after their upstream movements, flows from Sherburne Dam were turned off and the fish may have become stranded in shallow pools, where they subsequently perished under the ice. The B2 radio, recovered in the spring 1999, was subsequently re-implanted in another Boulder Creek fish (B6) that fall. Another Boulder Creek fish (B1) also ascended Swiftcurrent Creek before flows diminished but entered the outlet works of Sherburne dam, where it over-wintered in a deep pool inside the dam. Periodic contact was made with that fish until flows were released from the dam in May. A third confirmed mortality, a Kennedy Creek fish (K4), died after moving approximately 16 km downstream, where it spent the winter in the St. Mary River. Fish K4 also traveled a few hundred meters upstream, however, before it ostensibly died in the spring.

In 2000, the single ground-based search in January located two radioed bull trout near the international border, one of which (K3) was found in the same pool it had occupied the previous winter. On 2 February, an aerial search of the river between St. Mary Lake and St. Mary Reservoir, Alberta, and the Swiftcurrent drainage up to Sherburne Reservoir, located 13 of the 17 deployed transmitters (Figure 8). Among them, eight had been deployed in 1998 and five in 1999. Distances traveled between tagging and wintering areas ranged from 2.0 to 70.3 km (mean, 26.0 km). A Boulder Creek fish, B6, had passed over the St. Mary Diversion Dam enroute to wintering habitat 7 km downstream. A second Boulder fish, B7, was found in the deep pool immediately upstream from the diversion dam.

At least three radioed fish were recorded by the stationary receiver at Camp Nine in 1999, including two fish from Kennedy Creek (K3 and K9) and one from Boulder Creek (B2). Bull trout K3 was logged in June while it ascended the river enroute to spawning areas upstream, and

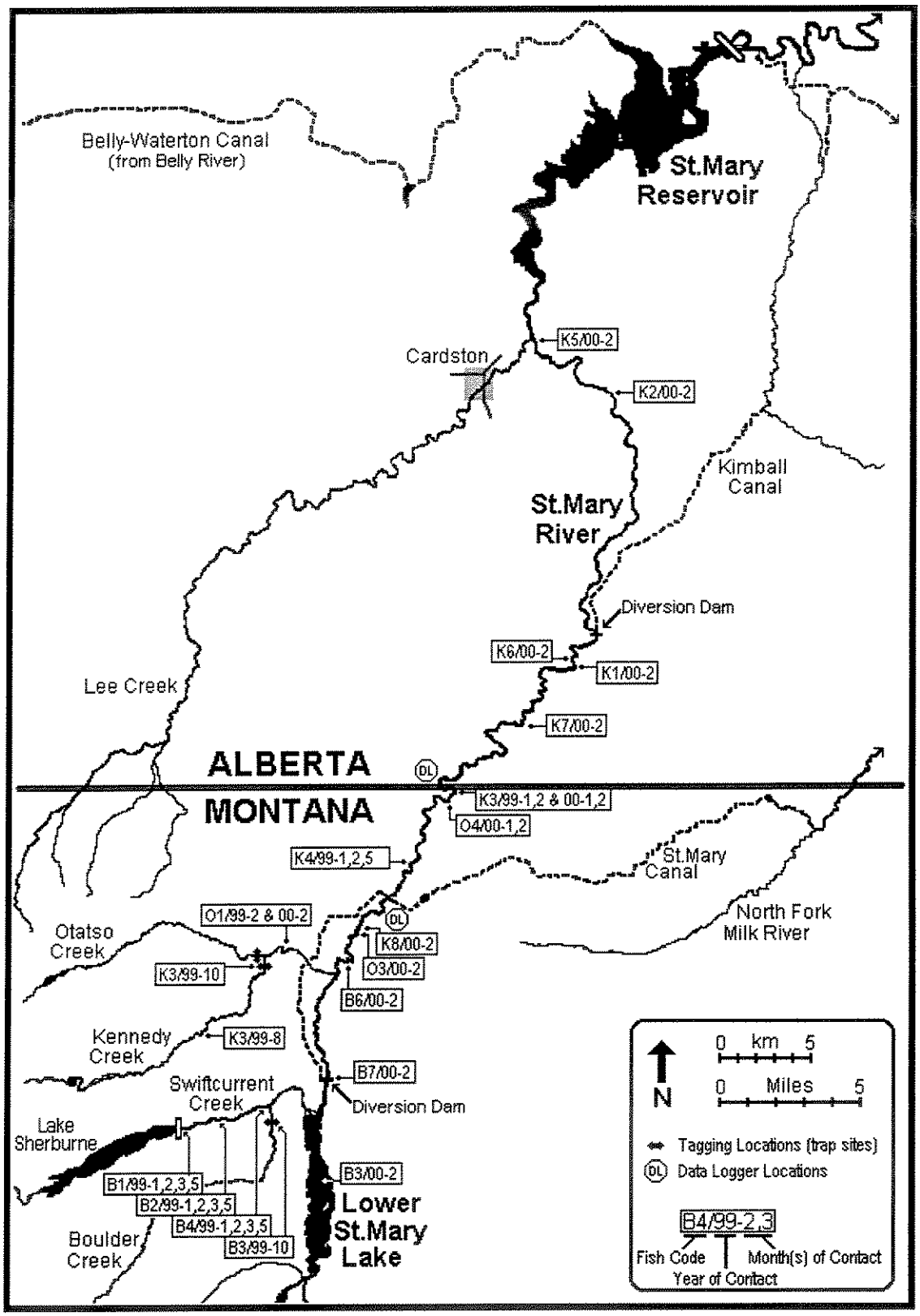

Figure 8. Locations of radiotagged bull trout, St. Mary River drainage, U.S. and Canada, 1999-2000.

again in October while moving back downstream to its wintering area. Bull trout K9 was similarly recorded while moving downstream in October 1999, although that fish was not contacted during the February 2000 aerial survey. Fish B2 was recorded on two occasions, nearly a week apart, in October, but wintered 4 km upstream near the confluence with Kennedy Creek. Bull trout B5 was recorded on 19 and 20 January by the stationary receiver installed at the international border on 12 January.

Redd Surveys

Preliminary redd surveys in 1997 identified bull trout spawning areas in Kennedy and Boulder creeks, both within the boundaries of Glacier National Park (Figure 9). In both streams, spawning occurred just downstream from seasonal migration barriers (regions of entirely subsurface flow during seasonal low-flow periods), in areas of apparent groundwater upwelling. Habitat characteristics in these spawning areas included widened valleys, braided, low-gradient channels with gravel substrates, and beaver activity. Redds were typically associated with some form of cover (undercut banks, root wads, or debris jams) and were constructed in substrates ranging from small cobble (<150 mm diameter) to fine gravel (>10 mm diameter), generally near the stream margins. A few redds were also found in areas of upwelling directly below beaver dams. Although suitable spawning habitat appeared to exist downstream from the spawning areas in Boulder and Kennedy creeks, no redds were identified in those areas. Only 12 redds were identified at the Boulder Creek spawning area in 1997, compared to 42 in 1998 and 20 in 1999. Surveys were conducted nearly a month later in 1997 (11 November) and 1999 (3 November) than in 1998 (14 October), and redds may have been easier to distinguish earlier in the season. At the Kennedy Creek spawning area, 23 and 37 bull trout redds were identified in 1997 (15 October) and 1998 (13 October), respectively (no survey conducted in 1999).

With the exception of two redds found just downstream from Slide Lakes in 1997, no spawning areas were found in the Otatso Creek drainage in 1997 or 1998. Unlike Otatso Creek, where spawning habitat is very limited, Divide Creek has complex habitats suitable for spawning. However, no redds were identified in Divide Creek in 1997 (the only year redd surveys were conducted in this stream), where only two bull trout (one male and one female) were captured in the trap that year.

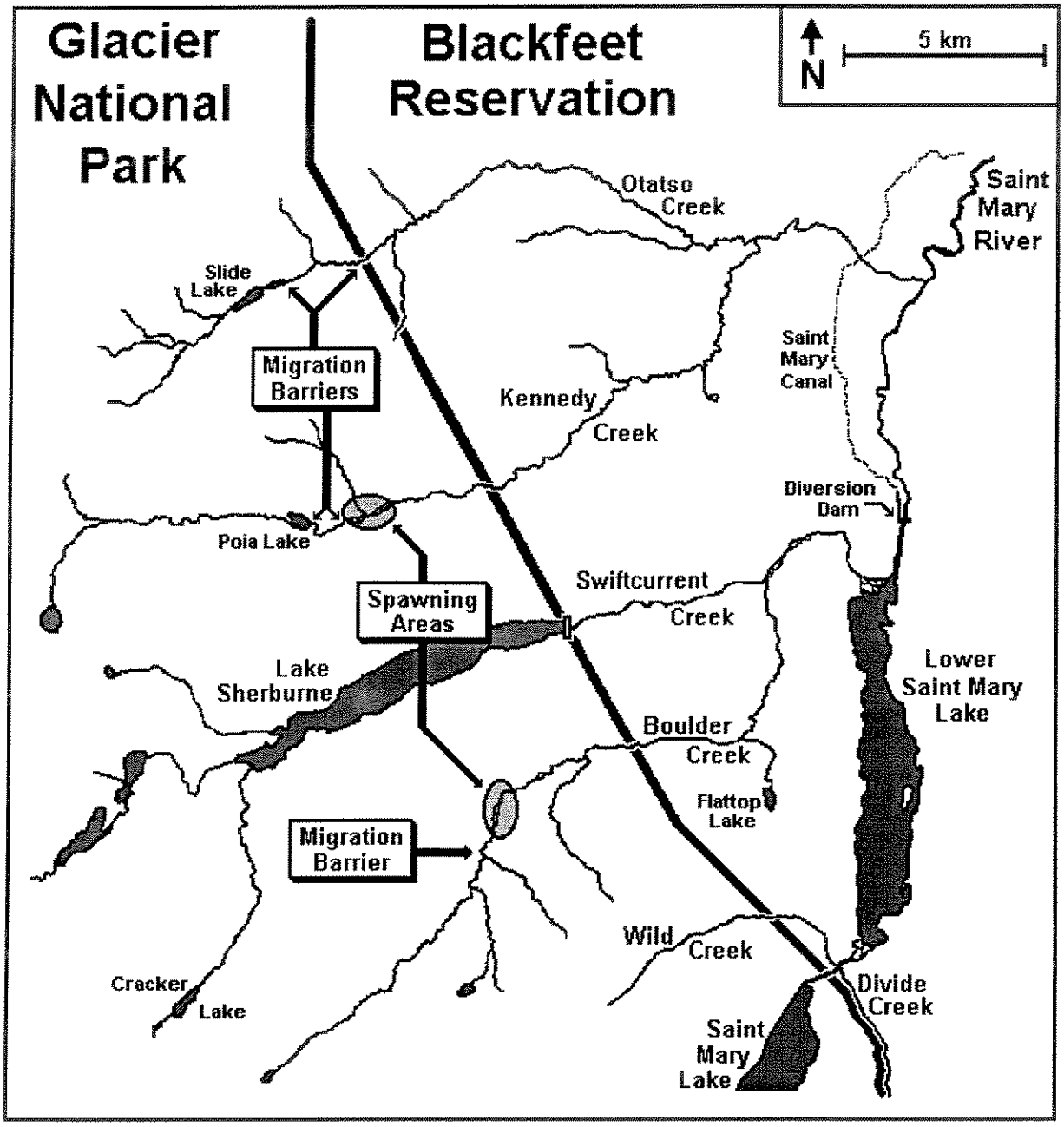

Figure 9. Approximate locations of spawning areas and migration barriers identified during redd surveys in Boulder, Kennedy and Otatso creeks, St. Mary River drainage, October-November, 1997-1999.

Saint Mary Canal Gillnetting

A total of 9 experimental gillnet sets made at six different locations along the first 2 km of the St. Mary Canal yielded 295 fish, including 6 bull trout (Table 5). In addition, 38 fish were seined from the Sherburne Dam outlet works during a temporary dam shut-down on 28 September 1999. Those fish including 1 bull trout (~ 300 mm TL), 6 northern pike, 13 burbot, 12 whitefish, and 6 suckers.

Table 5. Total numbers and ranges of lengths (mm) of all fish captured in experimental gill nets set (1-2 night sets) in the St. Mary Canal at six different locations (0-3 km downstream from headgates), St. Mary drainage Montana, 13-21 October. 1999.

		Bull Trout	CTT × RBT	Mountain Whitefish	Northern Pike	Burbot	Suckers
Pool 1	n	3	2	26	2	0	53
	Length Range (mm)	325-360	295-303	211-386	440-500		307-515
Pool 1	n	2	4	17	1	0	17
	Length Range (mm)	300-322	289-340	214-456	389		277-437
Headgate Pool	n	1	0	17	0	1	1
	Length Range (mm)	332		211-309		230	413
Canal Stretch 1	n	0	0	7	4	0	5
	Length Range (mm)			340-390	615-730		440-480
Pool 1	n	0	1	47	0	0	34
	Length Range (mm)		322	210-380			300-516
Canal Stretch 1	n	0	0	3	1	0	3
	Length Range (mm)			338-388	530		450-488
Pool 2	n	0	0	4	1	0	4
	Length Range (mm)			211-300	220		298-380
Canal Stretch 2	n	0	0	6	1	0	5
	Length Range (mm)			320-368	1090		452-490
Canal Stretch 3	n	0	0	8	7	0	7
	Length Range (mm)			332-370	520-795		440-500
Total		6	7	135	17	1	129

DISCUSSION

Distribution of Bull Trout

During the 3-yr investigation described in the present report, electrofishing and trapping revealed bull trout in each of the principal tributaries of the St. Mary River, while radio telemetry indicated the species ranged throughout much of the mainstem St. Mary River, in Montana and Alberta. Juvenile bull trout were most abundant in Boulder, Kennedy, and Lee creeks, less abundant in lower Otatso Creek, and none was found in Divide Creek. Adult bull trout were found in lower Otatso and Divide creeks but were most abundant in Boulder, Kennedy, and Lee creeks. All age groups of bull trout were abundant in upper Otatso Creek, upstream from the waterfall near the park boundary. Although not collected as part of the study described here, bull trout are also known to occur in Red Eagle Creek and Red Eagle Lake, and in Cracker Lake (Fredenberg 1996a; Michels 1996). Thus, bull trout are widely distributed in the St. Mary River drainage.

Spawning Areas for Migratory Bull Trout

On the basis of the occurrence of redds, spawning areas used by migratory (i.e., fluvial or adfluvial) bull trout were identified in Boulder and Kennedy creeks. Those areas may be the primary spawning areas for migratory bull trout in the St. Mary drainage. Numbers of redds counted in each creek varied among years, perhaps in response to annual variation in the numbers of adult bull trout spawning in those streams. During a 3-yr study in the Belly River drainage, annual numbers of redds were positively related to the numbers of bull trout collected in traps downstream (Clayton 1998).

Bull trout spawning areas in Boulder and Kennedy creeks typically occurred in areas of apparent groundwater upwellings, just downstream from seasonal barriers to the movements of fish. Characteristics of those spawning areas included widened valleys, braided, low-gradient channels with gravel substrates, and beaver activity.

Migratory bull trout probably also spawned in lower Otatso Creek (based on the capture of large, spent adults in the trap), although no redds have been found in that stream, and in Lee Creek. Although redd surveys have not been conducted in Lee Creek, electrofishing surveys, fish

trapping, and reports from anglers indicate the stream is used by large bull trout that may winter in lower Lee Creek.

Movements of Bull Trout

Spawning migrations of adults

Although timing of the upstream migration of adult bull trout in the St. Mary drainage is not known precisely, migrations into the spawning tributaries probably occurred before the traps were installed in late August because electrofishing revealed large numbers of adult bull trout upstream from the traps in July and August and no "blocked" fish were observed downstream from traps. In a similar trapping operation on the North Fork Belly River, in Alberta, the peak upstream migration of bull trout from the mainstem Belly River occurred prior to 23 July 1996, although ripe upstream migrants were captured as late as 23 September, in 1995 (Clayton, 1998; Fox et al. 1996). Adult bull trout in the Flathead River drainage generally entered spawning tributaries between July and September, particularly in August (Fraley and Shepard 1989). Those fish remained in the tributaries for a month or more–occupying deep pools or cover habitats–before spawning. Similar findings were reported for bull trout in Mackenzie Creek, in British Columbia (McPhail and Murray 1979).

Bull trout spawning is generally associated with seasonally declining water temperatures during September and October (Clayton 1998; Fox et al. 1996; Fraley and Shepard 1989; McPhail and Murray 1979) but as early as August in some areas (Goetz 1989; Riehle 1993). Stream temperatures that decline to 9.0°C to 5.0°C have been considered important to initiation of bull trout spawning (Fraley and Shepard 1989; McPhail and Murray 1979), and our data support that association.

Post-spawning bull trout generally move out of the tributaries soon after spawning (Fraley and Shepard 1989; Willamette National Forest 1989). Although we caught most bull trout in traps soon after the waters had cooled and spawning presumably had occurred, many of the adult bull trout that had been captured and marked upstream from the traps during electrofishing surveys in July and August 1998 or 1999 were not subsequently recaptured in the traps that year. That observation suggested either the spawning period extended into late October in those years, after

the traps had been removed, or some post-spawning bull trout lingered in spawning streams before moving back downstream. Alternatively, a portion of the adult fish that we tagged during electrofishing surveys may have consisted of resident fish that live entirely in the upstream areas. In the North Fork Belly River, Alberta, post-spawning bull trout began to be captured in traps in early September, and the downstream migration peaked around 20 September and ended by early October 1995-1997 (Clayton 1998).

Estimates of size of the bull trout spawning runs are not presently available but may be calculable using our recapture data. Such estimates will be provided in subsequent annual reports.

Feeding-wintering Areas for Adult Bull Trout

Radio telemetry revealed that adult bull trout occupied feeding-wintering areas scattered throughout much of the mainstem St. Mary River, as well as areas in two of its tributaries, Swiftcurrent and Kennedy creeks. Feeding-wintering habitats seemed to consist primarily of deep pools. Bull trout tagged in Kennedy and Otatso creeks tended to occupy feeding-wintering areas in the St. Mary River in Montana and Alberta, whereas bull trout tagged in Boulder Creek occupied feeding-wintering areas in Montana. A bull trout tagged in Kennedy Creek subsequently occupied a pool in Kennedy Creek, about 1 km downstream from the trap, in two consecutive winters. In addition, at least one bull trout, tagged in Boulder Creek, used Lower St. Mary Lake as a feeding-wintering area.

Movements of juveniles

Previous studies have indicated that most juvenile bull trout of migratory stocks remain in natal tributaries for one to three years before emigrating downstream to large rivers or lakes (Bjornn 1961; Fraley and Shepard 1989; McPhail and Murray 1979; Oliver 1979). Juvenile bull trout apparently used mainly shallow stream margins to emigrate downstream during June through August in the Flathead drainage (Fraley and Shepard 1989), and throughout the summer and fall in the Wigwam drainage, British Columbia (Oliver 1979). Because our traps were not designed to capture juvenile bull trout and were not installed until late August, the period of juvenile emigration could not be determined.

Bull Trout Life-History Forms

Historically, bull trout potentially moved freely among all of the creeks, rivers and lakes inhabited by the species in the St. Mary River and Belly River drainages. In addition, each of the three life-history forms– resident, fluvial, and adfluvial–would have been represented in that historic, widespread population. In his summary of the current and historical distributions of bull trout in southwestern Alberta, Fitch (1994) noted that both migratory (i.e., fluvial or adfluvial) and resident bull trout populations historically inhabited these drainages. Results of our investigation, and those conducted by previous researchers, indicate the three bull trout life-history forms remain in the St. Mary River-Belly River region today.

Bull trout that have the resident life-history form are known to occur in upper Otatso Creek, and are likely to occur in Boulder, Lee and Red Eagle creeks. The fluvial form of bull trout inhabits the mainstem St. Mary River below Lower St. Mary Lake, where its feeding-wintering areas extend downstream to at least Cardston, Alberta.

Adfluvial bull trout reside in St. Mary and Lower St. Mary lakes, and probably spawn in Boulder, Divide, and Red Eagle creeks, and perhaps other smaller tributaries within Glacier National Park. Little is known about the bull trout that spawn in upper Lee Creek, in Glacier National Park. We found many large, adult bull trout in Lee Creek, upstream from the international boundary. Those fish may have been fluvial bull trout that winter in lower stretches of Lee Creek or the St. Mary River, or they may have been adfluvial fish that use St. Mary Reservoir as feeding-wintering habitat. Bull trout have been caught in a commercial gillnet fishery on St. Mary Reservoir (Fredenberg 1996a). Although the proportions of each of the three bull trout life-history forms in the St. Mary drainage are unknown, our results suggest that the adfluvial form is least common.

The life-history forms exhibited by bull trout in the St. Mary River drainage represent an important component of the genetic diversity in the bull trout population. That diversity is important to the stability and persistence of the population in highly variable environments, and to the re-establishment of population segments that may become extirpated (Rieman and McIntyre 1993). The concept of an extensive population consisting of smaller, interconnected

subpopulations that inhabit a variety of habitats has been termed a "metapopulation" (Hanski and Gilpin 1991).

Milk River Project Effects on Bull Trout

In reaching its decision to list the bull trout as a threatened species, the Service concluded (*Federal Register* 64: 58909) that bull trout in the St. Mary River drainage are negatively affected by operation of the water-storage and delivery systems that are part of the Milk River Irrigation Project. Results of the study described here support the Service's conclusion that bull trout enter the St. Mary canal; those fish are unlikely to return to the river and are therefore lost from the reproducing population. In addition, our results from radio telemetry suggest that the acute reduction in discharge from Sherburne Dam at the end of the annual irrigation season produces low-flow conditions in Swiftcurrent Creek downstream that directly or indirectly result in the mortality of bull trout.

Although the Service also concluded (*Federal Register* 64: 58909) that the St. Mary diversion dam is a substantial barrier to the movement of bull trout, our results show considerable upstream and downstream movement of bull trout over the diversion. Timing of those movements is not precisely known but probably occurred when the dam was open, between October and April. In general, our results revealed more extensive movements of bull trout among regions of the St. Mary River drainage than had been earlier believed (*Federal Register* 64: 58909).

2000 STUDY PLANS

1. **Radiotelemetry:** Continue tracking radio-implanted bull trout. Thirteen mature bull trout captured at the traps in 1998, and 7 fish in 1999, were surgically implanted with 400-day radio transmitters. Continued tracking of those fish will provide definitive information on bull trout home ranges and relations between feeding-wintering and spawning habitats and timing of migrations. Searches for radiotagged fish should be made periodically from single engine aircraft and by fishery survey crews while conducting electrofishing activities. In addition, we plan to deploy an additional 10 radio tags in bull trout in 2000. Some of those tags will be placed in bull trout in Lee Creek.

2. **Fisheries Surveys:** Continue systematic electrofishing surveys during the summer months (June-August) in representative reaches of the St. Mary River and its tributaries to characterize the fish communities and bull trout populations. Surveys will provide definitive information on fish-community composition, bull trout population structure, status, and limiting factors, bull trout habitat-use and seasonal movements. Recaptures of bull trout tagged in previous years will provide important information on spawning-sight fidelity, straying, and age and growth.

3. **Trapping:** Continue operating fish traps on Boulder, Kennedy, Otatso, and Lee creeks, from August to October, to capture migratory bull trout entering or leaving these known bull trout spawning streams. Stream temperatures will be continually monitored. Trapping provides definitive information on bull trout populations that use tributary streams including critical information on the movements of bull trout between the St. Mary River and tributary streams and the relations between these movements and stream conditions. Recaptures of bull trout tagged in previous years will provide important information on spawning-sight fidelity, straying, and age and growth.

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APPENDICES

APPENDIX A

BULL TROUT TRAPPING OPERATION PROTOCOL

St. Mary River Drainage
Blackfeet Indian Reservation

Trap Locations:

1. **Divide Creek** (500 m above confluence with St. Mary River)
2. **Boulder Creek** (800 m above confluence with Swiftcurrent Creek)
3. **Kennedy Creek** (60 m above confluence with Otatso Creek)
4. **Otatso Creek** (10 m above confluence with Kennedy Creek)
5. **Lee Creek** (directly beneath the Chief Mountain Highway Bridge in Glacier Park)

* all traps are of a one-way design capturing downstream migrants only

Trapping Dates:

1. **Divide Creek**
   - **1997** - (8/26-10/8)
   - **1998** - (8/26-10/7)
2. **Boulder Creek**
   - **1997** - (8/26-10/8)
   - **1998** - (8/26-10/14)
   - **1999** - (9/1-10/20)
3. **Kennedy Creek**
   - **1997** - (8/27-10/9)
   - **1998** - (8/25-10/8)
   - **1999** - (8/31-10/19)
4. **Otatso Creek**
   - **1997** - (8/27-10/9)
   - **1998** - (8/25-10/8)
   - **1999** - (8/31-10/19)
5. **Lee Creek**
   - **1999** - (9/1-10/14)

Daily Trap Checking Procedures:

1. Slowly approach trap from downstream and observe if any fish are below the trap
   - if fish are observed below trap, attempt to identify and count them
   - modify weir to allow for upstream passage of these fish

2. Work fish in the following order, taking time between each step to allow for the fish to fully recover, minimize the time that fish are out of the water, and release all native fish downstream of traps in slack water.

   A. Bull Trout and Cutthroat Trout
   1. Weigh (g)
   2. Measure Total Length (mm)
   3. Take Scales for Age/Growth Analysis
   4. Mark fish with Fin Clip (save all bull trout adipose fins in labeled envelopes for genetic analysis)
   5. Mark all Bull Trout > 200 mm with Pit Tags inserted into muscle tissue directly ventral to the dorsal fin on left side of body (bull trout only)

   B. Burbot
   1. Weigh (g)
   2. Measure Total Length (mm)
   3. Mark with Left Pelvic Fin Clip (save fins in labeled tissue lysis buffer sample tubes for genetic analysis)

   C. Mountain Whitefish
   1. Count
   2. Mark with identifiable fin clip/punch (different fin for each stream)

   D. Rainbow and Brook Trout
   1. Weigh (g)
   2. Measure Total Length (mm)
   3. Sacrifice for Whirling Disease Testing and genetic analysis (place in zip-lock bags and freeze as soon as possible)

3. Clean and Repair traps if needed

4. Check data loggers (thermographs), be sure they are secure and completely submerged

Things to Remember:

- Be gentle with the fish
- Record all data on all-weather writing paper
- Label all samples
- Take lots of photos
- Pad-lock all trap boxes
- Be cautious of bears
- Take time to explain what we are doing when questioned by the public
- Take time to train volunteers and other personnel in various procedures

APPENDIX B

Table 6. Fish captured (raw data) during electrofishing surveys in Boulder Creek, St. Mary River drainage, Montana, 1998.

Boulder Creek - 7/28/98 - Electrofishing												
	Bull Trout					Cutthroat & Rainbow				Brook Trout		
Recap 1997	Length (mm)	Weight (g)	Condition (K)	Pit Tag Number	Scale Card Number	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
	158	30	0.76		19-3	177	58	1.05	18-1	167	42	0.90
	162	36	0.85		19-4	264	228	1.24	18-2	180	56	0.96
	158	32	0.81		19-5	430	728	0.92	18-3	238	128	0.95
	168	40	0.84		19-6	458	952	0.99	18-4	173	52	1.00
	157	32	0.83		19-7	425	716	0.93	18-5	190	60	0.87
	169	42	0.87		19-8	185	60	0.95	18-6	145	40	1.31
	168	42	0.89		19-9					115	12	0.79
	105	8	0.69		19-0					87	6	0.91
	138	24	0.91		20-1							
	178	46	0.82		20-2							
	158	34	0.86		20-3							
	170	46	0.94		20-4							
	273	190	0.93	41493D1E3D	19-1							
	280	206	0.94	41492D495B	19-2							
	390	514	0.87	413B340D6C	20-5							
	402	614	0.95	41485E3E5F	20-6							
	385	496	0.87	4144162029	20-7							
	648	2198	0.81	41477C441C	20-8							
	587	1946	0.96	414B0C3577	20-9							
	523	1146	0.80	414A106F51	20-0							
W54	532	1330	0.88	413B00197F	21-1							
	447	782	0.88	4148123534	21-2							
	533	1438	0.95	41477F7008	21-3							
	417	594	0.82	414A287D37	21-6							
	137	22	0.86		21-4							
	150	22	0.65		21-5							
	190	54	0.79		---							
	160	28	0.68		---							
	158	32	0.81		---							
	160	30	0.73		---							
	154	24	0.66		---							
	157	30	0.78		---							
	177	58	1.05		---							
	164	30	0.68		---							
	142	26	0.91		---							
	138	24	0.91		---							
	163	40	0.92		---							
	140	24	0.87		---							
	100	8	0.80		---							
	98	8	0.85		---							
	94	8	0.96		---							
	94	6	0.72		---							
	82	6	1.09		---							
n=	43					6				8		
Mean	231.7	287.1	0.85			323.2	457.0	1.01		161.9	49.5	0.96
Min	82	6	0.65			177	58	0.92		87	6	0.79
Max	648	2198	1.09			458	952	1.24		238	128	1.31

APPENDIX B (continued)

Table 7. Fish captured (raw data) during electrofishing surveys in Boulder Creek, St. Mary River drainage, Montana, 1999.

Boulder Creek - 8/23/99 - Electrofishing												
		Bull Trout					CTT & RBT			Brook Trout		
Recap		Length	Weight	Condition	Pit Tag	Scale Card	Length	Weight	Condition	Length	Weight	Condition
1997	1998	(mm)	(g)	(K)	Number	Number	(mm)	(g)	(K)	(mm)	(g)	(K)
	R	463	922	0.93	414855171D	B1-1	123	22	1.18	111	14	1.02
		182	52	0.86		B1-2	106	12	1.01	134	24	1.00
		115	14	0.92		B1-3	335	488	1.30	124	22	1.15
		122	16	0.88		B1-4				123	18	0.97
		116	12	0.77		B1-5						
		114	18	1.21		B1-6						
		113	12	0.83		B1-7						
		47	1	0.96								
		48	1	0.90								
		46	1	1.03								
		116	12	0.77								
		545	1628	1.01	5030761879	B1-8						
		547	1498	0.92	5030745D5E	B1-9						
	R	499	1088	0.88	4143771B28	B1-0						
	R	473	1028	0.97	413B3C3A4B	B2-1						
	R	492	1104	0.93	4144105165	B2-2						
	R	492	1080	0.91	4149336A1F	B2-3						
	R	640	2106	0.80	414375576A	B2-4						
	R	584	1716	0.86	414A733521	B2-5						
	R	422	638	0.85	414417474A	B2-6						
n=		20					3			4		
Mean		308.8	647.4	0.91			188.0	174.0	1.16	123.0	19.5	1.04
Min		46	1	0.77			106	12	1.01	111	14	0.97
Max		640	2106	1.21			335	488	1.30	134	24	1.15

APPENDIX B (continued

Table 8. Fish captured (raw data) during electrofishing surveys in Kennedy Creek, St. Mary River drainage, Montana, 1998.

Kennedy Creek - 7/15, 7/29, & 8/12 -1998 - Electrofishing												
	Bull Trout					Cutthroat & Rainbow				Brook Trout		
Recap 1997	Length (mm)	Weight (g)	Condition (K)	Pit Tag Number	Scale Card Number	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
	178	50	0.89	CU0	1-1	276	242	1.15	1-2	153	36	1.01
	127	20	0.98		1-3	411	616	0.89	1-6			
	143	28	0.96		1-4	368	574	1.15	1-7			
	117	14	0.87		1-5	271	248	1.25	1-8			
	345	384	0.94	CU1	2-1	324	400	1.18	1-9			
	430	648	0.82	CU2	2-2	341	434	1.09	1-0			
	182	54	0.90	CU5	2-5	284	280	1.22	---			
	184	56	0.90	CU6	2-6	145	28	0.92	---			
	170	40	0.81		23-0	225	106	0.93	30-8			
	485	944	0.83	413B25640B	2-3	180	52	0.89	30-9			
	423	792	1.05	4148434A62	2-4	144	24	0.80	30-0			
W31	466	918	0.91	4143765014	22-1							
W42	596	1696	0.80	414B040901	22-2							
	484	998	0.88	413A7E0943	22-3							
	331	356	0.98	4147747D53	22-4							
	420	590	0.80	413B14615D	22-5							
	550	1404	0.84	413B506C4F	22-6							
	464	1038	1.04	4144110E3D	22-7							
	580	1580	0.81	413B577305	22-8							
W44	663	2226	0.76	414841377E	22-9							
	665	2580	0.88	4149113634	22-0							
	378	502	0.93	414B051537	23-1							
	380	520	0.95	413B3E2C7C	23-2							
W84	725	2406	0.63	414378167F	23-3							
	405	560	0.84	41495B1048	23-4							
	580	1800	0.92	4148252C2B	23-5							
W80	608	1766	0.79	4148212B2A	23-6							
W60	612	2226	0.97	41483B0941	23-7							
W28	592	1730	0.83	4148717245	23-8							
	444	764	0.87	414830624E	23-9							
	453	802	0.86	4145672926	---							
	381	428	0.77	414A5F221E	30-1							
	405	584	0.88	4143753C41	30-2							
	422	492	0.65	4147586858	30-3							
	360	360	0.77	4148437E05	30-4							
	265	162	0.87	41440D2C3D	30-5							
	165	38	0.85		30-6							
	186	54	0.84		30-7							
	170	40	0.81		23-0							
n=	39					11				1		
Mean	404.3	831.8	0.86			269.9	273.1	1.04		153.0	36.0	1.01
Min	117	14	0.63			144	24	0.80		153	36	1.01
Max	725	2580	1.05			411	616	1.25		153	36	1.01

APPENDIX B (continued)

Table 9. Fish captured (raw data) during electrofishing surveys in Kennedy Creek, St. Mary River drainage, Montana, 1999.

Kennedy Creek - 7/26, 7/27, 8/9 & 8/25 -1999 - Electrofishing													
		Bull Trout					CTT & RBT			Brook Trout			
Recap		Length	Weight	Condition	Pit Tag	Scale Card	Length	Weight	Condition	Length	Weight	Condition	
1997	1998	(mm)	(g)	(K)	Number	Number	(mm)	(g)	(K)	(mm)	(g)	(K)	
		198	68	0.88		K1-1	282	208	0.93	127	20	0.98	
		277	190	0.89	5030632618	K1-2	357	424	0.93	224	112	1.00	
		144	26	0.87		K1-3	327	358	1.02	214	108	1.10	
		145	28	0.92		K1-4	298	300	1.13	191	74	1.06	
		215	86	0.87		K1-5	242	176	1.24	186	70	1.09	
		180	44	0.75		K1-6	254	176	1.07	92	8	1.03	
		154	30	0.82		K1-7	259	188	1.08	201	84	1.03	
		322	336	1.01	50307A0D65	K1-8	310	310	1.04	162	42	0.99	
		435	730	0.89	5030763B6D	K1-9	323	356	1.06	177	60	1.08	
		527	1514	1.03	503077610C	K1-0	294	280	1.10	177	58	1.05	
		150	28	0.83		K2-1	245	142	0.97	275	192	0.92	
		146	30	0.96		K2-2	209	84	0.92	210	98	1.06	
		192	62	0.88		K2-3	258	160	0.93	155	40	1.07	
	R	590	1980	0.96	4148252C2B	K2-4	300	266	0.99	155	36	0.97	
W85		615	2252	0.97	5030670617	K2-5	301	296	1.09	217	102	1.00	
		441	782	0.91	503064704E	K2-6	261	178	1.00	203	90	1.08	
		441	812	0.95	5030156507	K2-7	265	200	1.07	177	54	0.97	
	R	487	1008	0.87	41481C5665	K3-1	341	408	1.03	182	60	1.00	
	R	495	1154	0.95	4145672926	K3-2	103	10	0.92	170	52	1.06	
		400	564	0.88	5030715B68	K3-3	333	340	0.92	122	16	0.88	
W80	R	618	2010	0.85	4148212B2A	K3-4	259	190	1.09	151	32	0.93	
	R	434	736	0.90	4148437E05	K3-5	248	170	1.11				
W42	R	600	2024	0.94	414B040901	K3-6	277	196	0.92				
		429	720	0.91	50306D6E1B	K3-7	192	78	1.10				
		437	746	0.89	5030765046	K3-8	355	420	0.94				
		409	604	0.88	5030654861	K3-9	115	18	1.18				
		169	36	0.75		K3-0	328	320	0.91				
		266	166	0.88	5030705A5F	K4-1	306	300	1.05				
		234	112	0.87		K4-2	340	382	0.97				
		411	582	0.84	5030775448	K4-3	283	244	1.08				
		415	696	0.97	5030797760	K4-4	153	36	1.01				
		401	584	0.91	5030796855	K4-5	187	78	1.19				
		272	178	0.88	5030672A48	K4-6	220	120	1.13				
		222	114	1.04		K4-7	191	66	0.95				
		171	44	0.88		K4-8	237	122	0.92				
		182	50	0.83		K4-9							
		151	28	0.81		K4-0							
W57		539	1410	0.90	503074381D	K5-1							
W30		522	1224	0.86	5030722454	K5-2							
		477	904	0.83	50306E4F48	K5-3							
		522	1294	0.91	5030690F4E	K5-4							
		196	66	0.88		K5-5							
		165	40	0.89		K5-6							
		116	14	0.90		K5-7							
n=		44					35			21			
Mean		338.9	593.3	0.89			264.4	217.1	1.03	179.4	67.0	1.02	
Min		116	14	0.75			103	10	0.91	92	8	0.88	
Max		618	2252	1.04			357	424	1.24	275	192	1.10	

APPENDIX B (continued)

Table 10. Fish captured (raw data) during electrofishing surveys in Lower Otatso Creek (downstream from the park line), St. Mary River drainage, Montana, 1999.

Lower Otatso Creek (Downstream from Park Line) - 8/6/99 - Electrofishing										
		Bull Trout					Cutthroat & Rainbow			
Recap		Length	Weight	Condition	Pit Tag	Scale Card	Length	Weight	Condition	
1997	1998	(mm)	(g)	(K)	Number	Number	(mm)	(g)	(K)	
		316	338	1.07	5030676F08	O1-1	193	80	1.11	
		419	622	0.85	5030794C4C	O1-2	202	82	0.99	
		218	92	0.89	503069136C	O1-3	209	86	0.94	
		235	124	0.96		O1-4	150	30	0.89	
		259	164	0.94	503074772F	O1-5	80	6	1.17	
		368	482	0.97	5030751456	O1-6	220	124	1.16	
							224	120	1.07	
							154	34	0.93	
							111	16	1.17	
							140	24	0.87	
							230	130	1.07	
							170	54	1.10	
							170	52	1.06	
							230	118	0.97	
							235	120	0.92	
	n=	6					15			
	Mean	302.5	303.7	0.95			181.2	71.7	1.03	
	Min	218	92	0.85			80	6	0.87	
	Max	419	622	1.07			235	130	1.17	

APPENDIX B (continued)

Table 11. Fish captured (raw data) during electrofishing surveys in middle Otatso Creek upstream from park line - downstream from Slide Lakes, St. Mary River drainage, Montana, 1998.

Middle Otatso Creek (downstream from Slide Lakes/Landslide) 7/22/98 - Electrofishing							
Bull Trout					Cutthroat& Rainbow		
Length (mm)	Weight (g)	Condition (K)	Pit Tag Number	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
196	72	0.96		6-7	165	48	1.07
196	62	0.82		6-8	105	14	1.21
184	60	0.96		6-9	105	10	0.86
174	50	0.95		6-0	228	126	1.06
175	56	1.04		7-1			
146	28	0.90		7-2			
126	20	1.00		7-3			
125	22	1.13		7-5			
118	14	0.85		7-6			
110	12	0.90		7-7			
136	24	0.95		7-8			
125	18	0.92		7-4			
197	65	0.85		9-5			
203	76	0.91		9-6			
177	50	0.90		9-7			
188	66	0.99		9-8			
195	64	0.86		9-9			
196	72	0.96		9-0			
182	50	0.83		10-0			
130	18	0.82		10-2			
236	120	0.91		10-3			
183	58	0.95		12-3			
182	60	1.00		12-4			
190	66	0.96		12-5			
178	60	1.06		12-6			
137	18	0.70		12-7			
352	514	1.18	4149242B56	6-1			
270	180	0.91	41491D1A30	6-2			
265	156	0.84	414A2A2A5A	6-3			
241	136	0.97	414B125147	6-4			
205	82	0.95	413B097100	6-5			
210	88	0.95	413BA057A?	6-6			
472	1015	0.97	413B187C07	8-1			
435	720	0.87	414A44630C	8-2			
432	722	0.90	414A1E3336	8-3			
445	654	0.74	413B227975	8-4			
314	302	0.98	41480A4F79	8-5			
240	126	0.91	41482E6430	8-6			
242	138	0.97	4147620D50	8-7			
255	138	0.83	413B186B74	8-8			
246	152	1.02	414928472B	8-9			
300	240	0.89	41485E580B	8-0			
235	118	0.91	414A566975	9-1			
237	136	1.02	414806337A	9-2			
244	138	0.95	414A397955	9-3			
211	88	0.94	41481E0E43	9-4			
432	856	1.06	41487E526E	10-4			

	352	386	0.89	413B1D6209	10-5				
	373	456	0.88	413B2F1A57	10-6				
	284	228	1.00	413B361533	10-7				
	287	220	0.93	4148552643	10-8				
	274	194	0.94	4147292069	10-9				
	224	236	2.10	41483B5217	10-0				
	245	140	0.95	413B501134	11-1				
	273	182	0.89	4148797F6D	11-2				
	238	138	1.02	41437F1868	11-3				
	237	126	0.95	413B320775	11-4				
	253	144	0.89	414829533F	11-5				
	234	130	1.01	414405561C	11-6				
	249	140	0.91	4149214834	11-7				
	237	120	0.90	414944131B	11-8				
	236	126	0.96	414A670231	11-9				
	224	106	0.94	4149063009	11-0				
	227	116	0.99	4144065D3E	12-1				
	200	78	0.98	414912271A	12-2				
n=	65						4		
Mean	235.6	173.0	0.95				150.8	49.5	1.05
Min	110	12	0.70				105	10	0.86
Max	472	1015	2.10				228	126	1.21

APPENDIX B (continued)

Table 12. Fish captured (raw data) during electrofishing surveys in middle Otatso Creek upstream from park line - downstream from Slide Lakes, St. Mary River drainage, Montana, 1999.

Middle Otatso Creek (downstream from Slide Lakes/Landslide) 8/19-8/20 1999 - Electrofishing								
	Bull Trout					Cutthroat & Rainbow		
1998 Recap	Length (mm)	Weight (g)	Condition (K)	Pit Tag Number	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
R	310	294	0.99	414A397955	SL1-1	126	18	0.90
	237	136	1.02	5030695418	SL1-2	165	42	0.93
	264	196	1.07	503072227A	SL1-3	178	56	0.99
	245	144	0.98	502F266261	SL1-4	111	12	0.88
	195	60	0.81		SL1-5	202	82	0.99
	187	60	0.92		SL1-6	207	100	1.13
	192	66	0.93		SL1-7			
	190	68	0.99		SL1-8			
	135	20	0.81		SL1-9			
	143	24	0.82		SL1-0			
	265	188	1.01		SL2-1			
	220	94	0.88		SL2-2			
	255	148	0.89		SL2-3			
	207	88	0.99		SL2-4			
	219	84	0.80		SL2-5			
	197	60	0.78		SL2-6			
	138	22	0.84		SL2-7			
	125	20	1.02		SL2-8			
	129	22	1.02		SL2-9			
	234	116	0.91	5030746751	SL2-0			
	483	902	0.80	50306B7C3A	SL3-1			
	461	830	0.85	501F374D04	SL3-2			
	476	938	0.87	50306D4D0F	SL3-3			
	405	654	0.98	503067020D	SL3-4			
	493	998	0.83	5030793A66	SL3-5			
	457	804	0.84	50306A5071	SL3-6			
	292	250	1.00	5030635206	SL3-7			
	270	208	1.06	5030733333	SL3-8			
	279	184	0.85	5030146513	SL3-9			
	263	196	1.08	50306C5B4B	SL3-0			
	244	144	0.99		SL4-1			
	216	84	0.83		SL4-2			
	142	24	0.84		SL4-3			
	145	26	0.85		SL4-4			
	225	108	0.95		SL4-5			
	238	138	1.02		SL4-6			
	385	540	0.95		SL4-7			
	478	938	0.86		SL4-8			
	485	900	0.79		SL4-9			
	400	650	1.02		SL4-0			
	435	844	1.03	503065093B	SL5-1			
	413	668	0.95	5030717E52	SL5-2			
	491	998	0.84	5030744C03	SL5-3			
	448	778	0.87	5030663050	SL5-4			
	457	852	0.89	5030755116	SL5-5			
	69	3	0.91					
	273	180	0.88		SL5-6			
	197	60	0.78		SL5-7			
	240	138	1.00		SL5-8			

	205	78	0.91		SL5-9			
	210	92	0.99		SL5-0			
	203	74	0.88		SL6-1			
	193	60	0.83		SL6-2			
	197	60	0.78		SL6-3			
	148	28	0.86		SL6-4			
	127	18	0.88		SL6-5			
R	363	408	0.85	413B1D6209	SL6-6			
	490	990	0.84	503077556B	SL6-7			
	382	600	1.08	5030735818	SL6-8			
	448	780	0.87	5030756B19	SL6-9			
	425	836	1.09	4143705546	SL6-0			
	449	768	0.85					
	441	720	0.84	4144124E37	SL7-1			
	420	688	0.93	4143704D7E	SL7-2			
	461	918	0.94	41440E106F	SL7-3			
	413	666	0.95	414414504A	SL7-4			
	448	836	0.93	4144194542	SL7-5			
	451	764	0.83	41437E0270	SL7-6			
	438	720	0.86	41440F5F49	SL7-7			
	149	28	0.85		SL7-8			
	209	82	0.90		SL7-9			
	131	20	0.89		SL7-0			
	207	86	0.97		SL8-1			
	220	100	0.94		SL8-2			
	177	48	0.87		SL8-3			
	186	54	0.84		SL8-4			
	129	20	0.93		SL8-5			
	158	32	0.81		SL8-6			
	250	154	0.99		SL8-7			
	295	254	0.99	4144123178	SL8-8			
	267	182	0.96	41437E5926	SL8-9			
	468	808	0.79	4145786773	SL8-0			
	472	924	0.88	414409525D	SL9-1			
	432	778	0.97	41437F3603	SL9-2			
	451	836	0.91	414403205D	SL9-3			
	465	972	0.97	414408637B	SL9-4			
	443	774	0.89	41457B0243	SL9-5			
	432	842	1.04	414403734D	SL9-6			
	438	722	0.86	414379145F	SL9-7			
	463	808	0.81	4144176F0F	SL9-8			
n=	90					6		
Mean	301.6	379.4	0.91			164.8	51.7	0.97
Min	69	3	0.78			111	12	0.88
Max	493	998	1.09			207	100	1.13

APPENDIX B (continued)

Table 13. Fish captured (raw data) during electrofishing surveys in Otatso Creek upstream from Slide Lakes, St. Mary River drainage, Montana, 1998-1999.

Upper Otatso Creek – Slide Lakes (Above Landslide)
Electrofishing - 1998 & 1999

	Bull Trout 7/21/98				CTT & RBT 7/21/98			Bull Trout 8/20/99				CTT & RBT 8/20/99		
	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
	572	1092	0.58	3-1	341	332	0.84	316	272	0.86	SL9-9	115	14	0.92
	540	938	0.60	3-2	245	140	0.95	295	236	0.92	SL9-0			
	161	36	0.86	3-3				277	180	0.85	SL10-1			
	157	32	0.83	3-4				279	190	0.87	SL10-2			
	140	26	0.95	3-5				235	108	0.83	SL10-3			
	145	30	0.98	3-6				274	182	0.88	SL10-4			
	146	26	0.84	3-7				345	328	0.80	SL10-5			
	125	18	0.92	3-8				179	50	0.87	SL10-6			
	126	22	1.10	3-9				265	152	0.82	SL10-7			
	135	20	0.81	3-0				232	106	0.85	SL10-8			
	96	8	0.90	4-1				177	46	0.83	SL10-9			
	110	12	0.90	4-2				201	72	0.89	SL10-0			
	101	8	0.78	4-3				223	106	0.96				
	120	16	0.93	4-4				168	40	0.84				
	100	6	0.60	4-5				207	80	0.90				
	101	10	0.97	4-6				236	132	1.00				
	90	8	1.10	4-7				99	8	0.82				
	97	8	0.88	4-8				474	850	0.80				
	84	4	0.67	4-9				530	1000	0.67				
	90	4	0.55	4-0				537	1080	0.70				
	68	2	0.64	---				459	804	0.83				
	82	4	0.73	---				173	46	0.89				
	72	4	1.07	---				156	32	0.84				
	70	2	0.58	---				180	52	0.89				
	62	2	0.84	---				183	54	0.88				
	75	4	0.95	---				76	4	0.91				
	76	4	0.91	---				124	18	0.94				
	75	4	0.95	---										
	423	716	0.95	5-1										
	367	466	0.94	5-2										
	367	438	0.89	5-3										
	247	132	0.88	5-4										
	238	114	0.85	5-5										
	225	106	0.93	5-6										
	235	128	0.99	5-7										
	226	100	0.87	5-8										
	155	32	0.86	5-9										
	152	34	0.97	5-0										
	87	4	0.61	---										
n=	39				2			27				1		
Mean	167.6	118.5	0.85		293.0	236.0	0.89	255.6	230.7	0.86		115.0	14.0	0.92
Min	62	2	0.55		245	140	0.84	76	4	0.67		115	14	0.92
Max	572	1092	1.10		341	332	0.95	537	1080	1.00		115	14	0.92

APPENDIX B (continued)

Table 14. Cutthroat trout x rainbow trout captured (raw data) during electrofishing surveys in Divide Creek, St. Mary River drainage, Montana, 1998-1999.

Divide Creek - Electrofishing - 1998 & 1999 Cutthroat and Rainbow Trout						
	07/08/1998			08/05/1999		
	Length (mm)	Weight (g)	Condition (K)	Length (mm)	Weight (g)	Condition (K)
	80	4	0.78	186	62	0.96
	220	84	0.79	162	40	0.94
				128	18	0.86
				134	20	0.83
				131	16	0.71
				110	12	0.90
				113	14	0.97
				110	12	0.90
				75	4	0.95
				82	4	0.73
				84	6	1.01
				77	6	1.31
				79	4	0.81
				69	4	1.22
				75	4	0.95
n=	2			15		
Mean	150.0	44.0	0.79	107.7	15.1	0.94
Min	80	4	0.78	69	4	0.71
Max	220	84	0.79	186	62	1.31

APPENDIX B (continued)

Table 15. Westslope cutthroat trout captured (raw data) during electrofishing surveys in Wild Creek, St. Mary River drainage, Montana, 1998-1999.

Wild Creek - Electrofishing - 1998 & 1999							
	Westslope CTT - 7/27/98				Westslope CTT - 7/23/99		
	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
	147	34	1.07	15-1			
	104	10	0.89	15-2	65	3	1.09
	157	40	1.03	15-3	63	2	0.80
	147	36	1.13	15-4	113	14	0.97
	138	32	1.22	15-5	148	34	1.05
	186	74	1.15	15-6	115	18	1.18
	125	22	1.13	15-7	122	16	0.88
	148	34	1.05	15-9	114	12	0.81
	113	14	0.97	15-0	118	12	0.73
	144	34	1.14	15-8	114	12	0.81
	140	28	1.02	16-1	62	2	0.84
	127	20	0.98	16-2	61	2	0.88
	125	20	1.02	16-3	62	2	0.84
	55	1	0.60	16-4	63	4	1.60
	134	24	1.00	16-5	64	4	1.53
	143	32	1.09	16-6	144	32	1.07
	130	22	1.00	16-7	130	22	1.00
	143	32	1.09	16-8	113	14	0.97
	197	90	1.18	16-9	155	42	1.13
	133	22	0.94	16-0	110	14	1.05
	130	22	1.00	17-1	133	28	1.19
	147	34	1.07	17-2	175	60	1.12
	124	18	0.94	17-3	154	40	1.10
	66	2	0.70	17-4	130	26	1.18
	148	32	0.99	17-5	103	14	1.28
	124	18	0.94	17-6	125	24	1.23
	116	16	1.03	17-7			
	110	12	0.90	17-8			
	113	14	0.97	17-9			
	75	2	0.47	17-0			
	110	10	0.75	---			
	108	10	0.79	---			
	109	14	1.08	---			
	64	3	1.14	---			
	66	2	0.70	---			
n=	34				25		
Mean	124.2	23.7	0.98		110.2	18.1	1.05
Min	55	1	0.47		61	2	0.73
Max	197	90	1.22		175	60	1.60

APPENDIX B (continued)

Table 16. Fish captured (raw data) during electrofishing surveys in Lee Creek, St. Mary River drainage, Montana, 1998.

Lee Creek - 8/18/98 - Electrofishing									
	Bull Trout					Cutthroat & Rainbow			
	Length (mm)	Weight (g)	Condition (K)	Pit Tag Number	Scale Card Number	Length (mm)	Weight (g)	Condition (K)	Scale Card Number
	137	16	0.62		30-1	143	24	0.82	32-1
	118	12	0.73		30-2	231	116	0.94	32-2
	131	18	0.80		30-3	160	32	0.78	32-3
	121	12	0.68		30-4	160	34	0.83	32-4
	129	18	0.84		30-5	161	36	0.86	32-5
	126	16	0.80		30-6	211	88	0.94	32-6
	92	6	0.77		30-7	178	54	0.96	32-7
	93	6	0.75		35-2	190	56	0.82	32-8
	128	16	0.76		35-3	100	6	0.60	32-9
	97	8	0.88		35-4	96	8	0.90	32-0
	52	1	0.71		35-5	172	44	0.86	33-1
	520	974	0.69	4143722632	30-8	142	24	0.84	33-2
	475	802	0.75	4144134D34	30-9	121	18	1.02	33-3
	394	486	0.79	4144023B66	30-0	105	10	0.86	33-4
	403	510	0.78	4143712E07	31-1	148	24	0.74	33-5
	545	1286	0.79	413B442A78	31-2	70	2	0.58	33-6
	562	1206	0.68	414373796A	31-3	382	528	0.95	33-7
	514	1168	0.86	4144176167	31-4	202	78	0.95	33-8
	470	900	0.87	41440D4A69	31-5	219	108	1.03	33-9
	400	546	0.85	414400675A	31-6	132	20	0.87	33-0
	480	1004	0.91	41456D5B26	31-7	141	22	0.78	---
	410	592	0.86	41437E4B6C	31-8	157	32	0.83	---
	472	966	0.92	4144002E46	31-9				
	450	850	0.93	4144151E4F	31-0				
	453	778	0.84	414D2A5479	---				
	475	1034	0.96	414D17686C	---				
	500	1114	0.89	41440A0C41	34-2				
	442	840	0.97	41436E3342	34-3				
	445	960	1.09	414371582D	34-4				
	458	890	0.93	414D300D47	34-5				
	462	896	0.91	41440B154E	34-6				
	532	1312	0.87	4144167723	34-7				
	592	1704	0.82	4144025574	34-8				
	568	1664	0.91	41440F391D	34-9				
	563	1642	0.92	41437C3349	34-0				
	510	1228	0.93	4144177737	35-1				
n=	36					22			
Mean	370.0	707.8	0.83			164.6	62.0	0.85	
Min	52	1	0.62			70	2	0.58	
Max	592	1704	1.09			382	528	1.03	

APPENDIX B (continued)

Table 17. Fish captured (raw data) during electrofishing surveys in Lee Creek, St. Mary River drainage, Montana, 1999.

Lee Creek - 7/24 & 8/24 - 1999 - Electrofishing								
	Bull Trout					Cutthroat & Rainbow		
	Length (mm)	Weight (g)	Condition (K)	Pit Tag Number	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
	387	492	0.85	5030686B3A	L1-1	190	72	1.05
	440	820	0.96	503072535D	L1-2	145	30	0.98
	155	36	0.97		L1-3	203	84	1.00
	163	32	0.74		L1-4	140	26	0.95
	170	38	0.77		L1-5	139	24	0.89
	139	24	0.89		L1-6	138	22	0.84
	160	38	0.93		L1-7	105	10	0.86
	168	38	0.80		L1-8	315	300	0.96
	164	36	0.82		L1-9	278	202	0.94
	128	16	0.76		L1-0	211	78	0.83
	175	44	0.82		L2-1	131	20	0.89
	129	16	0.75		L2-2	98	8	0.85
	141	22	0.78		L2-3	185	54	0.85
	180	50	0.86		L2-4	147	30	0.94
	413	654	0.93	501F35130C	L2-5	163	42	0.97
	358	350	0.76	50306D6150	L2-6	163	40	0.92
	370	454	0.90	502F277425	L2-7	94	8	0.96
	355	350	0.78	5030713354	L2-8	108	10	0.79
	185	54	0.85		L2-9	138	24	0.91
	147	26	0.82		L2-0	80	4	0.78
	167	36	0.77		L3-1	233	134	1.06
	121	16	0.90		L3-2	108	10	0.79
	164	36	0.82		L3-3	225	124	1.09
	154	32	0.88		L3-4	221	100	0.93
	168	36	0.76		L3-5	205	85	0.99
	165	34	0.76		L3-6			
	162	36	0.85		L3-7			
	158	34	0.86		L3-8			
	101	10	0.97		L4-1			
	151	28	0.81		L4-2			
	150	26	0.77		L4-3			
	142	20	0.70		L4-4			
	147	24	0.76		L4-5			
	100	8	0.80		L4-6			
	55	1	0.60					
	151	30	0.87		L4-7			
	108	12	0.95		L4-8			
	98	8	0.85		L4-9			
	384	456	0.81	5030721429	L4-0			
	160	36	0.88		L5-1			
	142	24	0.84		L5-2			
	143	24	0.82		L5-3			
	380	466	0.85	5030794D6F	L5-4			
n=	43					25		
Mean	190.7	116.8	0.83			166.5	61.6	0.92
Min	55	1	0.60			80	4	0.78
Max	440	820	0.97			315	300	1.09

APPENDIX B (continued)

Table 18. Fish captured (raw data) during electrofishing surveys in Jule Creek, St. Mary River drainage, Montana, 1998-1999.

Jule Creek - Electrofishing - 1998 & 1999												
	Bull Trout 8/11/98			CTT & RBT 8/11/98			Bull Trout 7/13/99			CTT & RBT 7/13/99		
	Length (mm)	Weight (g)	Condition (K)	Length (mm)	Weight (g)	Condition (K)	Length (mm)	Weight (g)	Condition (K)	Length (mm)	Weight (g)	Condition (K)
	148	26	0.80	140	26	0.95	95	8	0.93	64	2	0.76
	125	14	0.72	177	54	0.97	132	18	0.78	70	4	1.17
	104	8	0.71	195	70	0.94				68	2	0.64
	120	12	0.69	162	42	0.99				67	2	0.66
	100	8	0.80	156	34	0.90				63	2	0.80
	101	6	0.58	138	24	0.91				72	4	1.07
	99	8	0.82	152	34	0.97				64	4	1.53
	92	6	0.77	130	22	1.00				104	10	0.89
	89	6	0.85	135	24	0.98				141	22	0.78
	91	6	0.80	130	18	0.82				148	26	0.80
	95	6	0.70	118	14	0.85				81	4	0.75
				122	16	0.88						
				125	16	0.82						
				118	16	0.97						
				100	8	0.80						
				126	18	0.90						
				130	20	0.91						
				118	14	0.85						
				117	14	0.87						
				125	20	1.02						
				110	10	0.75						
				100	8	0.80						
				84	2	0.34						
				112	6	0.43						
				80	4	0.78						
				109	12	0.93						
				74	4	0.99						
				101	8	0.78						
				110	12	0.90						
				110	14	1.05						
				115	14	0.92						
				86	6	0.94						
				132	14	0.61						
				120	14	0.81						
				118	20	1.22						
				120	26	1.50						
				85	6	0.98						
n=	11			37			2			11		
Mean	105.8	9.6	0.75	121.1	18.5	0.89	113.5	13.0	0.86	85.6	7.5	0.90
Min	89	6	0.58	74	2	0.34	95	8	0.78	63	2	0.64
Max	148	26	0.85	195	70	1.50	132	18	0.93	148	26	1.53

APPENDIX B (continued)

Table 19. Fish captured (raw data) during electrofishing surveys in Middle Fork Lee Creek, St. Mary River drainage, Montana, 1998-1999.

Middle Fork Lee Creek - Electrofishing - 1998 & 1999											
	Bull Trout 8/11/98				CTT & RBT 8/11/98				CTT & RBT 7/13/99		
	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)
	235	100	0.77	28-1	234	108	0.84	28-3	155	34	0.91
	175	46	0.86	28-2	205	80	0.93	28-4	191	66	0.95
					150	38	1.13	28-5	178	54	0.96
					160	40	0.98	28-6	180	68	1.17
					180	60	1.03	28-7	172	52	1.02
					115	14	0.92	28-8	175	60	1.12
					185	58	0.92	28-9	176	60	1.10
					155	40	1.07	28-0			
					160	32	0.78	29-1			
					150	32	0.95	29-2			
					174	54	1.03	29-3			
					135	26	1.06	29-4			
					162	40	0.94	29-5			
					145	26	0.85	29-6			
n=	2				14				7		
Mean	205.0	73.0	0.81		165.0	46.3	0.96		175.3	56.3	1.03
Min	175	46	0.77		115	14	0.78		155	34	0.91
Max	235	100	0.86		234	108	1.13		191	68	1.17

APPENDIX B (continued)

Table 20. Cutthroat Trout captured (raw data) during electrofishing surveys in East Fork Lee Creek and Roberts Creek, St. Mary River drainage, Montana, 1999.

East Fork Lee Creek - Cutthroat
7/12/99 - Electrofishing

	Length (mm)	Weight (g)	Condition (K)
	148	32	0.99
	217	114	1.12
	124	20	1.05
	103	10	0.92
	135	24	0.98
	157	38	0.98
	198	84	1.08
	191	68	0.98
	174	50	0.95
	140	30	1.09
	128	22	1.05
	180	64	1.10
	192	88	1.24
	150	36	1.07
	123	20	1.07
	148	34	1.05
	161	52	1.25
	137	26	1.01
	132	22	0.96
	113	14	0.97
	135	24	0.98
	128	24	1.14
	98	8	0.85
	96	10	1.13
	119	18	1.07
	108	14	1.11
	105	12	1.04
n=27			
Mean	142.2	35.5	1.04
Min	96	8	0.85
Max	217	114	1.25

Roberts Creek - Cutthroat Trout
7/13/99 - Electrofishing

	Length (mm)	Weight (g)	Condition (K)
	98	8	0.85
	177	52	0.94
	165	42	0.93
	135	18	0.73
	110	10	0.75
n=5			
Mean	137.0	26.0	0.84
Min	98	8	0.73
Max	177	52	0.94

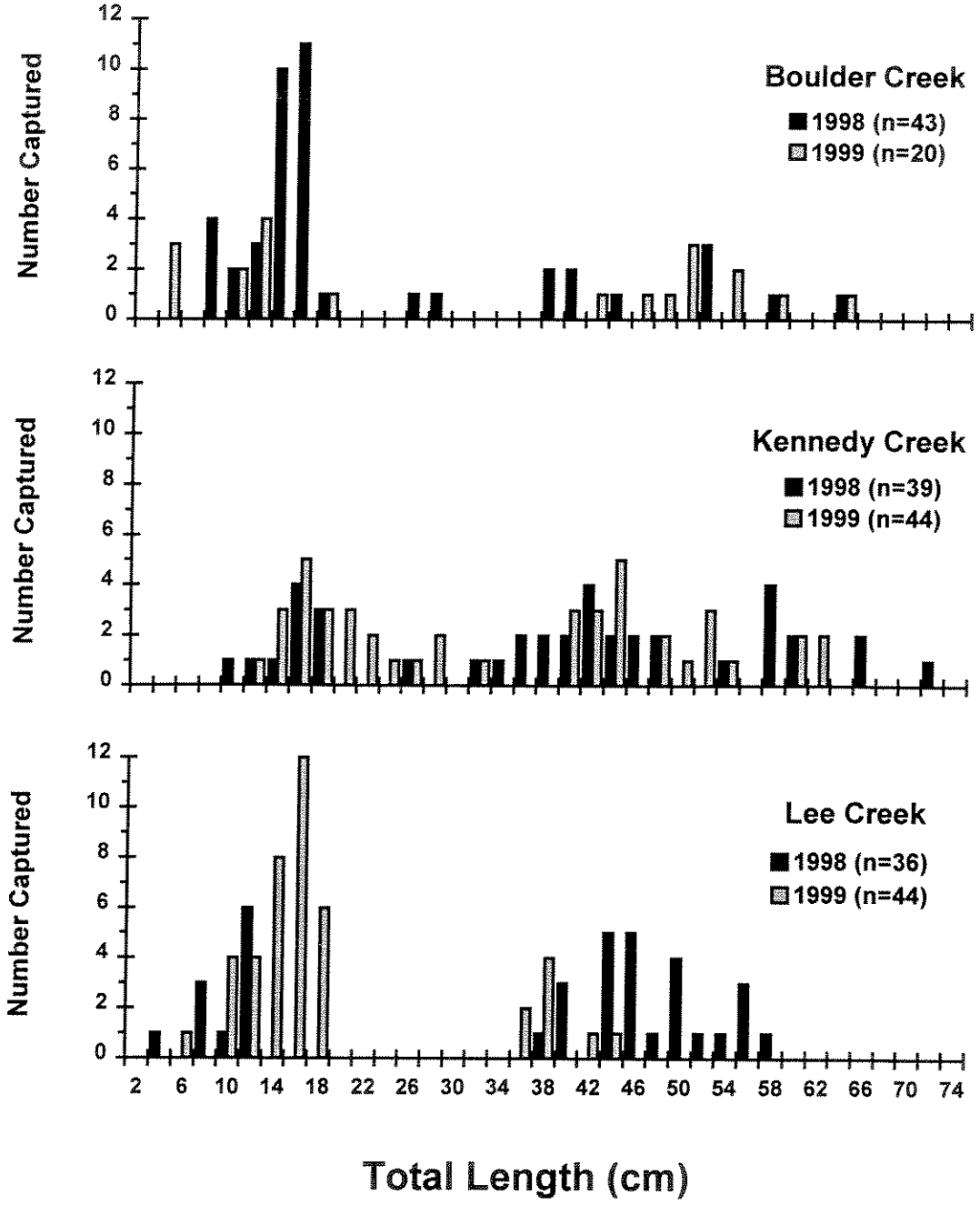

Figure 10. Length-frequency distributions for all bull trout captured during electrofishing surveys in Boulder, Kennedy, and Lee creeks, St. Mary River drainage, Montana, 1998-1999.

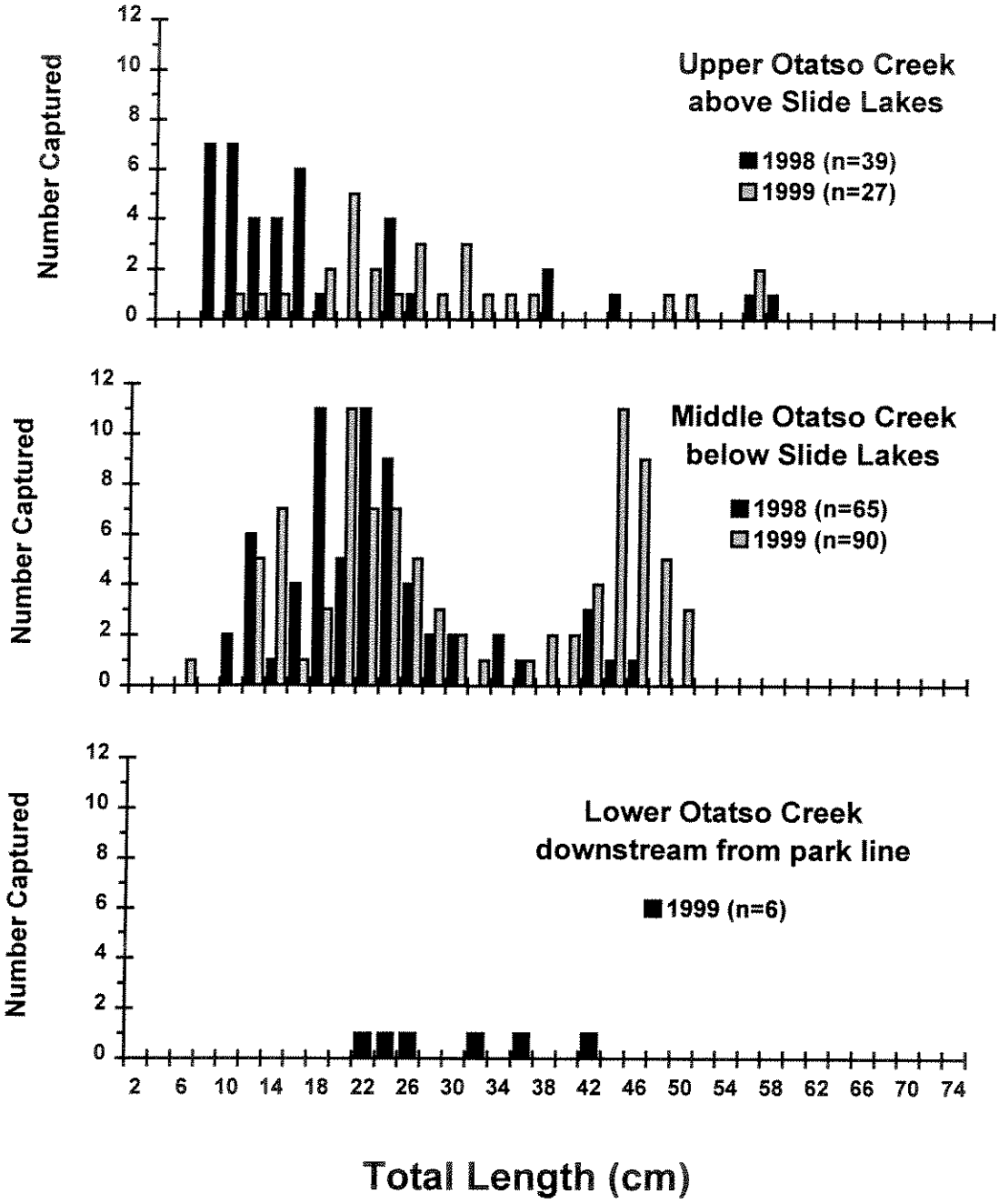

Figure 11. Length-frequency distributions for all bull trout captured during electrofishing surveys in Otatso Creek, St. Mary River drainage, Montana, 1998-1999.

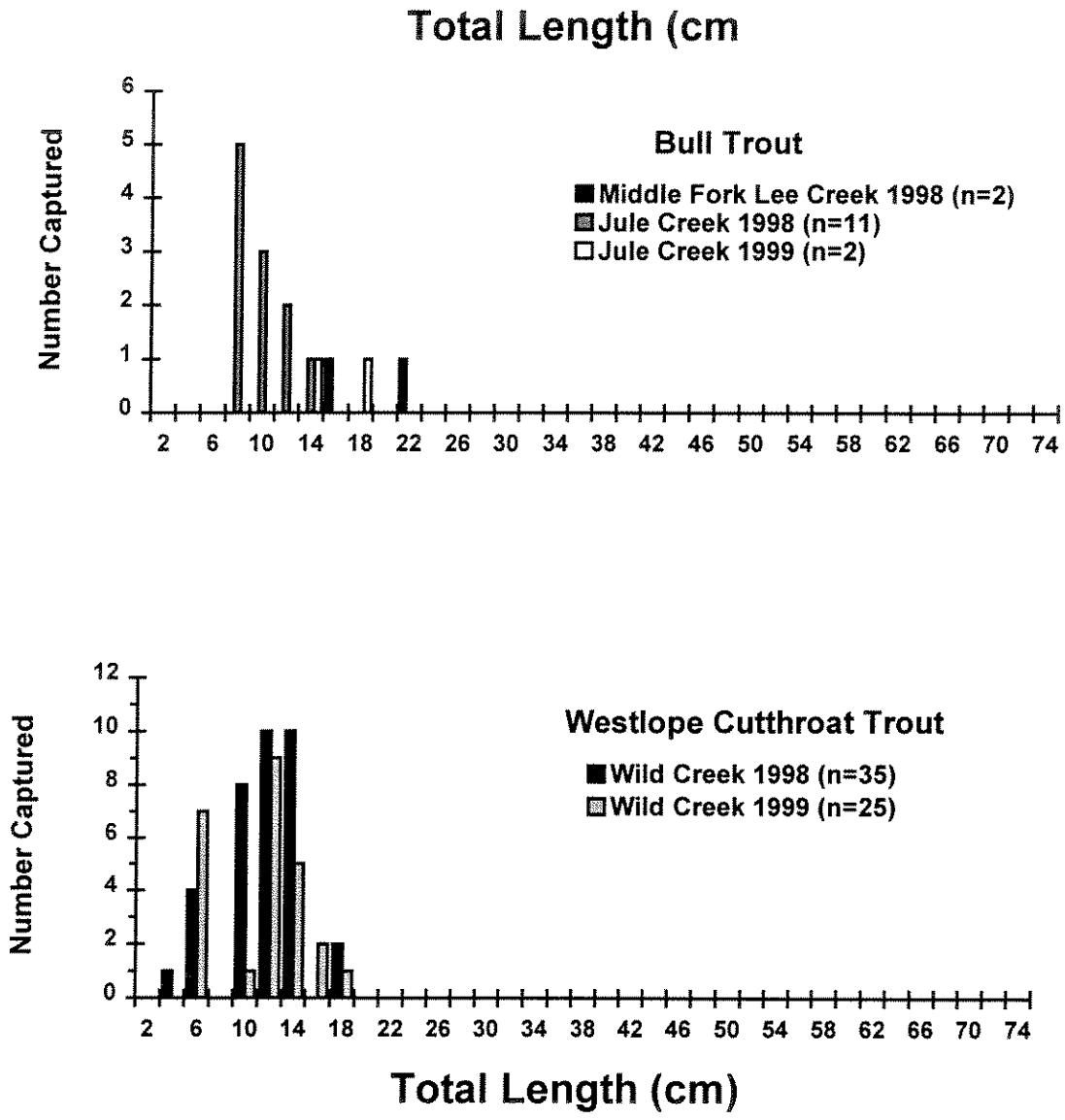

Figure 12. Length-frequency distributions for all bull trout captured during electrofishing surveys in Middle Fork Lee and Jule creeks and all westslope cutthroat trout captured during electrofishing surveys in Wild Creek, St. Mary River drainage, Montana, 1998-1999.

APPENDIX C

Table 21. Mean daily stream temperatures (°C) for Boulder, Kennedy, Otatso, Divide, Lee, and Swiftcurrent creeks and the St. Mary River, St. Mary drainage, Montana August - October. 1997-1999.

Date	Boulder Creek			Kennedy Creek			Otatso Creek			Divide Creek		Lee Creek	Swiftcurrent Creek		St. Mary River
	1997	1998	1999	1997	1998	1999	1997	1998	1999	1997	1998	1999	1997	1998	1999
30-Aug	10.6	12.9	8.9	11.8	14.6	10.8	11.5	14.5	10.3	9.9	13.4	7.8	15.5	16.6	14.7
31-Aug	10.3	13.0	8.9	11.6	14.6	10.7	11.1	14.6	10.2	9.6	13.5	7.7	15.5	16.7	14.6
1-Sep	11.2	12.9	7.8	12.7	14.5	8.9	12.2	14.5	8.6	10.4	13.4	7.1	15.5	16.7	13.3
2-Sep	11.7	13.0	7.3	13.1	14.6	8.3	12.7	14.6	8.1	10.8	13.5	6.3	15.4	16.7	12.8
3-Sep	11.9	13.0	8.2	13.7	14.4	9.6	13.8	14.3	9.6	11.3	13.3	7.1	15.7	16.7	13.2
4-Sep	11.2	12.3	8.5	12.8	13.9	9.6	12.8	13.6	9.5	10.7	12.5	7.1	15.3	16.6	13.4
5-Sep	10.1	12.1	9.5	11.3	13.4	10.7	11.0	13.0	10.3	9.4	12.3	8.1	15.0	16.5	13.6
6-Sep	10.7	12.1	9.2	12.3	13.7	10.3	11.7	13.3	9.8	9.5	12.3	8.0	15.1	16.8	12.9
7-Sep	9.5	11.7	8.2	10.9	13.6	9.1	10.3	13.4	8.7	8.7	12.1	7.2	14.6	17.1	12.3
8-Sep	10.4	12.5	8.6	11.9	14.8	9.6	11.2	14.2	9.0	9.7	13.1	7.0	15.0	17.0	12.9
9-Sep	10.0	11.5	9.2	11.4	13.5	10.3	10.8	13.2	9.9	9.2	11.9	7.4	15.2	16.6	13.6
10-Sep	10.1	11.5	9.1	11.4	13.1	10.7	10.9	12.4	10.1	9.4	11.8	7.8	15.2	15.6	13.7
11-Sep	9.8	10.7	7.7	11.2	12.2	8.7	10.8	11.6	8.2	9.4	11.2	6.2	14.8	14.3	11.9
12-Sep	9.4	11.0	7.3	10.3	12.4	8.2	10.1	11.8	7.8	9.0	11.3	5.8	14.2	14.1	12.0
13-Sep	8.8	11.4	8.5	9.5	12.8	9.3	8.9	11.9	8.6	8.4	11.8	6.5	13.6	15.9	12.9
14-Sep	9.4	10.9	9.3	10.4	12.2	10.3	9.7	11.8	9.7	9.0	11.0	7.0	13.6	15.9	13.4
15-Sep	9.2	11.1	9.6	10.5	12.7	10.5	9.9	12.0	9.9	8.5	11.5	7.4	13.3	16.0	14.0
16-Sep	8.3	11.2	9.3	9.3	12.4	10.4	8.6	11.8	9.7	7.7	11.6	7.4	12.5	15.8	13.5
17-Sep	8.0	11.1	9.6	9.2	13.3	10.6	9.0	12.5	10.1	7.8	11.1	7.5	12.1	15.4	13.4
18-Sep	6.0	10.4	8.2	6.7	12.4	9.4	6.4	11.9	9.0	6.0	10.7	6.9	11.0	15.3	12.2
19-Sep	7.0	8.7	7.1	7.4	9.3	7.7	6.2	9.0	6.9	6.4	8.9	5.8	11.3	13.8	11.4
20-Sep	7.8	7.8	8.2	8.6	8.5	9.0	7.3	7.8	8.0	7.0	8.1	6.5	11.4	13.4	12.3
21-Sep	8.1	7.9	9.5	8.9	8.1	10.4	7.8	7.0	9.4	7.3	8.0	7.4	11.3	13.2	13.5
22-Sep	8.0	8.5	9.6	8.9	9.0	10.6	7.7	7.9	9.4	7.4	8.4	7.8	11.5	13.4	13.4
23-Sep	8.7	9.9	9.5	9.9	10.9	10.7	8.5	9.9	9.5	8.5	9.9	8.0	11.9	13.7	13.4
24-Sep	8.5	9.6	8.0	9.6	10.7	9.1	8.4	10.1	8.3	8.2	9.9	7.2	12.1	12.9	12.3
25-Sep	8.9	8.8	6.5	10.0	9.9	7.0	9.0	9.6	6.3	8.6	8.9	5.8	12.3	12.5	10.2
26-Sep	8.5	8.6	4.1	9.6	9.3	4.9	9.3	8.0	4.1	8.3	8.6	3.4	11.9	11.9	9.3
27-Sep	6.7	8.6	4.5	7.2	9.3	4.9	6.7	8.0	3.9	6.6	8.8	3.4	10.5	11.4	8.9
28-Sep	6.8	8.8	4.1	7.6	9.6	4.0	7.0	8.4	3.1	6.4	9.1	3.1	9.8	11.4	8.4
29-Sep	8.1	7.7	5.4	8.5	8.5	5.7	7.7	7.7	4.9	8.0	7.6	3.9	10.0	10.8	8.2
30-Sep	8.4	8.8	4.9	9.4	9.5	5.0	8.8	8.3	4.1	8.2	8.7	3.7	10.3	11.0	8.4
1-Oct	9.1	8.3	3.9	10.2	9.0	4.0	9.8	8.0	3.4	9.0	8.2	3.1	10.5	11.1	6.7
2-Oct	8.5	7.6	3.3	9.1	8.3	2.9	9.0	8.0	2.6	8.1	7.3	2.2	10.3	10.5	6.4
3-Oct	6.7	6.0	4.2	7.1	5.9	3.8	6.7	5.5	3.4	6.4	5.5	2.7	8.3	8.4	7.2
4-Oct	6.7	5.3	5.6	6.9	4.8	5.2	6.4	3.7	4.4	6.3	5.0	3.6	7.5	7.0	8.3
5-Oct	5.7	5.7	5.6	5.8	5.5	5.6	5.2	4.3	4.7	5.5	5.2	3.7	5.6	6.2	8.2
6-Oct	5.7	7.1	5.9	5.8	7.2	6.4	4.5	6.2	5.2	5.3	6.8	4.1	6.4	5.6	8.9
7-Oct	4.9	7.0	5.6	5.4	7.3	6.0	4.5	6.2	5.0	4.5	6.8	4.4	3.3	5.6	8.3
8-Oct		7.3	6.6		7.8	6.9		7.3	6.5		7.2	4.8		6.1	8.7
9-Oct		6.5	4.7		6.5	5.6		5.8	5.0		6.0	4.0			8.2
10-Oct		4.7	4.1		4.9	3.9		4.2	3.2		4.5	3.2			6.7
11-Oct		5.3	4.3		5.4	4.5		4.4	3.5		4.7	3.1			7.0
12-Oct		5.4	3.9		5.6	4.1		4.4	2.9		4.7	2.3			6.9
13-Oct		5.6	5.5		5.8	5.9		4.7	4.8		4.9	3.7			8.1
14-Oct		5.1	4.1		4.8	4.9		4.4	4.4		4.5	3.5			7.5
15-Oct			2.1			2.4			2.0			1.7			5.5
16-Oct			1.8			2.0			1.4			1.1			5.4
17-Oct			3.4			4.1			3.4			2.2			6.2
18-Oct			4.1			4.5			3.5			2.4			6.8
19-Oct			3.9			4.9			3.6			2.5			6.9
20-Oct			3.7			4.9			3.8			2.6			6.6

APPENDIX D

Table 22. Fish captures (raw data), Boulder Creek fish trap, St. Mary River drainage, Montana, 1997.

BOULDER CREEK FISH TRAP - 1997

A-BLT (17)				J-BLT (30)				CTT & RBT (27)		
TAG #	LENGTH (mm)	WEIGHT (g)	K	TAG #	LENGTH (mm)	WEIGHT (g)	K	LENGTH (mm)	WEIGHT (g)	K
W02	425	774	1.008	W00	245	128	0.870	185	68	1.074
W03	416	780	1.083	W01	220	88	0.826	223	132	1.190
W27	433	816	1.005	W04	211	80	0.852	195	88	1.187
W29	478	962	0.881	W05	227	98	0.838	206	92	1.052
W32	515	1144	0.838	W06	224	92	0.819	465	934	0.929
W40	438	744	0.885	W09	255	144	0.868	196	74	0.983
W43	472	896	0.852	W17	179	50	0.872	210	100	1.080
W46	545	1308	0.808	W19	195	66	0.890	209	90	0.986
W47	524	1158	0.805	W20	206	72	0.824	245	152	1.034
W53	431	654	0.817	W21	221	86	0.797	225	120	1.053
W54	501	1022	0.813	W24	223	86	0.776	201	80	0.985
W55	555	1414	0.827	-	182	48	0.796	185	62	0.979
W62	465	784	0.780	W26	202	66	0.801	237	132	0.992
W65	554	1402	0.825	W52	248	132	0.865	211	100	1.065
W70	565	1410	0.782	W61	237	114	0.856	202	84	1.019
W71	586	1650	0.820	W69	243	114	0.794	233	128	1.012
W76	493	900	0.751	W75	226	102	0.884	205	74	0.859
				-	185	56	0.884	203	86	1.028
				-	192	58	0.819	172	42	0.825
				-	186	52	0.808	193	72	1.002
				W78	244	124	0.854	245	148	1.006
				W79	230	104	0.855	230	120	0.986
				-	194	60	0.822	190	64	0.933
				-	184	54	0.867	170	50	1.018
				W81	229	98	0.816	206	92	1.052
				-	194	56	0.767	194	72	0.986
				-	191	62	0.890	321	312	0.943
				-	182	48	0.796			
				-	188	48	0.722			
				-	178	44	0.780			
AVE	493.9	1,048.1	0.858		210.7	81.0	0.830	220.6	132.1	1.010
MIN	416	654	0.751		178	44	0.722	170	42	0.825
MAX	586	1,650	1.083		255	144	0.890	465	934	1.190

Table 23. Fish captures (raw data), Kennedy Creek fish trap, St. Mary River drainage, Montana, 1997.

KENNEDY CREEK FISH TRAP - 1997

A-BLT (32)				J-BLT (1)				CTT & RBT (13)		
TAG #	LENGTH (mm)	WEIGHT (g)	K	TAG #	LENGTH (mm)	WEIGHT (g)	K	LENGTH (mm)	WEIGHT (g)	K
W08	442	812	0.940	-	156	26	0.685	109	10	0.772
W12	360	472	1.012					262	164	0.912
W13	480	1050	0.949					113	12	0.832
W14	506	1394	1.076					340	350	0.890
W18	358	408	0.889					207	78	0.879
W22	409	616	0.900					266	166	0.882
W23	356	406	0.900					248	150	0.983
W25	396	594	0.957					321	374	1.131
W28	550	1476	0.887					333	342	0.926
W30	428	622	0.793					250	174	1.114
W31	400	570	0.891					174	44	0.835
W36	665	1828	0.622					197	66	0.863
W37	495	814	0.671					210	80	0.864
W39	565	1312	0.727							
W41	542	1306	0.820							
W42	565	1418	0.786							
W44	636	2020	0.785							
W45	492	1000	0.840							
W49	422	582	0.774							
W50	555	1360	0.796							
W51	550	1380	0.829							
W57	474	928	0.871							
W60	582	1620	0.822							
W63	516	1002	0.729							
W64	571	1434	0.770							
W67	445	682	0.774							
W68	643	1798	0.676							
W74	470	760	0.732							
W80	580	1518	0.778							
W84	720	2504	0.671							
W85	611	1940	0.851							
W86	615	1886	0.811							
AVE	512.5	1,172.3	0.823		156.0	26.0	0.685	233.1	154.6	0.914
MIN	356	406	0.622		156	26	0.685	109	10	0.772
MAX	720	2,504	1.076		156	26	0.685	340	374	1.131

Table 24. Fish captures (raw data), Otatso Creek fish trap, St. Mary River drainage, Montana, 1997.

OTATSO CREEK FISH TRAP - 1997										
A-BLT (16)				J-BLT (1)				CTT & RBT (16)		
TAG #	LENGTH (mm)	WEIGHT (g)	K	TAG #	LENGTH (mm)	WEIGHT (g)	K	LENGTH (mm)	WEIGHT (g)	K
W07	354	462	1.041	W16	196	58	0.770	247	146	0.969
W11	422	670	0.892					227	120	1.026
W33	581	1264	0.644					194	66	0.904
W34	415	636	0.890					182	56	0.929
W35	304	234	0.833					142	24	0.838
W38	601	1572	0.724					240	134	0.969
W48	508	1016	0.775					285	234	1.011
W56	467	734	0.721					263	196	1.077
W59	482	976	0.872					125	12	0.614
W66	617	1720	0.732					107	8	0.653
W72	418	536	0.734					178	48	0.851
W73	440	776	0.911					256	186	1.109
W77	395	406	0.659					124	14	0.734
W82	428	594	0.758					175	50	0.933
W83	561	1324	0.750					293	260	1.034
-	419	522	0.710					178	48	0.851
AVE	463.3	840.1	0.790		196.0	58.0	0.770	201.0	100.1	0.906
MIN	304	234	0.644		196	58	0.770	107	8	0.614
MAX	617	1,720	1.041		196	58	0.770	293	260	1.109

Table 25. Fish captures (raw data), Divide Creek fish trap, St. Mary River drainage, Montana, 1997.

DIVIDE CREEK FISH TRAP - 1997										
A-BLT (2)				J-BLT (0)				CTT & RBT (27)		
TAG #	LENGTH (mm)	WEIGHT (g)	K	TAG #	LENGTH (mm)	WEIGHT (g)	K	LENGTH (mm)	WEIGHT (g)	K
W10	546	1728	1.062					158	36	0.913
W58	362	396	0.835					147	30	0.944
								179	58	1.011
								199	78	0.990
								129	19	0.885
								205	70	0.813
								196	90	1.195
								200	80	1.000
								189	64	0.948
								187	60	0.918
								191	68	0.976
								191	70	1.005
								127	18	0.879
								102	8	0.754
								186	60	0.932
								147	30	0.944
								164	46	1.043
								184	56	0.899
								184	58	0.931
								201	74	0.911
								180	54	0.926
								115	14	0.921
								185	66	1.042
								158	36	0.913
								165	48	1.069
								184	60	0.963
								207	96	1.082
AVE	454.0	1,062.0	0.948					171.3	52.0	0.951
MIN	362	396	0.835					102	8	0.754
MAX	546	1,728	1.062					205	90	1.195

Table 26. Fish captures (raw data), Boulder Creek fish trap, St. Mary River drainage, Montana, 1998.

BOULDER CREEK FISH TRAP - 1998

A-BLT (64)						J-BLT (23)					CTT & RBT (15)		
PIT TAG #	RECAP 1997	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	PIT TAG #	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	LENGTH (mm)	WEIGHT (g)	K
414417474A		311	322	1.070	42-1	4143794161	171	44	0.880	42-2	184	48	0.771
41437E320D		343	306	0.758	42-3	4143732C54	183	48	0.783	42-5	215	94	0.946
41440B6C2F		520	1256	0.893	42-4	---	181	46	0.776	42-6	270	96	0.488
41440F2963		404	594	0.901	42-7	---	163	32	0.739	46-1	243	146	1.017
tag not read		408	596	0.878	42-8	---	169	36	0.746	46-2	197	66	0.863
41437E2A35		409	604	0.883	42-9	---	181	44	0.742	46-9	225	111	0.974
414855171D		393	546	0.900	42-0	---	174	42	0.797	46-0	230	120	0.986
41487D4263		400	600	0.938	46-3	---	185	48	0.758	47-2	245	134	0.911
413B0D4052		447	756	0.846	46-4	---	189	54	0.800	49-4	190	72	1.050
4149065073		332	344	0.940	46-6	---	179	40	0.697	49-5	126	10	0.500
41456E4777	W40	500	1148	0.918	46-5	---	174	38	0.721	49-6	221	64	0.593
41456C4B4C		566	1532	0.845	46-7	---	169	34	0.704	51-9	221	92	0.852
4143786F1E		335	335	0.891	46-8	---	205	74	0.859	51-0	220	90	0.845
414903163C		519	1272	0.910	47-1	---	183	48	0.783	57-5	172	42	0.825
414A733521		516	1330	0.968	47-3	---	185	52	0.821	57-6	224	105	0.934
41437F5F1C		409	534	0.780	47-4	---	180	46	0.789	---			
4144023037	W62	497	1067	0.869	47-5	---	182	30	0.498	---			
4144146F7C		397	488	0.780	47-6	---	173	24	0.464	57-9			
4148123D72		417	596	0.822	47-7	---	182	34	0.564	57-0			
41437A035F		585	1638	0.818	47-8	4144187977	235	104	0.801	60-5			
4143774838		492	1023	0.859	47-9	---	183	44	0.718	---			
41437D127D		459	808	0.836	49-1	---	171	38	0.760	---			
413B3C3A4B		422	706	0.939	49-2	---	214	74	0.755	---			
4144140928		468	880	0.859	49-3								
414A287D37		416	534	0.742	---								
---		385	450	0.789	49-7								
41437B0B0D		513	1008	0.747	49-8								
4144164449		623	1772	0.733	49-9								
4143736548	(lost)	512	1084	0.808	49-0								
41440B365A		504	902	0.705	51-1								
41437D1C15		511	1122	0.841	51-2								
41440B5B5F		478	884	0.809	51-3								
4144105165		434	766	0.937	51-4								
4143727B4A		470	900	0.867	51-5								
414403172D		441	666	0.777	51-6								
4143734A00		496	884	0.724	51-7								
4144024207	W71	611	1871	0.820	51-8								
41437B2445		565	1448	0.803	57-2								
4143764149		576	1604	0.839	57-3								
4143712B3E		491	926	0.782	57-4								
4148123534		436	818	0.987	---								
413B00197F	W54	523	1212	0.847	---								
41440A6B36		648	2365	0.869	57-7								
41477C441C		632	1668	0.661	---								
4144083C5B	(lost)	536	1364	0.886	60-1								
41437F256A	(lost)	462	874	0.886	60-2								
41436F4920		487	1350	1.169	60-3								
4144052321		368	424	0.851	60-4								
414415472D		493	1262	1.053	60-6								
41440D3E77		603	1756	0.801	60-7								
41437E7925		582	1688	0.856	60-9								
41456F2137		561	1598	0.905	60-0								
414B0C3577		575	1768	0.930	61-1								

414413616B		621	2168	0.905	61-2								
4143762010		690	2654	0.808	61-3								
41440D1228		656	2678	0.949	---								
4143753B4C		442	672	0.778	---								
414418137F		419	582	0.791	---								
41440E5016		430	672	0.845	---								
41436C580E		589	1658	0.811	---								
414374412E		448	792	0.881	---								
---		639	2166	0.830	---								
---		529	1362	0.920	---								
414375576A		590	2102	1.023	---								
AVE		492.7	1,121.2	0.860			183.1	46.7	0.737		212.2	86.0	0.837
MIN		311	306	0.661			163	24	0.464		126	10	0.488
MAX		690	2,678	1.169			235	104	0.880		270	146	1.050

Table 27. Fish captures (raw data), Kennedy Creek fish trap, St. Mary River drainage, Montana, 1998.

KENNEDY CREEK FISH TRAP - 1998

A-BLT (38)						J-BLT (6)					CTT & RBT (6)		
PIT TAG #	RECAP 1997	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	PIT TAG #	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	LENGTH (mm)	WEIGHT (g)	K
414411121F		357	356	0.782	44-2	4144090D11	279	200	0.921	---	166	44	0.962
4148102303		394	532	0.870	44-3	413B231547	190	52	0.758	44-1	255	140	0.844
41436E3261		461	846	0.864	44-4	---	233	104	0.822	52-0	210	90	0.972
414A5F221E		375	416	0.789	30-1	---	237	116	0.871	53-1	280	198	0.902
414A71691D		382	440	0.789	44-5	---	211	78	0.830	53-5	257	154	0.907
41481C5665		424	618	0.811	44-6	4144012503	227	92	0.787	53-8	219	100	0.952
4144100D3E		355	378	0.845	44-7								
41437D0203		471	886	0.848	44-8								
414419436C		481	864	0.776	44-9								
41440D7648		436	698	0.842	44-0								
414413561B		395	550	0.892	52-1								
414916347F		384	458	0.809	52-2								
41440A785F		373	450	0.867	52-3								
414411767F		350	384	0.896	52-4								
4144153729		374	422	0.807	52-5								
41495D2C02		351	382	0.883	52-6								
4144060D39		354	386	0.870	52-7								
4144170507		370	408	0.805	52-8								
---		316	256	0.811	52-9								
41437A3322		401	560	0.868	53-2								
41436D793A		415	574	0.803	53-3								
4144070F19		383	502	0.894	53-4								
4149113634		650	2236	0.814	---								
4144107271	W13	542	1396	0.877	---								
4148717245	W28	577	1602	0.834	---								
41440F5E6A	(lost)	560	1604	0.913	53-6								
413A7E0943		482	882	0.788	---								
414B040901	W42	570	1510	0.815	---								
4144110E3D		477	798	0.735	---								
4144160604		462	770	0.781	53-7								
4143771B28		451	840	0.916	53-9								
4143765014	W31	455	780	0.828	---								
4144135F7E		435	822	0.999	53-0								
41437A3201	W14	534	1320	0.867	58-1								
414377383C	W51	552	1306	0.776	58-2								
4144184762		367	420	0.850	58-3								
413B506C4F		541	1358	0.858	---								
414408662E		553	1698	1.004	54-2								
AVE		442.4	808.1	0.844			229.5	107.0	0.832		231.2	121.0	0.915
MIN		316	256	0.735			190	52	0.758		166	44	0.844
MAX		650	2,236	1.004			279	200	0.921		280	198	0.972

Table 28. Fish captures (raw data), Otatso Creek fish trap, St. Mary River drainage, Montana, 1998.

OTATSO CREEK FISH TRAP - 1998

A-BLT (19)						J-BLT (17)					CTT & RBT (29)		
PIT TAG #	RECAP 1997	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	PIT TAG #	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	LENGTH (mm)	WEIGHT (g)	K
41457D585D		307	312	1.078	41-1	41436C092A	291	246	0.998	41-2	224	108	0.961
413B3C6D41		447	904	1.012	41-7	41440F2D79	234	108	0.843	41-3	197	66	0.863
4149336A14		424	638	0.837	41-8	---	254	142	0.867	41-4	157	30	0.775
41437D404E	W82	464	816	0.817	48-3	---	172	36	0.707	41-5	201	76	0.936
41440D7C3A	W38	615	1562	0.672	41-0	---	166	34	0.743	41-6	187	58	0.887
41436C6A47		378	420	0.778	50-1	---	197	60	0.785	50-3	149	24	0.726
4144021951		450	762	0.836	50-5	---	191	54	0.775	50-4	121	16	0.903
4143796924	W48	524	1148	0.798	55-1	41440E1829	238	102	0.757	50-2	217	96	0.939
41440E1C33	W49	461	784	0.800	50-0	---	200	60	0.750	50-6	210	86	0.929
4144187D6B		358	420	0.915	50-9	---	188	50	0.752	50-7	203	76	0.909
4144004759		375	510	0.967	50-8	---	177	42	0.757	55-3	182	56	0.929
414403781C		480	962	0.870	55-2	---	193	54	0.751	55-4	353	148	0.336
414374484B		606	2108	0.947	55-5	---	238	104	0.771	---	185	58	0.916
414415293F		548	1302	0.791	55-6	---	175	44	0.821	55-0	266	172	0.914
41440E3D13	W87	438	668	0.795	55-7	---	172	36	0.707	---	220	104	0.977
41437F556E		462	918	0.931	55-8	---	190	52	0.758	59-3	224	100	0.890
414410745F		425	694	0.904	55-9	---	180	50	0.857	---	212	90	0.945
41436E5516		420	526	0.710	59-1						238	128	
41437A092D		335	298	0.793	59-2						187	52	
											166	34	
											166	44	
											215	94	
											228	108	
											227	112	
											139	22	
											146	24	
											127	16	
											225	112	
											272	206	
AVE		448.3	829.1	0.855			203.3	74.9	0.788		201.5	79.9	0.867
MIN		307	298	0.672			166	34	0.707		121	16	0.336
MAX		615	2,108	1.078			291	246	0.998		353	206	0.977

Table 29. Fish captures (raw data), Boulder Creek fish trap, St. Mary River drainage, Montana, 1999.

BOULDER CREEK FISH TRAP - 1999

A-BLT (23)								J-BLT (36)				CTT & RBT (26)		
PIT TAG #	RECAP 1997	RECAP 1998	RECAP 1999E	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	LENGTH (mm)	WEIGHT (g)	K
4149065073		R		410	802	1.164	BT1-1	175	48	0.896	---	200	78	0.975
50306D1243				422	814	1.083	BT2-1	207	74	0.834	BT2-2	176	42	0.770
5030654D58				389	608	1.033	BT2-5	159	32	0.796	BT2-3	234	118	0.921
414417474A		R	E	410	582	0.844	BT2-8	175	44	0.821	BT2-4	224	106	0.943
50306D6364				471	944	0.903	BT2-9	187	46	0.703	BT2-6	139	26	0.968
41437A3322		R		466	826	0.816	BT2-0	162	32	0.753	BT2-7	150	34	1.007
41456E4777	W40	R		554	1692	0.995	BT1-6	158	32	0.811	---	215	98	0.986
414375576A		R	E	613	2048	0.889	BT1-7	181	44	0.742	BT1-4	163	38	0.877
41436F4920		R		534	1622	1.065	BT1-8	169	38	0.787	BT1-5	147	26	0.819
5030733862				432	840	1.042	BT1-9	169	42	0.870	---	205	88	1.021
5030775814				543	1522	0.951	BT1-0	173	44	0.850	---	210	90	0.972
41440A6B36		R		695	3220	0.959	BT3-1	203	62	0.741	BT3-3	247	138	0.916
414415472D		R		545	1446	0.893	BT3-2	204	68	0.801	BT4-1	232	108	0.865
4143734A00		R		518	1248	0.898	BT3-4	210	70	0.756	BT4-2	255	166	1.001
41477C441C		R		662	2152	0.742	BT3-5	216	86	0.853	BT4-3	215	94	0.946
4143762010				690	2872	0.874	BT3-6	207	74	0.834	BT4-4	195	60	0.809
---------	???			643	2448	0.921	BT3-7	181	46	0.776	BT4-5	208	88	0.978
4144105165		R	E	489	978	0.836	BT3-8	182	44	0.730	BT4-6	296	264	1.018
41456F2137		R		610	2022	0.891	BT3-9	191	58	0.832	BT4-7	229	128	1.066
5030797A1F				650	2120	0.772	BT3-0	184	48	0.771	BT4-8	225	100	0.878
414A733521		R	E	560	1728	0.984	BT5-1	183	40	0.653	BT4-9	206	82	0.938
41437A035F		R		613	1860	0.807	---	173	42	0.811	BT4-0	195	70	0.944
MORT				454	836	0.893	BT6-2	162	36	0.847	---	227	126	1.077
								181	42	0.708	---	203	66	0.789
								168	34	0.717	---	185	50	0.790
								183	46	0.751	---	172	38	0.747
								170	42	0.855	---			
								165	36	0.801	BT5-2			
								186	52	0.808	BT5-3			
								177	46	0.830	BT5-4			
								167	40	0.859	BT5-5			
								184	54	0.867	BT5-6			
								185	50	0.790	BT5-7			
								176	40	0.734	BT5-8			
								165	36	0.801	BT5-9			
Recaps (n=)	2	14	4					160	34	0.830	BT5-0			
AVE				538.0	1532	0.924		180	47	0.795		206	89	0.924
MIN				389	582	0.742		158	32	0.653		139	26	0.747
MAX				695	3220	1.164		216	86	0.896		296	264	1.077

Table 30. Fish captures (raw data), Kennedy Creek fish trap, St. Mary River drainage, Montana, 1999.

KENNEDY CREEK FISH TRAP -1999

				A-BLT (20)				J-BLT (10)				CTT & RBT (7)		
PIT TAG	RECAP			LENGTH	WEIGHT	K	SCALE	LENGTH	WEIGHT	K	SCALE	LENGTH	WEIGHT	K
#	1997	1998	1999E	(mm)	(g)		CARD	(mm)	(g)		CARD	(mm)	(g)	
414916347F		R		466	860	0.850	KT1-1	189	60	0.889	---	322	324	0.970
414403781C		R		565	1588	0.880	KT1-2	170	38	0.773	KT2-9	241	140	1.000
502F3E5409				475	900	0.840	OT/KT-5	145	26	0.853	KT2-0	213	90	0.931
----------				395	544	0.883	---	206	76	0.869	KT3-1	110	14	1.052
503072173E				406	540	0.807	KT2-1	191	56	0.804	KT3-2	210	82	0.885
4148437E05		R	E	446	748	0.843	KT1-3	210	72	0.777	KT3-3	262	178	0.990
5030791134				456	824	0.869	KT1-4	180	46	0.789	KT3-4	210	100	1.080
5030796855				400	574	0.897	KT1-5	213	86	0.890	KT3-6			
4145672926		R	E	482	934	0.834	KT1-6	181	48	0.809	KT3-7			
414410745F		R		485	966	0.847	KT1-7	209	80	0.876	KT3-8			
4144135F7E		R		455	842	0.894	KT2-2							
503077610C			E	525	1214	0.839	KT2-3							
503074381D	W57		E	529	1172	0.792	KT2-4							
414408662E		R		580	1666	0.854	KT2-5							
50306E1313				478	828	0.758	KT2-6							
50306A4D70				455	814	0.864	---							
41436C092A		R		361	430	0.914	KT2-7							
413B506C4F		R		590	1700	0.828	KT2-8							
414B040901	W42	R	E	603	1618	0.738	---							
41495D2C02		R		410	594	0.862	KT3-5							
Recaps (n=)	2	11	5											
AVE				478	968	0.845		189	59	0.833		224	133	0.990
MIN				361	430	0.738		145	26	0.773		110	14	0.885
MAX				603	1700	0.914		213	86	0.890		322	324	1.080

APPENDIX D (continued)

Table 31. Fish captures (raw data), Otatso Creek fish trap, St. Mary River drainage, Montana, 1999.

OTATSO CREEK FISH TRAP - 1999

	A-BLT (11)							J-BLT (6)				CTT & RBT (15)		
PIT TAG #	RECAP 1997	1998	1999E	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	LENGTH (mm)	WEIGHT (g)	K	SCALE CARD	LENGTH (mm)	WEIGHT (g)	K
503O6A4D70				465	870	0.865	OT1-1	186	48	0.746	---	143	26	0.889
41436C6A47		R		435	772	0.938	OT/KT-1	185	46	0.727	OT1-4	243	148	1.031
5030662517				456	820	0.865	OT/KT-2	196	58	0.770	OT1-5	240	154	1.114
---				321	288	0.871	OT/KT-3	207	78	0.879	---	227	112	0.958
---				340	308	0.784	OT/KT-4	246	120	0.806	OT1-6	225	112	0.983
41440E1C33		R		487	874	0.757	OT1-2	221	84	0.778	OT1-9	186	66	1.026
4148434A62		R		469	1096	1.062	OT1-3					149	28	0.846
5030750C6E				424	586	0.769	OT1-7					154	30	0.821
5030745021				420	658	0.888	OT1-8					227	116	0.992
41437F556E		R		531	1272	0.850	OT1-0					140	20	0.729
41437D404E	W82	R		504	1020	0.797	OT2-1					132	18	0.783
												136	18	0.716
												195	80	1.079
												142	26	0.908
Recaps (n=)	1	5	0									240	150	1.085
AVE				441	779	0.859		207	72	0.784		185	74	0.931
MIN				321	288	0.757		185	46	0.727		132	18	0.716
MAX				531	1272	1.062		246	120	0.879		243	154	1.114

Table 32. Fish captures (raw data), Lee Creek fish trap, St. Mary River drainage, Montana, 1999.

LEE CREEK FISH TRAP - 1999

A-BLT (19)							J-BLT (69)					CTT & RBT (19)		
PIT TAG	RECAP		LENGTH	WEIGHT	K	SCALE	PIT TAG	LENGTH	WEIGHT	K	SCALE	LENGTH	WEIGHT	K
#	1998	1999E	(mm)	(g)		CARD	#	(mm)	(g)		CARD	(mm)	(g)	
5030721429		E	375	440	0.834	---		192	60	0.848	LT1-1	245	164	1.115
41436E3342	R		489	916	0.783	---		187	60	0.918	LT1-2	202	82	0.995
5030730D26			409	604	0.883	LT2-1		193	62	0.862	LT1-3	240	154	1.114
414D300D47	R		487	966	0.836	LT2-2		182	52	0.863	LT1-4	182	64	1.062
502F3D7F28			424	624	0.819	LT2-4		174	40	0.759	LT1-5	182	66	1.095
502F3E4477			470	786	0.757	LT3-5		193	56	0.779	LT1-6	233	126	0.996
5030646509			384	516	0.911	LT3-6		189	56	0.829	LT1-7	242	140	0.988
41437C3349	R		580	1710	0.876	LT4-1		200	64	0.800	LT1-8	254	178	1.086
5030646509			391	496	0.830	---		192	58	0.819	LT1-9	254	178	1.086
4143712E07	R		449	746	0.824	LT4-2		170	38	0.773	LT1-0	213	94	0.973
502F277425		E	358	358	0.780	---		202	66	0.801	LT2-3	185	64	1.011
5030640F01			381	500	0.904	LT4-3		206	76	0.869	LT2-5	220	100	0.939
5030687A67			374	480	0.918	LT4-4		226	96	0.832	LT2-6	175	54	1.008
			435	686	0.833	LT4-0		212	78	0.819	LT2-7	264	200	1.087
50306C3559			405	592	0.891	LT5-1		165	34	0.757	LT2-8	205	90	1.045
5030752326			389	492	0.836	LT5-2		184	52	0.835	LT2-9	215	104	1.046
4144167723	R		549	1554	0.939	LT6-1		175	46	0.858	LT2-0	216	96	0.953
503079014A			387	434	0.749	---		210	74	0.799	LT3-1	221	106	0.982
503072535D		E	465	788	0.784	LT7-1		204	66	0.777	LT3-2	161	44	1.054
								219	80	0.762	LT3-3			
								174	44	0.835	LT3-4			
								195	60	0.809	LT3-7			
								168	38	0.801	LT3-8			
								193	64	0.890	LT3-9			
								193	58	0.807	LT3-0			
								191	56	0.804	---			
								170	38	0.773	LT4-5			
								183	44	0.718	LT4-6			
								213	78	0.807	LT4-7			
								204	70	0.825	LT4-8			
								195	62	0.836	LT4-9			
							501F377232	289	190	0.787	LT5-3			
								221	86	0.797	LT5-4			
								175	40	0.746	LT5-5			
								160	32	0.781	---			
								185	48	0.758	---			
								143	20	0.684	LT5-6			
								185	46	0.727	LT5-7			
								149	26	0.786	LT5-8			
								160	30	0.732	LT5-9			
								193	56	0.779	LT5-0			
								185	50	0.790	---			

									154	30	0.821	---					
									179	44	0.767	---					
									175	43	0.802	---					
									170	32	0.651	---					
									181	34	0.573	---					
									144	20	0.670	---					
									165	30	0.668	---					
									209	74	0.811	LT6-2					
									174	42	0.797	---					
									170	38	0.773	---					
									195	64	0.863	---					
									184	50	0.803	---					
									197	60	0.785	LT6-3					
									198	60	0.773	LT6-4					
									200	62	0.775	LT6-5					
									195	68	0.917	LT6-6					
									176	40	0.734	LT6-7					
									172	40	0.786	---					
									143	24	0.821	---					
									144	24	0.804	---					
									185	54	0.853	LT6-8					
									180	56	0.960	LT6-9					
									182	52	0.863	LT6-0					
									173	44	0.850	---					
									137	22	0.856	---					
									146	26	0.835	---					
Recaps (n=)	5	3							197	60	0.785	---					
AVE			432	720	0.841				184	53	0.798			216	111	1.029	
MIN			358	358	0.749				137	20	0.573			161	44	0.939	
MAX			580	1710	0.939				289	190	0.960			264	200	1.114	

APPENDIX E

Table 33. Total lengths of 65 bull trout recaptured during trapping (T) or electrofishing (E). Recaptures with missing or unreadable tags (*) included but not used in growth increment calculations.

Recaptured Bull Trout, Electrofishing and Trapping 1997 - 1999

	Tag Number		Capture Method			Total Length (mm)			Growth Increment		Same-Year Recap	
	V.I. Tag	Pit Tag	1997	1998	1999	1997	1998	1999	1997-1998	1998-1999	1998	1999
Boulder	W62	4144023037	T	T		465	497		32			
	W71	4144024207	T	T		586	611		25			
	W54	413B00197F	T	E-T		501	523		22		E-532	
	***	4144083C5B	T	T			536					
	***	4143736548	T	T			512					
	***	41437F256A	T	T			462					
	***	*****	T		T			643				
	W40	41456E4777	T	T	T	438	500	554	62	54		
		4149065073		T	T		332	410		78		
		41436F4920		T	T		487	534		47		
		41440A6B36		T	T		648	695		47		
		414415472D		T	T		493	545		52		
		4143734A00		T	T		496	518		22		
		41456F2137		T	T		561	610		49		
		41437A035F		T	T		585	613		28		
		41477C441C		E-T	T		632	662		30	E-648	
		41437A3322		Kt	T		401	466		65		
		4143771B28		Kt	E		451	499		48		
		4149336A1F		Ot	E		424	492		68		
		4144105165		T	E-T		434	489		55		E-492
		414417474A		T	E-T		311	410		99		E-422
		414A733521		T	E-T		516	560		44		E-584
		413B3C3A4B		T	E		422	473		51		
		414375576A		T	E		590	640		50		
Kennedy	W13	4144107271	T	T		480	542		62			
	W14	41437A3201	T	T		506	534		28			
	W51	414377383C	T	T		550	552		2			
	***	41440F5E6A	T	T			560					
	W49	41440E1C33	T	Ot		422	461		39			
	W31	4143765014	T	E-T		400	455		55		E-466	
	W28	4148717245	T	E-T		550	577		27		E-592	
	W60	41483B0941	T	E		582	612		30			
	W44	414841377E	T	E		636	663		27			
	W84	414378167F	T	E		720	725		5			
	W80	4148212B2A	T	E	E	580	608	618	28	10		
	W42	414B040901	T	E-T	E-T	565	570	603	5	33	E-596	E-600
	W57	503074381D	T		E-T	474		529		55('97)		E-539
	W30	5030722454	T		E	428		522		94('97)		
	W85	5030670617	T		E	611		615		4('97)		
		41481C5665		T	E		424	487		63		
		4144135F7E		T	T		435	455		20		
		414408662E		T	T		553	580		27		
		41495D2C02		T	T		351	410		59		
		414916347F		T	T		384	466		82		
		414403781C		Ot	T		480	565		85		
		414410745F		Ot	T		425	485		60		
		41436C092A		Ot	T		291	361		70		
		41437A3322		T	Bt		401	466		65		
		4143771B28		T	Be		451	499		48		
		4148434A62		E	Ot		423	469		46		
		413B506C4F		E	T		550	590		40		
		4148252C2B		E	E		580	590		10		
		4145672926		E	E-T		453	495		42		T-482
		4148437E05		E	E-T		360	434		74		T-446
Otatso	W87	41440E3D13	T	T		419	438		19			
	W48	4143796924	T	T		508	524		16			
	W38	41440D7C3A	T	T		601	615		14			
	W82	41437D404E	T	T	T	428	464	504	36	40		
	W49	41440E1C33	Kt	T	T	422	461	487	39	26		
		41436C6A47		T	T		378	435		57		
		41437F556E		T	T		462	531		69		
		41436C092A		T	Kt		291	361		70		
		414403781C		T	Kt		480	565		85		
		414410745F		T	Kt		425	485		60		
		4149336A1F		T	Be		424	492		68		
		4148434A62		Ke	T		423	469		46		
		414A397955		MO-E	MO-E		244	310		66		
		413B1D6209		MO-E	MO-E		274	363		89		
Lee		41436E3342		E	T		442	489		47		
		414D300D47		E	T		458	487		29		
		41437C3349		E	T		563	580		17		
		4143712E07		E	T		403	449		46		
		4144167723		E	T		532	549		17		

APPENDIX F

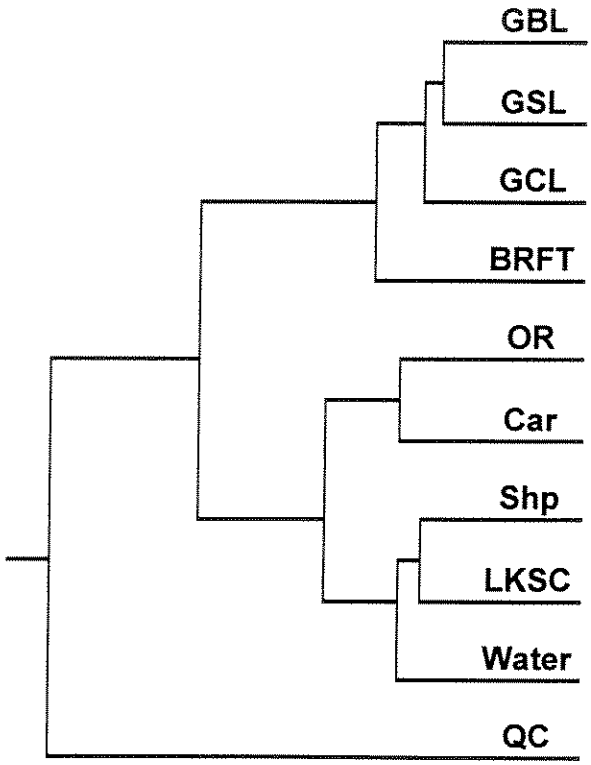

Figure 13. Phenogram representing genetic distances among Glacier National Park (GSL=Slide Lake; GCL=Cracker Lake; GBL=Red Eagle Creek) and Alberta (BRFT=Belly River; OR=Oldman River; Car=Carbondale River; Shp=Sheep River, LKSC=Smith-Dorian Creek and Water=Waterton River). Brook trout from Quirk Creek (QK), Alberta were included as an outgroup. Distance values were calculated using the Cavalli-Sforza algorithm and the distance tree was drawn with KITSCH from PHYLIP ver. 3.5 (from Thomas et al. 1997).

APPENDIX G

Table 34. Numbers and mean total length (MTL) in millimeters at capture of age classes of bull trout captured in Boulder, Kennedy and Otatso creeks, St. Mary River drainage, Montana, 1997. Divide Creek (n=1; age-IV; MTL=362) included in combined. Numbers based on 74 scale samples and only represent 75% of all bull trout (99) captured in 1997. Impressions of scales were made on sheets of cellulose acetate and examined using a Bioscope (model 60-A) projector at 10 X magnification. Data were entered into a computer program written in Turbo-Basic (version 1.1) by USFWS personnel. Based on the direct proportion method, back-calculated lengths at annuli were estimated by the scale method (Bagnal and Tesh 1978) and mean age was estimated by expanding results with an age-length key (Westrheim and Ricker 1978).

Age Class	Combined (all streams)		Boulder Creek	
	Number (%)	MTL	Number (%)	MTL
I	0 (0%)	---	0 (0%)	---
II	15 (20%)	187 (156-196)	13 (37%)	189 (179-195)
III	13 (18%)	238 (206-304)	12 (34%)	232 (206-255)
IV	10 (14%)	380 (354-419)	0 (0%)	---
V	16 (22%)	439 (415-492)	5 (14%)	438 (425-465)
VI	9 (12%)	482 (438-508)	2 (6%)	470 (438-501)
VII	6 (8%)	550 (515-565)	2 (6%)	540 (515-565)
VIII	4 (5%)	600 (565-636)	1 (3%)	586 (586-586)
IX	1 (1%)	665 (665-665)	0 (0%)	---
Totals	74 (100%)	351 (156-665)	35 (100%)	287 (179-586)

Age Class	Kennedy Creek		Otatso Creek	
	Number (%)	MTL (Range)	Number (%)	MTL (Range)
I	0 (0%)	---	0 (0%)	---
II	1 (4%)	156 (156-156)	1 (7%)	196 (196-196)
III	0 (0%)	---	1 (7%)	304 (304-304)
IV	6 (25%)	379 (356-404)	3 (22%)	389 (354-419)
V	6 (25%)	452 (422-492)	5 (35%)	425 (415-440)
VI	4 (16%)	486 (470-506)	3 (22%)	486 (467-508)
VII	3 (13%)	552 (550-555)	1 (7%)	561 (561-561)
VIII	3 (13%)	605 (565-636)	0 (0%)	---
IX	1 (4%)	665 (665-665)	0 (0%)	---
Totals	24 (100%)	468 (156-665)	14 (100%)	415 (196-561)

Table 35. Mean back-calculated total lengths (MBCTL) at annuli and mean growth increment (MGI) between annuli in millimeters of 74 bull trout captured in Divide, Boulder, Kennedy and Otatso creeks, St. Mary River drainage, Montana, 1997. Impressions of scales were made on sheets of cellulose acetate and examined using a Bioscope (model 60-A) projector at 10 X magnification. Data were entered into a computer program written in Turbo-Basic (version 1.1) by USFWS personnel. Based on the direct proportion method, back-calculated lengths at annuli were estimated by the scale method (Bagnal and Tesh 1978) and mean age was estimated by expanding results with an age-length key (Westrheim and Ricker 1978).

Drainage	Age Class								
	I	II	III	IV	V	VI	VII	VIII	IX
Divide Creek (n=1)									
MBCTL	64	117	187	298					
MGI	64	53	70	111					
Boulder Creek (n=35)									
MBCTL	74	135	208	307	388	450	510	558	
MGI	74	61	75	86	81	61	68	50	
Kennedy Creek (n=24)									
MBCTL	77	144	233	328	412	474	532	578	630
MGI	77	67	88	95	86	62	48	44	42
Otatso Creek (n=14)									
MBCTL	76	147	225	319	398	471	539		
MGI	76	70	79	94	86	54	44		
Combined (n=74)									
MBCTL	76	140	221	320	402	467	526	574	630
MGI	76	65	81	93	85	60	53	45	42