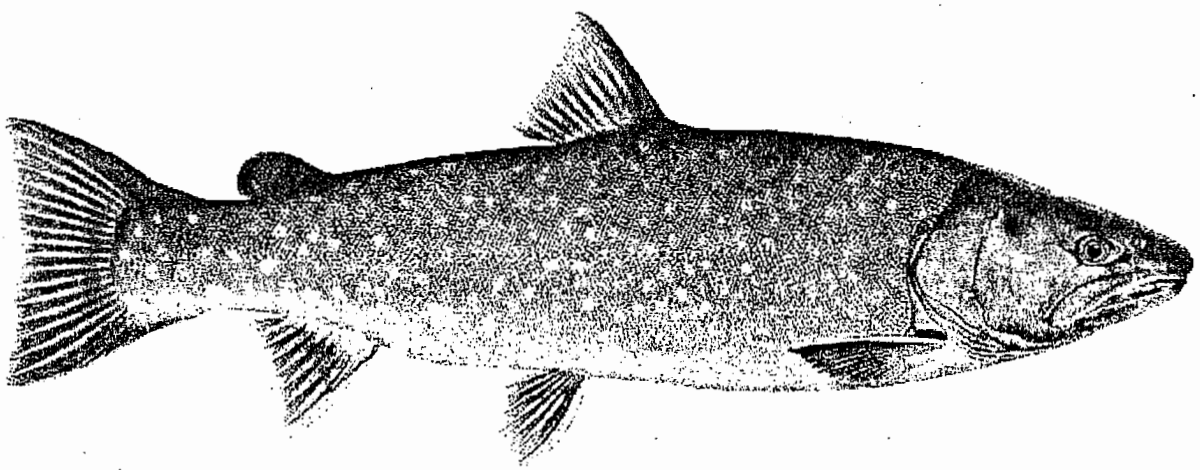
BULL TROUT (*Salvelinus confluentus*) INVESTIGATIONS in the SAINT MARY RIVER DRAINAGE of MONTANA



A Progress Report

February, 1999

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Montana Fish and Wildlife Management Assistance Office
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February 22, 1999

Dear Interested Party:

The attached report, **Bull trout (*Salvelinus confluentus*) investigations in the Saint Mary River drainage of Montana**, describes the results of a field study conducted in 1997 and 1998 and funded largely by the U.S. Bureau of Reclamation (Interagency Agreement 7-AA-60-08690). The report was prepared by Mr. Jim Mogen, Branch of Native Fishes Management, U.S. Fish and Wildlife Service. Field activities were a cooperative effort, however, accomplished by Jim and numerous employees of the Service and Blackfeet Tribe.

If you have comments or questions concerning the report, please direct them to the letterhead address.

Sincerely,

Lynn R. Kaeding, Chief
Branch of Native Fishes Management

BULL TROUT (*Salvelinus confluentus*) INVESTIGATIONS in the SAINT MARY RIVER DRAINAGE of MONTANA

A Progress Report
Based on Field Investigations Conducted in 1997 and 1998

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INTRODUCTION

Bull trout (*Salvelinus confluentus*), indigenous to inland Rocky Mountain habitats in both the United States and Canada, are the Northwest's largest native migratory trout. They are actually a char and a separate species from their smaller coastal relative, the Dolly Varden (*Salvelinus malma*) (Cavender 1978, Haas and McPhail 1991). Brown (1971) described the natural range of bull trout as northern California to the Bering Sea, including the Columbia and Saskatchewan river drainages in Montana. In Canada bull trout are found on both sides of the Continental Divide in the provinces of Alberta and British Columbia. In the United States, however, the only bull trout populations east of the divide are found in the headwaters of the Oldman River, a tributary to the Saskatchewan River drainage. This international drainage is formed by the Waterton, Belly, and Saint Mary rivers, which originate on the east slopes of the Rocky Mountains in Glacier National Park, Montana. The Waterton and Belly rivers flow north into Waterton Lakes National Park, Alberta. The Saint Mary River flows northeasterly across the northwest corner of the Blackfeet Reservation before crossing the international border. Bull trout apparently immigrated to the headwaters of the Oldman River drainage via postglacial dispersal routes originating in the Columbia refugium (Nelson and Paetz 1992).

Bull trout exhibit complex life histories with three distinct patterns identified: resident, adfluvial and fluvial. Resident populations are typically found in headwater streams or geographically isolated areas where they spend their entire lives. In migratory populations, adults undergo migrations from lakes (adfluvial) or larger streams and rivers (fluvial) to smaller tributaries where spawning and initial juvenile rearing occur. All three life history patterns potentially exist in the Saint Mary Drainage.

Bull trout represent a biological indicator of ecosystem and watershed health. Being a migratory top-predator, they are directly linked to the connectivity and function of entire watersheds. They are dependent upon pristine conditions and are sensitive to environmental disturbances, particularly human-caused changes (Fraley and Shepard 1989, Thomas 1992, Rieman and McIntyre 1993, 1995). Today, bull trout are in decline and considered a species of special concern throughout the majority of their range. Bull trout are extinct in California, only reside in

one river system in Nevada, and are currently threatened with elimination from many waterways in Oregon, Washington, Idaho, and Montana (Fraley 1994). In much of their historic range in Montana, bull trout are largely relegated to small, isolated, resident populations (Thomas 1992). In June 1998, the U.S. Fish and Wildlife Service listed the Columbia River and Klamath River bull trout population in the United States as threatened under the Federal Endangered Species Act. In separate actions, the agency also proposed listing of the Coastal-Puget Sound, Jarbridge River, and Saint Mary-Belly River populations as threatened (USFWS 1998). The status of bull trout in Canada has been under review by the Committee on the Status of Endangered Wildlife in Canada since 1988 (Groft et al. 1997). The American Fisheries Society and Montana Department of Fish, Wildlife and Parks list Bull trout as a species of special concern (Thomas 1992). In 1994, the Governor of Montana established a Bull Trout Restoration Team to develop restoration plans for bull trout in Montana.

Causes of the bull trout decline are generally attributed to habitat disturbances and fragmentation, competition and hybridization with non-native species, and overharvest. Dams and culverts block migratory pathways while sedimentation, dewatering, elevated temperatures, and loss of habitat diversity decrease the ability of streams to support bull trout. Introduced species, such as brook (*Salvelinus fontinalis*), rainbow (*Oncorhynchus mykiss*), brown *(Salmo trutta*), and lake (*Salvelinus namaycush*) trout, create additional problems in the form of competition for food and habitat and predation on eggs and juveniles. Brook trout also pose a threat of hybridization with bull trout, producing mostly sterile offspring (Kitano et al. 1994, Leary et al. 1993). The bull trout, once considered to be a "trash fish" and the "cannibal of the trout family," was targeted for eradication in the early 1900's and harvested commercially (Brown 1971, Fraley 1994). Today many people consider bull trout a trophy fish. Because of its size and catchability, the bull trout is very attractive to fisherman and poachers, making it vulnerable to overharvest.

Due to its fragmented condition and jurisdictional issues, the Saint Mary River drainage was identified as the lowest priority of the twelve Montana management areas under consideration for development of a restoration plan by the Montana Bull Trout Restoration Team. However, bull trout and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in the Oldman River drainage have been under investigation through cooperative efforts involving Glacier National Park, the U.S.

Bureau of Reclamation (USBR), the U.S. Fish and Wildlife Service (USFWS), and the Blackfeet Tribe in Montana, and Waterton Lakes National Park, the Alberta Conservation Association, and the Blood Tribe in Alberta, Canada.

According to Fitch (1994), bull trout populations in the Oldman River drainage have declined substantially from historic levels and now occupy about 30% of their historic range. In the upper Saint Mary drainage, only remnant resident populations exist in Lee Creek and in the Saint Mary River in Montana and Alberta. However, information on the current status of bull trout and other native salmonids in this drainage is lacking. Recent observations suggest that bull trout and westslope cutthroat trout numbers have declined to low levels. Electrofishing surveys of the Saint Mary River and its tributaries found no bull trout and few cutthroat trout (Wagner and Fitzgerald 1995, R. Wagner, personal communication). Fredenberg (1996a), however, noted that anglers still report catching bull trout from the Saint Mary River north of the international border and Marnell (1988) believes a few remnant westslope cutthroat trout populations remain in isolated headwater reaches.

Core areas are drainages that currently support the strongest remaining bull trout populations and require the most stringent level of protection, because they are the primary source of fish for recolonization of surrounding waters (Rieman and McIntyre 1993). Fredenberg (1996a) tentatively identified the entire Saint Mary River drainage in Montana as a core area and considered determining the status and abundance of bull trout in core area streams the highest priority for future work. By obtaining a baseline inventory, population trends and restoration progress can be assessed. The primary objective of this study was to characterize the remnant bull trout populations that exist in the Saint Mary drainage of Montana. This study is a cooperative effort among the Blackfeet Tribe, Glacier National Park, U.S. Bureau of Reclamation, and the U.S. Fish and Wildlife Service.

STUDY AREA

The Saint Mary River originates at Gunsight Lake within Glacier National Park and flows east for approximately 10 km before entering Saint Mary Lake (Figure 1). Red Eagle Creek, the first major tributary, enters Saint Mary Lake from the south. Upon leaving the lake, the Saint Mary River flows onto the Blackfeet Reservation and continues northeast for about 2 km before entering Lower Saint Mary Lake. Divide and Wild creeks enter the river near the midpoint of this short river stretch. Divide Creek flows in from the south and Wild Creek enters from the north. After leaving Lower Saint Mary Lake the river flows northerly for approximately 20 km before entering Alberta, Canada. Four major tributaries contribute to flows in this stretch. Swiftcurrent Creek enters Lower Saint Mary Lake at the outlet of the lake. Boulder Creek flows into Swiftcurrent Creek about 5 km above the lake. Kennedy Creek enters the river about 8 km downstream from the lake, and Otatso Creek flows into Kennedy Creek about 5 km above the river. After crossing the international boundary, the Saint Mary River continues north through mostly private lands in Alberta. Lee Creek, a major tributary that heads in Glacier Park and flows northeast into Alberta, enters the river approximately 35 km downstream from the international boundary near the town of Cardston. The Saint Mary River joins the Oldman River a few km upstream from Lethbridge, downstream from the confluence of the Belly River

Bull trout, westslope cutthroat trout, and mountain whitefish (*Prosopium williamsoni*) occur naturally in streams and lakes of the Saint Mary drainage while lake trout are native to Saint Mary and Lower Saint Mary lakes. Northern pike (*Esox lucius*), burbot (*Lota lota),* 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*) are also indigenous to the drainage (Brown 1971). Introduced salmonids include Yellowstone cutthroat trout (*Oncorhynchus clarki bouveri*), rainbow trout, brook trout, kokanee salmon (*Oncorhynchus nerka*), and lake whitefish (*Coregonis clupeaformis*).

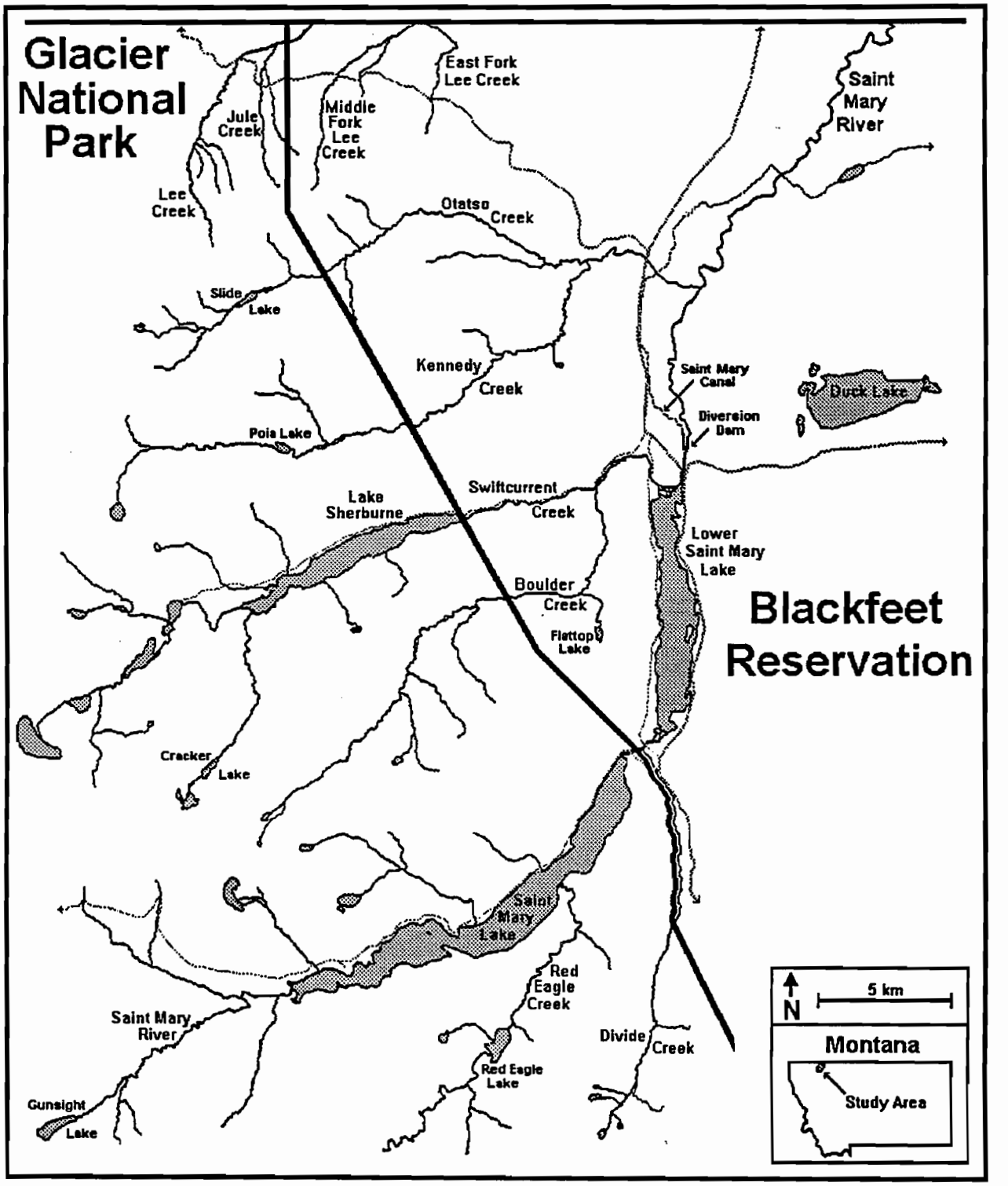

Figure 1. Study Area, Saint Mary River drainage, Montana.

Several small alpine lakes exist within the Saint Mary drainage and support mostly introduced fisheries. Gunsight Lake, origin of the Saint Mary River, contains an assemblage of brook, rainbow, and Yellowstone cutthroat trout (and probably hybrids) (Fredenberg 1996a). Red Eagle Lake, located about 8 km upstream from Saint Mary Lake in the Red Eagle Creek drainage, supports bull trout in addition to brook trout and Yellowstone cutthroat X rainbow hybrids (Fredenberg 1996a, Michels 1996). Flattop Lake, located at the head of a small nameless tributary to Boulder Creek, contains a self-sustaining population of McBride strain Yellowstone cutthroat trout (R. Wagner, USFWS, personal communication). Cracker Lake, a small isolated lake high in the Swiftcurrent Creek drainage, supports an abundant population of slow-growing bull trout believed to be introduced around the turn of the century (Fredenberg 1996a, Michels 1996). Cracker Lake is drained by Canyon Creek, which flows north about 7 km over a series of barriers before entering the upper end of Lake Sherburne, a large storage reservoir on Swiftcurrent Creek. A chain of several small lakes also exists in the upper Swiftcurrent drainage upstream from Lake Sherburne. Most of these lakes support populations of introduced species. Slide Lake, formed by a landslide across Otatso Creek approximately 15 km above its confluence with Kennedy Creek, supports a population of bull trout and Yellowstone cutthroat X rainbow hybrids (Fredenberg 1996a, Michels 1996).

Duck Lake is a large (600 hectares) pothole lake near the Hudson Bay Divide, approximately 5 km east of the outlet of Lower Saint Mary Lake. Duck Lake lies within the Saint Mary drainage but is actually a closed-basin lake with only intermittent tributaries and no known outlets. Historically fishless, Duck Lake now contains a variety of introduced species including rainbow trout, brown trout (*Salmo trutta*), Bonneville cutthroat trout (*Oncorhynchus clarki utah*), brook trout, and white suckers (R. Wagner, USFWS, personal communication). In 1996 bull trout were experimentally stocked into Duck Lake to replace previously stocked brown trout and fill their predatory role as a tool in suppression of white sucker numbers. Nationally known for its fast-growing trophy rainbow trout, Duck Lake is maintained as a put, grow and take fishery. The lake is stocked annually because natural salmonid reproduction does not occur.

Between 1914 and 1921 the USBR constructed several water control structures in the Saint Mary River drainage of the Blackfeet Reservation for the purpose of water transfer to the Milk River Project for irrigation (Wagner and Fitzgerald 1995). A major diversion dam was built on the Saint Mary River about 1.2 km downstream from Lower Saint Mary Lake. Water is diverted into an extensive canal system and eventually conveyed 47 km over the Hudson Bay Divide to the North Fork of the Milk River. Swiftcurrent Creek, which originally flowed into the Saint Mary River, was rerouted by use of a dike to flow into Lower Saint Mary Lake. Upper Swiftcurrent Creek was impounded by a 33-m high dam forming Lake Sherburne (Figure 1), which extends westerly across the reservation line into Glacier National Park. This large reservoir has a surface area of 648 hectares at full pool and a total storage capacity of nearly 84 million cubic meters. Lake Sherburne supports a diverse, self-sustaining fishery which includes introduced rainbow trout, brook trout, and kokanee salmon, and native mountain whitefish, burbot, northern pike, and suckers (Fredenberg 1996a, Wagner and Fitzgerald 1995). Bull trout and westslope cutthroat trout historically existed in this system, but little is known of their status today.

Fisheries have been affected by the Saint Mary delivery system in a number of ways. The diversion dam is a barrier to migration, at least seasonally. The canal headgates do not incorporate any means of excluding fish, and several species are known to enter and reside in the canal during irrigation season and possibly through the winter (Wagner and Fitzgerald 1995). Swiftcurrent Creek is maintained at bankful discharge from Sherburne Dam to its confluence with Lower Saint Mary Lake during the irrigation season, but after irrigation ends, flows are reduced substantially and Swiftcurrent Creek becomes largely dewatered from Sherburne Dam to the Boulder Creek confluence.

The USBR has funded a study to evaluate fish loss and entrapment in the canal system; thus far no bull trout or cutthroat trout have been captured (Wagner and Fitzgerald 1995). The USFWS has proposed several changes in the operations of the Saint Mary delivery system to lessen impacts on the Saint Mary River drainage. These include installing fish screens at the canal headgates, staged reduction in flows at the end of irrigation season, providing winter survival flows in the canal, and providing a more natural flow regime in Swiftcurrent Creek.

METHODS

Electrofishing (1998)

Electrofishing surveys were conducted during the summer, 1998, in Glacier National Park and on the Blackfeet Reservation to characterize fish communities and bull trout populations. Surveys were conducted in representative reaches of tributaries to the Saint Mary River, including Kennedy, Otatso, Boulder, Divide, Lee, and Wild creeks and their tributaries. Our primary objective was to determine the distributions of bull trout and westslope cutthroat trout rather than to make estimates of abundance. Sampling was conducted during low-flow periods from mid-July through August. Fish were captured using a Smith-Root battery-powered backpack electrofisher, model 15-B. Voltages ranged from 500-800 volts depending on stream temperature and conductivity. Low frequency (25-30 Hz) DC current was used to minimize injury to fish. Single passes were made through each reach, taking care to fish slowly and extensively through all possible cover.

Fish Trapping (1997-98)

Fish traps with weirs were installed in four tributaries to the Saint Mary River on the Blackfeet Reservation in 1997 and 1998 to monitor downstream movement of post-spawn, adult, migratory bull trout and provide definitive information on bull trout populations that use tributary streams. Trapping provides critical information on the movements of bull trout between the Saint Mary River and tributary streams and the relations between these movements and stream conditions. In 1997, the Kennedy and Otatso creek traps were installed 27 August and removed 9 October and the Boulder and Divide creek traps were installed 26 August and removed 8 October. In 1998, the Kennedy and Otatso creek traps were installed 25 August and removed 8 October, the Boulder Creek trap was installed 26 August and removed 14 October, and the Divide Creek trap was installed 26 August and removed 7 October. Traps were installed at the same locations in both years. The Kennedy Creek trap was installed approximately 60 m above the confluence with Otatso Creek and the Otatso Creek trap was installed about 10 m above the confluence with Kennedy Creek. The Boulder Creek trap was installed about 800 m above the confluence with Swiftcurrent Creek and the Divide Creek trap was installed approximately 500 m above the

confluence with the Saint Mary River. Throughout the trapping period all traps were cleaned and checked once daily according to the protocol described in Appendix A. The traps were removed after downstream migration of bull trout appeared to have ended or weather and other conditions precluded further sampling.

Fish traps were designed to capture downstream moving adult bull trout and consisted of box traps with weir wings that spanned the entire widths (5-12 m) of the 4 streams. The box traps measured 1.0 m long, 1.0 m wide, and 1.0 m high. They had 2.5 cm steel, square-tubing frames, 1.3 cm mesh galvanized hardware screen walls and bottoms, and plywood lids secured with padlocks. Vexar mesh funnels were fastened to the trap entrances, allowing fish to enter but not exit. Weir wings were attached at the entrances and angled upstream to opposite streambanks to help direct fish into the trap boxes and prohibit downstream passage around the traps. The wings were constructed from pickets (1.0-1.3 m lengths of 1.3 cm metal conduit) spaced at 2.5 cm and cabled together to form weir similar to a "picket fence." The wings were supported by fence posts driven into the substrate. The relatively large space (2.5 cm) between pickets was chosen to help minimize the problem of debris build up and subsequent "blow-out" of the weir. Spacing was large enough to allow the majority of leaves and other small debris to flow through the weir while still prohibiting the passage of large fish.

Collection of Biological Data (1997-98)

Fish captured during the study were identified to species, counted, and marked with fin clips. Total length (mm) and weight (g) were obtained from all trout and scales were taken for subsequent age and growth analysis. Bull trout greater than 200 mm total length were also tagged. In 1997 visual implant (V.I.) tags were injected behind the left eye, and in 1998 passive integrated transponders (PIT) tags were injected into muscle tissue on the left side of the body, directly ventral of the dorsal fin. Adipose fin samples were also collected from all bull trout for mitochondrial DNA analysis.

Fulton's condition factor (K) was computed for all trout using the formula described by Nielson and Johnson (1983):

$$K = \frac{100\,W}{L^3}$$

where: K = condition factor
W = total weight (g)
L = total length (cm)

Age and Growth Analysis (1997-98)

Scales were taken from an area posterior to the dorsal fin and above the lateral line from all trout captured during the study and used for age and growth analysis. 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).

Radio Implants - Radio Telemetry (1998)

Thirteen adult bull trout (>1250 g) captured at the traps in 1998 (6 fish in Kennedy, 3 in Otatso, and 4 in Boulder) were surgically implanted with 400-day radio transmitters (Appendix E, Table 25). Tracking of these 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 signals in the 30 MHz range, weighed 25 g, and did not exceed 2% of fish weight. Fish were anesthetized with MS-222 (tricaine methanesulfonate). Transmitters were inserted internally through a 20-mm ventral incision made 10-mm off of and parallel to the mid-ventral line, starting 20-mm anterior to the pelvic girdle. We utilized an angiocath (12GA) and a modified shielded needle technique (Ross and Kleiner 1982) to provide an outlet for the whip antennae. The antennas exited the body 20-mm posterior and slightly caudal to the origin of the left pelvic fin. Incisions were closed with four or five non-absorbable sutures (3-0 Ethilon nylon monofilament, Ethicon Corp.). Surgeries lasted 6-10 minutes (mean 7 min), during which time the gills were continuously flushed with water and anesthetic. About 1 minute prior to completion of surgery the water and anesthetic were replaced with fresh stream water to begin the recovery process.

Redd Surveys (1997-98)

Estimation of abundance of redds has been important in monitoring trends in many salmonid populations. As part of the Saint Mary study, preliminary redd surveys were conducted in each of

the four tributaries in 1997 to locate spawning areas and potentially establish a baseline for future monitoring of the Saint Mary drainage bull trout populations. Surveys were conducted in each stream after outmigration of adults appeared to have ended. In 1997, Kennedy, Otatso, and Divide creeks were surveyed on 15, 16, and 21 October, respectively, lower Boulder Creek on 22 October, and upper Boulder Creek on 11 November. In 1998, Kennedy, Boulder, and Otatso creeks were surveyed on 13, 14, and 15 October, respectively. Divide Creek was not surveyed in 1998.

Redd surveys were conducted in a manner similar to that described by Spalding (1997). Because 1997 was the initial year of surveys in these drainages, basin-wide counts that year were performed to survey all available spawning habitat and establish index areas in each stream for subsequent annual redd counts. A survey crew of 2-4 members walked the length of each stream until upstream barriers to fish movement were encountered. Upon discovery of a potential redd, its certainty was decided upon by the group. Brief descriptions of the redds and the spawning areas in general were noted and their approximate locations were marked on topographic maps. In 1998, only known spawning areas (index area) were surveyed for redds. Redds were classified as either "definite" or "probable" based on criteria outlined by Spalding (1997):

Definite: "No Doubt. The area is definitely cleaned and a pit and tailspill are recognizable. Not in an area normally cleaned by stream hydraulics."

Probable: "An area cleaned that may possibly be due to stream hydraulics, but a pit and tailspill are recognizable, or an area that does not appear clean, but has a definite pit and tailspill."

Because the "probable" category has such a high degree of certainty, Spalding recommends that definite redds and probable redds be counted together in the final tabulation.

Stream Temperatures (1997-98)

Temperatures of the tributaries were continuously monitored (bi-hourly) from late August to mid-October using Onset Optic StowAway® data-loggers. The recording thermometers were installed at the trap sites in Divide, Boulder, Kennedy, and Otatso creeks, and in Swiftcurrent Creek at the West Shore Road Bridge.

RESULTS

Electrofishing Conditions

Other than low stream temperatures and low conductivities, which often decrease electrofishing efficiency, conditions were nearly ideal for electrofishing during the summer of 1998. Throughout the shocking period, stream flows were low, clear, and manageable and the weather was warm with little precipitation.

Electrofishing Surveys

Electrofishing surveys were conducted primarily to characterize fish communities, and determine the distributions of bull trout and westslope cutthroat trout. They provided definitive information on fish-community composition, limiting factors, bull trout status, habitat-use, and seasonal movements, and westslope cutthroat trout status in the Saint Mary drainage. Only qualitative information was gained and no estimates of population sizes were made.

The Divide Creek drainage was surveyed 8 July at several locations within Glacier National Park, from its head to the Park boundary. Despite much sampling effort, no bull trout and only two cutthroat trout (220 and 80 mm total length) were captured. Both fish were captured just inside the Park boundary. No barriers to the upstream movement of fish were encountered within Divide Creek itself; however, high-gradient cascades prohibit fish passage into the few small fishless tributaries of the drainage.

The Kennedy Creek drainage was surveyed the weeks of 13 July and 27 July at several locations within Glacier National Park and on the Blackfeet Reservation. A large waterfall (10 m high) at the outlet of Poia Lake is a barrier to the upstream movement of fish. Upstream from the barrier, no fish were encountered and Kennedy Creek and Poia Lake appear to be fishless. Downstream from the barrier, bull trout (range, 40-725 mm total length), cutthroat x rainbow trout hybrids (144-411 mm), one brook trout (153 mm), and many mountain whitefish were captured (Appendix B, Table 10 and Figure 12). Twenty seven large (>300 mm) bull trout were captured from a 2 km stretch of Kennedy Creek near the park boundary, 4 km downstream from the nown

bull trout spawning area. Seven (26%) of these bull trout had been caught and marked at the Kennedy Creek fish trap during their outmigration in 1997. Approximately 3 km upstream from the Park boundary is a tributary that enters Kennedy Creek from the north and appears large enough to support fish; however, a large waterfall (20 m high) near its confluence prohibits fish passage upstream. All other tributaries to the drainage are either too small or have gradients too high to support fish.

The Otatso Creek drainage was surveyed the week of 20 July. A small waterfall (3 m high) near the Park boundary prohibits upstream passage of fish from lower Otatso Creek. Downstream from the waterfall, two tributaries enter Otatso Creek from the south, one near the Park boundary and the other near the Kennedy Creek confluence. Both streams appeared large enough to support fish; however no fish were encountered during electrofishing surveys. Approximately 3 km upstream from the waterfall a large landslide across Otatso Creek acts as a seasonal barrier to fish movement, only permitting passage during high flows. In the stretch of Otatso Creek between the waterfall and the landslide, resident bull trout (110-472 mm total length), cutthroat x rainbow trout hybrids (105-228 mm) and mountain whitefish were captured (Appendix B, Table 11 and Figure 12). Slide Lakes, which are formed upstream from the landslide, support a resident population of bull trout and cutthroat x rainbow hybrids. The stream is fishless above a large waterfall (50 m high) in Otatso Creek approximately 1km upstream from the lakes. Bull trout (62-572 mm) and cutthroat x rainbow hybrids (245-341 mm) were captured in the stretch of Otatso Creek between the waterfall and the lakes and in the 200-m stretch between the lakes (Appendix B, Table 12 and Figure 12).

The Boulder Creek drainage was surveyed the week of 28 July. Bull trout (82-648 mm total length), cutthroat x rainbow hybrids (177-458 mm), brook trout (87-238), and mountain whitefish were captured at several locations 4-8 km upstream from the Glacier National Park boundary (Appendix B, Table 9 and Figure 12). Approximately 6 km upstream from the Park boundary, the entire Boulder Creek flow is subsurface and passes through gravel-cobble alluvium for approximately 300 m before reemerging via groundwater upwelling. This stretch apparently presents only a seasonal barrier to fish movement because all species previously mentioned were captured upstream as well. Just downstream from the seasonal barrier, in the vicinity of the known

bull trout spawning area, 12 large (>300 mm) bull trout were captured, one of which was previously captured and marked at the Boulder Creek fish trap during the outmigration in 1997. All tributaries to Boulder Creek were small and barren of fish.

Wild Creek was surveyed on 27 July at several locations near the Glacier National Park Boundary. The only fish captured in this small stream were potentially pure westslope cutthroat trout (55-197 mm total length, Appendix B, Table 13). A small waterfall-cascade complex about 1 km upstream from the Park boundary appears to be a barrier to upstream movement. No fish were captured from a 200 m reach directly upstream from this barrier.

Lee Creek, upstream from the Chief Mountain Highway in northeast Glacier National Park, was surveyed on 18 August.. Bull trout (52-592 mm total length), cutthroat x rainbow hybrids (70-382 mm), and mountain whitefish were captured, and 25 large bull trout (>400 mm) were PIT-tagged (Appendix B, Table 14 and Figure 13). Middle Fork Lee Creek and Jule Creek, two small tributaries to Lee Creek, were surveyed the week of 11 August. In Jule Creek, juvenile bull trout (89-148 mm) and cutthroat x rainbow hybrids (74-195 mm) were captured from the short reach between the highway and the confluence with Lee Creek (Appendix B, Table 15 and Figure 13). Two bull trout (175-235 mm) and several cutthroat x rainbow hybrids (115-234 mm) were captured from a 300 m reach of Middle Fork Lee Creek, directly downstream of Chief Mountain Highway (Appendix B, Table 16 and Figure 13). This stream appears to be highly degraded. Streamside grazing has resulted in a heavy silt load and high turbidity levels, and the highway culvert creates a barrier (2 m waterfall) to the upstream movement of fish. Directly upstream from the barrier, no fish were captured from a 200-m reach.

Trapping Conditions

Fish trapping in the Saint Mary River drainage occurred from 26 August to 10 October in 1997 and from 25 August to 14 October in 1998. Weather conditions were mild and stream flows were clear, consistent, and manageable throughout the trapping periods in both years, resulting in ideal trapping conditions. Minor problems included leaves, namely aspen (*Populus tremuloides*), which occasionally clogged the weir and traps; mink predation resulted in the loss of several whitefish, cutthroat, and at least four small bull trout. Mink traps were set at the trap sites and one

mink was captured in 1997, and seven mink were captured in 1998. Only one incident of vandalism occurred (1997) when someone unscrewed the pad-lock latch to access the Kennedy Creek trap.

Stream temperatures during the trapping periods were slightly cooler in 1997 than 1998 (Figure 2). Temperatures in 1997 ranged from a minimum of 2.4° C in Otatso Creek to a maximum of 18.1° C in Kennedy Creek, while temperatures in 1998 ranged from a minimum of 1.3° C in Otatso Creek to a maximum of 18.8° C in Kennedy Creek. Although temperature trends were similar between the four study streams, Kennedy Creek generally exhibited the warmest temperatures in both years, followed by Otatso Creek, Boulder Creek, and Divide Creek (Figure 2 and Appendix C Table 17). Mean daily temperatures in Swiftcurrent Creek, however, were significantly higher than those of the other streams throughout most of the trapping periods. Flows in Swiftcurrent Creek are regulated and released from Lake Sherburne, a large reservoir approximately 5 km upstream from the Boulder Creek confluence. Due to extreme flow reductions in Swiftcurrent Creek in early October of both years, temperatures were not recorded after the first week of October.

Fish Captured in Traps

Bull trout were captured at all trap locations in 1997 and at all trap locations except Divide Creek in 1998. Although the traps were designed to capture adult bull trout, large samples of smaller fish were also inadvertently obtained. A total of 682 salmonids was captured in downstream traps in 1997 (Table 1 and Appendix D Tables 18-21) compared to 797 in 1998 (Table 1 and Appendix D Tables 22-24). Native fish species included bull trout (99 in 1997 and 167 in 1998), cutthroat trout, mountain whitefish, white, mountain, and longnose suckers, longnose dace, and sculpins (suckers, dace and sculpins were uncounted and not included in the study). Non-native fish included rainbow trout and brook trout. Because cutthroat and rainbow trout coexist in these systems and are likely to interbreed and produce hybrids (CTT x RBT), these two species were totaled together. Mountain whitefish dominated the catch at all trap sites and accounted for nearly 73% of the total catch in both years, followed by bull trout (15% in 1997 and 21% in 1998),

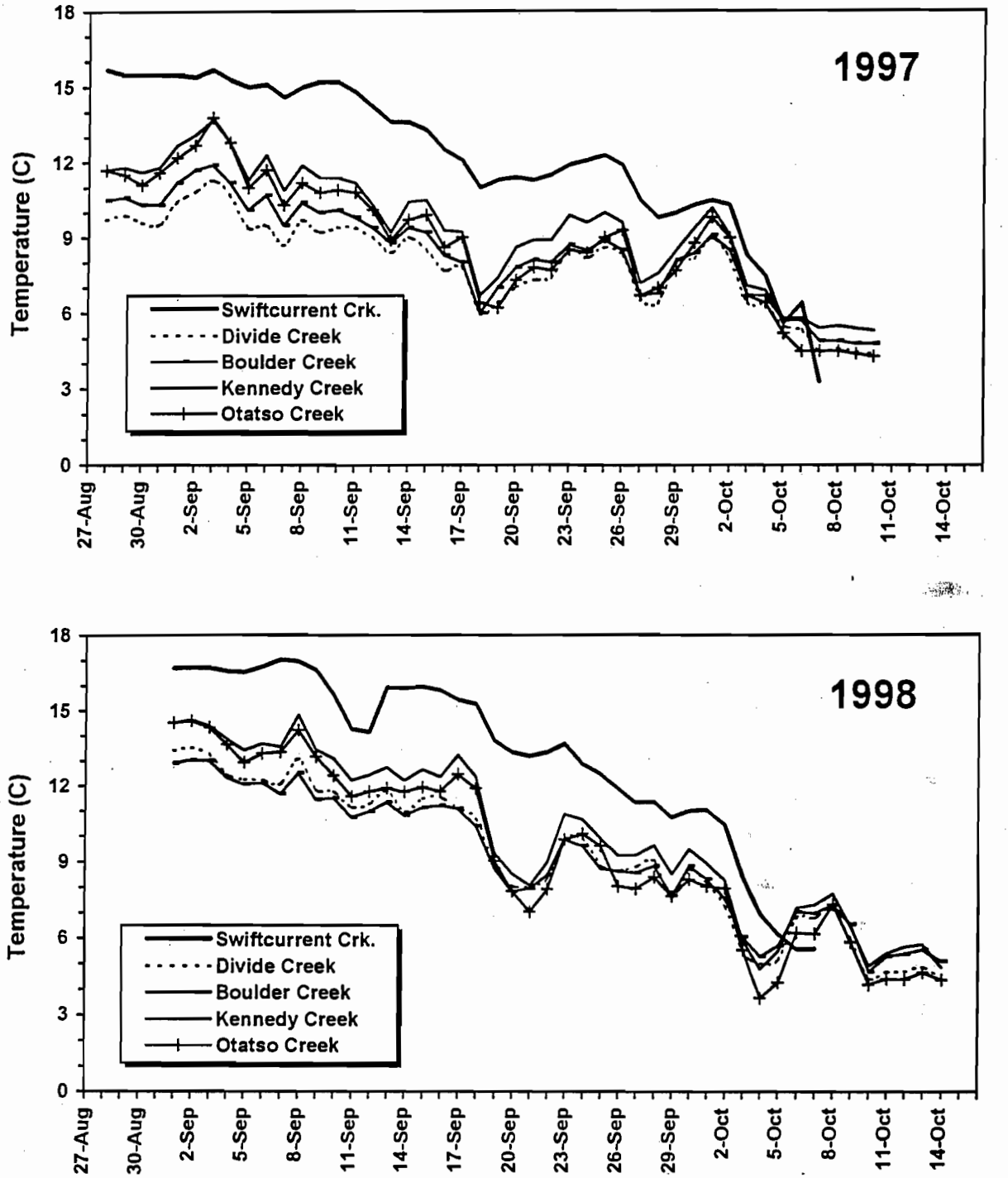

Figure 2. Mean daily stream temperatures (°C) in Swiftcurrent, Divide, Boulder, Kennedy and Otatso creeks, Saint Mary River drainage, Montana, Aug.-Oct., 1997-98.

Table 1. Total numbers of salmonids captured in Divide, Boulder, Kennedy and Otatso Creek fish traps, Saint Mary River drainage, Montana, 1997-98.

Trap Site	Bull Trout (<30 cm)		Bull Trout (>30 cm)		CTT x RBT		Brook Trout		Mountain Whitefish		Totals	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
Divide	0	0	2	0	27	3	1	0	44	18	72	21
Boulder	30	23	17	64	27	15	0	2	63	132	136	236
Kennedy	1	6	32	38	13	6	0	0	181	147	226	197
Otatso	1	17	16	19	16	19	0	0	220	278	248	343
Totals	32	46	67	121	85	53	1	2	497	575	682	797

and CTT x RBT (12% in 1997 and 6% in 1998). In both years, the Otatso Creek trap yielded the largest overall catch; however, the majority of large (>30 cm long) bull trout was captured in the Kennedy Creek trap in 1997 (48%) and in the Boulder Creek trap in 1998 (53%). The Boulder Creek trap provided the largest sample of small (<30 cm) bull trout in both years.

Thirteen large (> 1250 g) adult bull trout (Appendix E Table 25) captured at the traps in 1998 were surgically implanted with radio transmitters. Several searches (aircraft and ground-based) are planned for the winter of 1998-99. Results of the telemetry study are not yet available.

Adipose fin samples were collected from all bull trout captured during the study for subsequent mitochondrial DNA analysis. Five cutthroat trout were sacrificed from each stream for electrophoretic analysis at the University of Montana Salmon and Trout Genetics Lab. Samples of non-native trout (rainbow and brook) were sacrificed for whirling disease analysis at the USFWS Fish Health Lab in Bozeman, MT. Genetics and disease analyses have not yet been completed.

Divide Creek Catch Statistics

The Divide Creek fish trap captured the fewest number of fish in both trapping seasons. Altogether, 72 fish were captured in 1997 and 21 in 1998 (Table 1). Mountain whitefish dominated the catch in both years followed by CTT x RBT. Two adult bull trout were captured during outmigration from Divide Creek, both in 1997. A large female (546 mm, 1728 g) was captured 1 September, 1997, and a smaller male (362 mm, 396 g) was captured 22 days later on 23 September (Figure 3 and Table 2). Mean-daily stream temperatures during this period ranged from 6.0 to 11.3 °C. No juvenile bull trout were captured from Divide Creek during the study. One brook trout (100 mm, 6 g) was captured in 1997 and none in 1998.

Table 2. Total numbers and means and ranges in total lengths, weights, and condition factors for all bull trout and cutthroat x rainbow trout hybrids (CTT x RBT) captured in the Divide Creek fish trap, Saint Mary River drainage, Montana, 1997-98.

Divide Creek	Bull Trout (<30 cm)		Bull Trout (>30 cm)		CTT x RBT	
	1997	1998	1997	1998	1997	1998
Total Number	0	0	2	0	27	3
Mean Length (mm)	---	---	454	---	171	252
Range			362-546		102-205	99-492
Mean Weight (g)	---	---	1062	---	52	292
Range			396-1728		8-90	6-836
Mean Condition (K)	---	---	0.95	---	0.95	0.69
Range			0.84-1.06		0.75-1.20	0.62-0.74

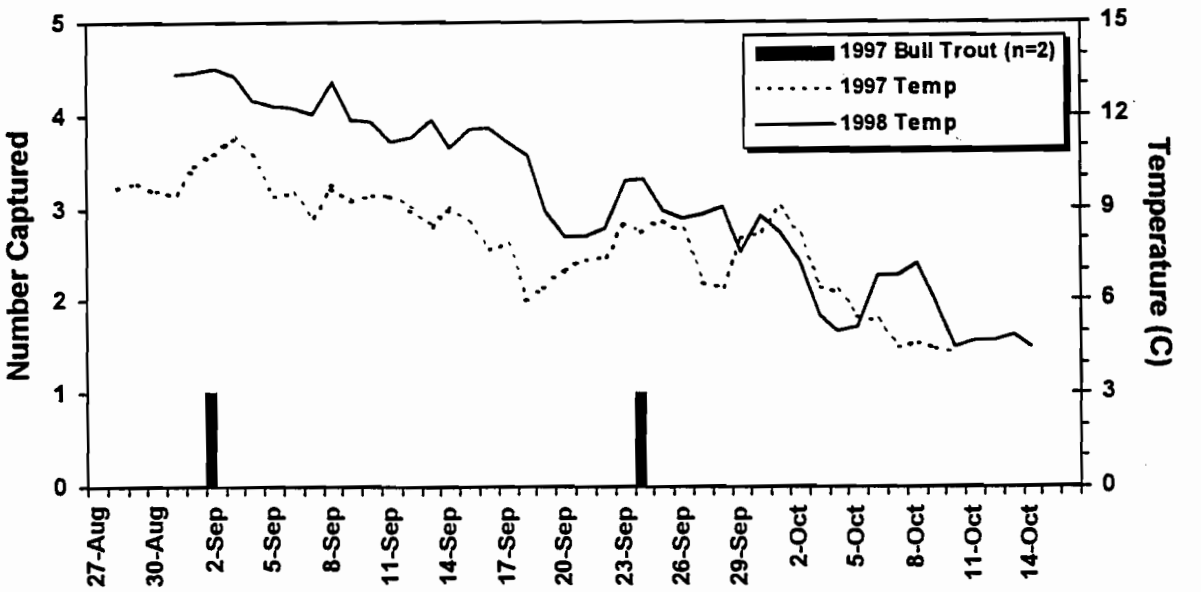

Figure 3. Chronology of captures of downstream-migrating adult bull trout and corresponding mean daily temperatures (°C) in Divide Creek, Saint Mary River drainage, Montana, August-October, 1997-98.

Boulder Creek Catch Statistics

Totals of 136 (17 adult bull trout) and 236 (64 adult bull trout) fish were captured in the Boulder Creek fish trap in 1997 and 1998, respectively (Table 1). In both years, outmigrating adult bull trout were captured shortly after the trap was installed (Figure 4). However, the majority (71% and 80% in 1997 and 1998, respectively) of adult bull trout captures occurred after mean daily stream temperatures had dropped below 9.0 °C (13 and 19 September in 1997 and 1998, respectively). Although the average size and condition (K) of adult bull trout was consistent between the two trapping seasons, a much broader range of size and condition was obtained in 1998 (Table 3). Seven (41%) of the 17 adult bull trout captured and marked (V.I. tagged) at the Boulder Creek trap in 1997 were recaptured at the trap in 1998. Five (42%) of the 12 large bull trout captured and marked (PIT-tagged) during the summer electrofishing surveys in Boulder Creek upstream from the trap were recaptured at the trap. Total numbers and means and ranges in total lengths, weights, and condition factors for all bull trout and CTT x RBT captured at the Boulder Creek fish trap are presented in Table 3.

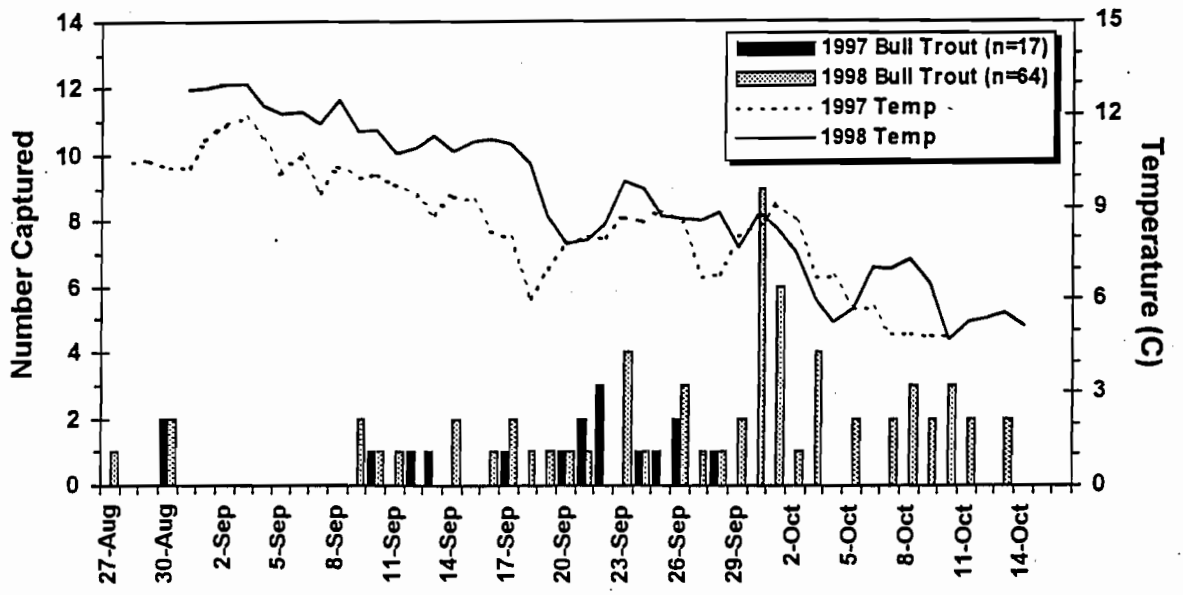

Figure 4. Chronology of captures of downstream-migrating adult bull trout and corresponding mean daily temperatures (°C) in Boulder Creek, Saint Mary River drainage, Montana, August-October, 1997-98.

Table 3. Total numbers and means and ranges in total lengths, weights, and condition factors for all bull trout and cutthroat x rainbow trout hybrids (CTT x RBT) captured in the Boulder Creek fish trap, Saint Mary River drainage, Montana, 1997-98.

Boulder Creek	Bull Trout (<30 cm)		Bull Trout (>30 cm)		CTT x RBT	
	1997	1998	1997	1998	1997	1998
Total Number	30	23	17	64	27	15
Mean Length (mm)	211	183	494	493	221	212
Range	178-255	163-235	416-586	311-690	170-465	126-270
Mean Weight (g)	81	47	1048	1121	132	86
Range	44-144	24-104	654-1650	306-2678	42-934	10-146
Mean Condition (K)	0.83	.73	0.86	0.86	1.01	0.84
Range	0.72-0.90	0.46-0.89	0.75-1.09	0.66-1.17	0.83-1.19	0.49-1.05

Kennedy Creek Catch Statistics

Totals of 226 (32 adult bull trout) and 197 (38 adult bull trout) fish were captured in the Kennedy Creek fish trap in 1997 and 1998, respectively (Table 1). In 1997, adult bull trout were captured shortly after the trap was installed (Figure 5). However, as with Boulder Creek, most (72 %) adult outmigrants were captured after mean-daily stream temperatures had dipped to nearly 9.0 °C (13 Sept.). In 1998, all adult bull trout captures occurred after mean-daily stream temperatures dropped below 9.0 °C (19 Sept). Although the total number captured was similar between the two years, the average size of adult bull trout declined from 1997 to 1998 (Table 4). Condition, however, was nearly the same. The decline in size can be attributed to the preponderance of smaller (340-380 mm) adult bull trout in 1998 and several large (>580 mm) adults in 1997. Seven (22%) of the 32 adult bull trout captured and marked (V.I. tagged) at the Kennedy Creek trap in 1997 were recaptured at the trap in 1998. Seven (26%) of the 26 large bull trout captured and marked (PIT-tagged) during the summer electrofishing surveys in Kennedy Creek upstream from the trap were recaptured at the trap. Total numbers and means and ranges in total lengths, weights, and condition factors for all bull trout and CTT x RBT captured at the Kennedy Creek fish trap are presented in Table 4.

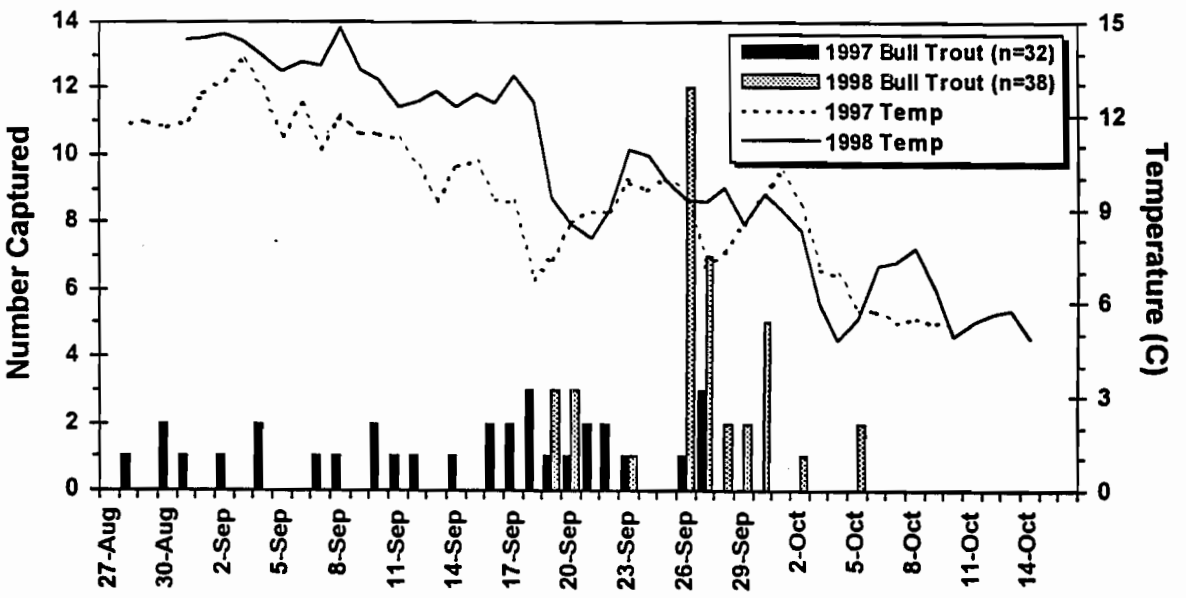

Figure 5. Chronology of captures of downstream-migrating adult bull trout and corresponding mean daily temperatures (°C) in Kennedy Creek, Saint Mary River drainage, Montana, August-October, 1997-98.

Table 4. Total numbers and means and ranges in total lengths, weights, and condition factors for all bull trout and cutthroat x rainbow trout hybrids (CTT x RBT) captured in the Kennedy Creek fish trap, Saint Mary River drainage, Montana, 1997-98.

Kennedy Creek	Bull Trout (<30 cm)		Bull Trout (>30 cm)		CTT x RBT	
	1997	1998	1997	1998	1997	1998
Total Number	1	6	32	38	13	29
Mean Length (mm)	156	230	513	442	233	231
Range	---	190-279	356-720	316-650	109-340	166-280
Mean Weight (g)	26	107	1172	808	155	121
Range	---	52-200	406-2504	256-2236	10-374	44-198
Mean Condition (K)	0.69	0.83	0.82	0.84	0.91	0.92
Range	---	0.76-0.92	0.62-1.08	0.74-1.00	0.77-1.13	0.84-0.97

Otatso Creek Catch Statistics

In both years, the Otatso Creek trap produced the largest combined catch; however; fewer bull trout were captured in this stream than in Kennedy or Boulder Creeks. Totals of 248 (16 adult bull trout) and 343 (19 adult bull trout) fish were captured in the Otatso Creek fish trap in 1997 and 1998, respectively (Table 1). In both years, outmigrating adult bull trout were captured shortly after the trap was installed (Figure 6). However, the majority (88% and 95% in 1997 and 1998, respectively) of adult bull trout captures occurred after mean-daily stream temperatures had dropped below 9.0 °C (13 and 19 September in 1997 and 1998, respectively). Average size and condition (K) of adult bull trout were similar between the two trapping seasons (Table X). Five (31%) of the 16 adult bull trout captured and marked (V.I. tagged) at the Otatso Creek trap in 1997 were recaptured at the trap in 1998. None of the 39 large bull trout captured and marked (PIT-tagged) during the summer electrofishing surveys in Otatso Creek upstream of the trap was recaptured at the trap. Total numbers and means and ranges of total lengths, weights, and condition factors for all bull trout and CTT x RBT captured at the Otatso Creek fish trap are presented in Table X.

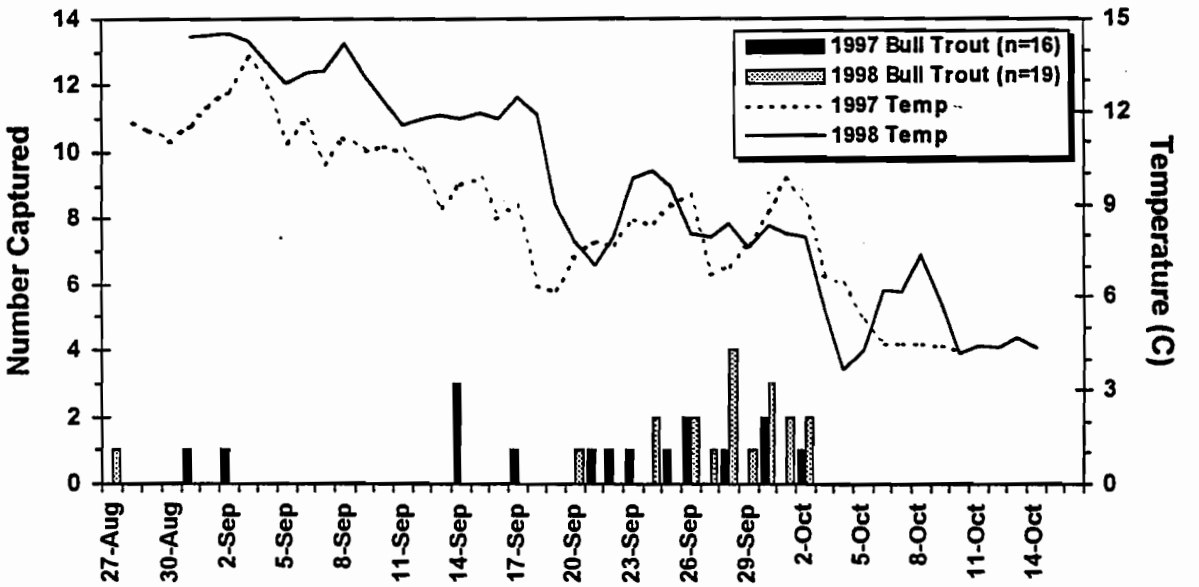

Figure 6. Chronology of captures of downstream-migrating adult bull trout and corresponding mean daily temperatures (°C) in Otatso Creek, Saint Mary River drainage, Montana, August-October, 1997-98.

Table 5. Total numbers, means and ranges in total length and weight, and condition factor for all bull trout and cutthroat x rainbow trout hybrids (CTT x RBT) captured in the Otatso Creek fish trap, Saint Mary River drainage, Montana, 1997-98.

Otatso Creek	Bull Trout (<30 cm)		Bull Trout (>30 cm)		CTT x RBT	
	1997	1998	1997	1998	1997	1998
Total Number	1	17	16	19	16	29
Mean Length (mm)	196	203	463	448	201	202
Range	---	166-291	304-617	307-615	107-293	121-353
Mean Weight (g)	58	75	840	829	100	80
Range	---	34-246	234-1720	298-2108	8-260	16-206
Mean Condition (K)	0.77	0.79	0.79	0.86	0.91	0.89
Range	---	0.71-1.00	0.64-1.04	0.67-1.08	0.61-1.11	0.73-0.98

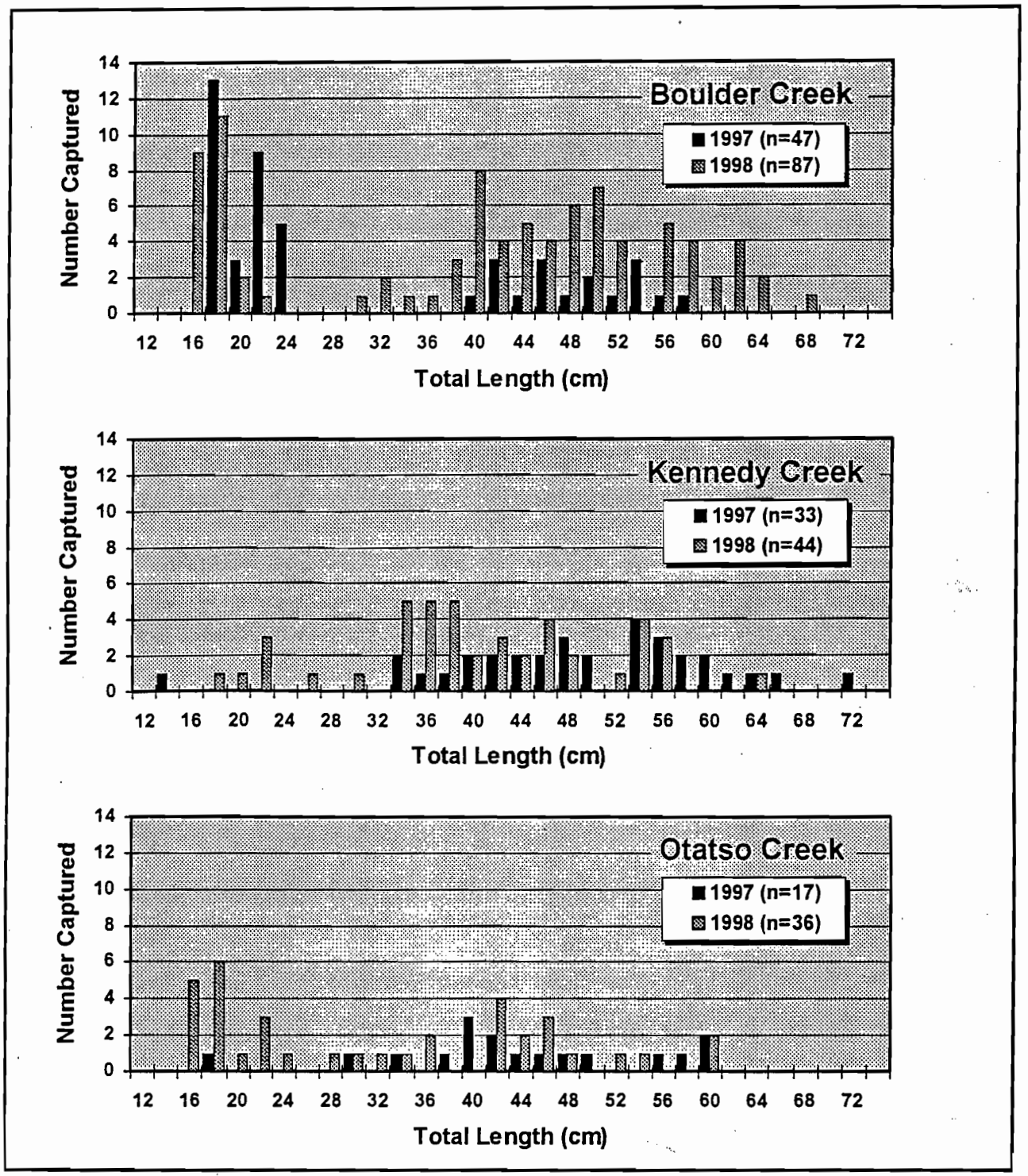

Figure 7. Length-frequency distributions for bull trout captured in Boulder, Kennedy and Otatso creeks, Saint Mary River drainage, Montana, 1997-98. Divide Creek not included due to its small sample sizes (n=2 in 1997 and n=0 in 1998).

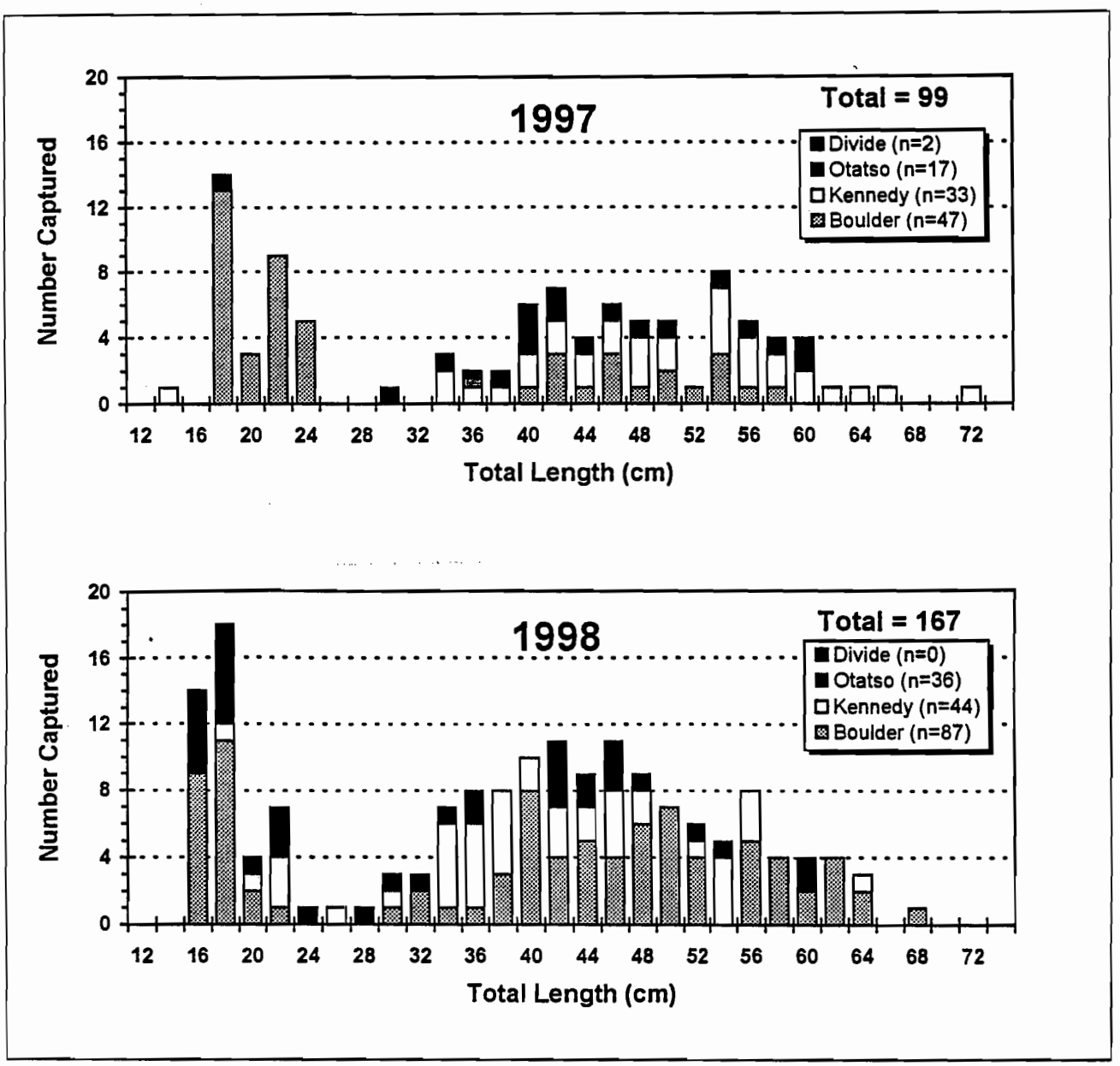

Figure 8. Length-frequency distribution for all bull trout captured in fish traps in the Saint Mary River Drainage, Montana, 1997-98.

Length-Frequencies

Length-frequency distributions for all bull trout captured in the Boulder, Kennedy and Otatso creek fish traps are compared in Figures 7 and 8. Total lengths of all bull trout captured in the fish traps averaged 403 mm (range, 156-720 mm) and 395 mm (163-690 mm) in 1997 and 1998, respectively (Figure 8). Adult migrants averaged 495 mm (304-720 mm) and 470 mm (307-690 mm), respectively. Length-frequency distributions of all bull trout captured during summer electrofishing surveys are presented in Appendix B, Figures 12-13.

Recaptures

Twenty-four (36%) of the 67 adult bull trout captured and marked at the fish traps in 1997 were recaptured in 1998. Eight (1 in Boulder and 7 in Kennedy) were recaptured during summer electrofishing surveys, 19 (7 in Boulder, 7 in Kennedy, and 5 in Otatso) were recaptured at the fish traps, and three (1 in Boulder and 2 in Kennedy) were recaptured during electrofishing and again in the traps. As expected, no marked fish were recaptured during electrofishing surveys in Otatso Creek because all electrofishing was conducted upstream from a barrier (3 m high waterfall). Tags (V.I. tags) were retained in 20 (83%) of the 24 recaptures (an adipose fin-clip had also been applied), which allowed individual growth from 1997 to 1998 to be calculated (Table 6).

Five (42%) of the 12 large bull trout captured and PIT-tagged during electrofishing surveys upstream from the trap in Boulder Creek were recaptured at the Boulder Creek trap. Seven (26%) of the 27 large bull trout captured and PIT-tagged during electrofishing surveys in Kennedy Creek were recaptured at the Kennedy Creek trap. None of the 39 large bull trout captured and PIT-tagged during electrofishing surveys in Otatso Creek were recaptured at the Otatso Creek trap.

During electrofishing surveys and fish trapping in 1998, most recaptures of bull trout marked at the traps in 1997 occurred in the stream from which the fish was originally captured. There was only one instance of a bull trout marked in one stream (Otatso Creek) being recaptured in another (Kennedy Creek). Saint Mary bull trout may exhibit a degree of spawning-site fidelity. However, because spawning tributaries are limited in the Saint Mary drainage, use of spawning streams may be influenced as much by availability as choice.

Table 6. Individual increase and mean increase per stream in total length (mm) from 1997 to 1998 of 20 recaptured bull trout. Recaptures with missing or unreadable tags (*) included but not used in calculations.

Stream (Trap Location)	Total Length 1997	Total Length 1998	Individual Increase	Mean Increase Per Stream
Boulder Creek	438	500	62	35
	465	497	32	
	501	523	22	
	586	611	25	
	*	512	*	
	*	536	*	
	*	462	*	
Kennedy Creek	400	466	66	30
	400	455	55	
	480	542	62	
	506	534	28	
	550	577	27	
	550	552	2	
	565	570	5	
	580	608	28	
	582	612	30	
	636	663	17	
	720	725	5	
	*	560	*	
Otatso Creek	419	438	19	25
	422	461	39	
	428	464	36	
	508	534	16	
	601	615	14	
Average	---	---	(Range 2 – 66)	29.5

Age and Growth

Bull trout age and growth data were obtained from analysis of 74 scale samples collected in 1997. Scales were also taken from all bull trout captured in 1998 (electrofishing and traps), but scale analysis has not yet been completed. Although scales were taken from all 99 bull trout captured in 1997, only 74 (75%) of the samples were considered readable (G. Boltz, USFWS, personal communication). These include one sample from Divide Creek, 35 from Boulder Creek, 24 from Kennedy Creek, and 14 from Otatso Creek. Estimated bull trout ages varied from II-IX in the study area with age-V fish most commonly encountered (Table 7). Estimated ages ranged from II-VIII in Boulder Creek, II-IX in Kennedy Creek and II-VII in Otatso Creek. The single fish from Divide Creek was age IV. Age-IV bull trout accounted for 25% and 22% of the samples in Kennedy and Otatso creeks, respectively; however, no age-IV fish were captured in Boulder Creek. The oldest fish encountered during the study was captured in Kennedy Creek and was estimated as age IX and was 665 mm in total length. A 720-mm bull trout was also captured in Kennedy Creek but its scale sample was not readable.

Annual growth increments ranged from 42 mm to 111 mm in the study area (Table 8). Growth was greatest between ages III and IV in all streams and generally steadily declined thereafter (Table 8 and Figure 9). Kennedy Creek bull trout consistently averaged slightly longer at each age than bull trout from the other streams, while bull trout from Boulder Creek (and Divide Creek) consistently averaged slightly shorter.

Age and growth data obtained from analysis of scale samples from 59 cutthroat trout and 4 rainbow trout collected during the study are presented in Appendix F Table 26.

Table 7. Numbers and mean total length (MTL) in millimeters at capture of age classes of bull trout captured in Boulder, Kennedy and Otatso creeks, Saint 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.

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 8. 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, Saint Mary River drainage, Montana, 1997.

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

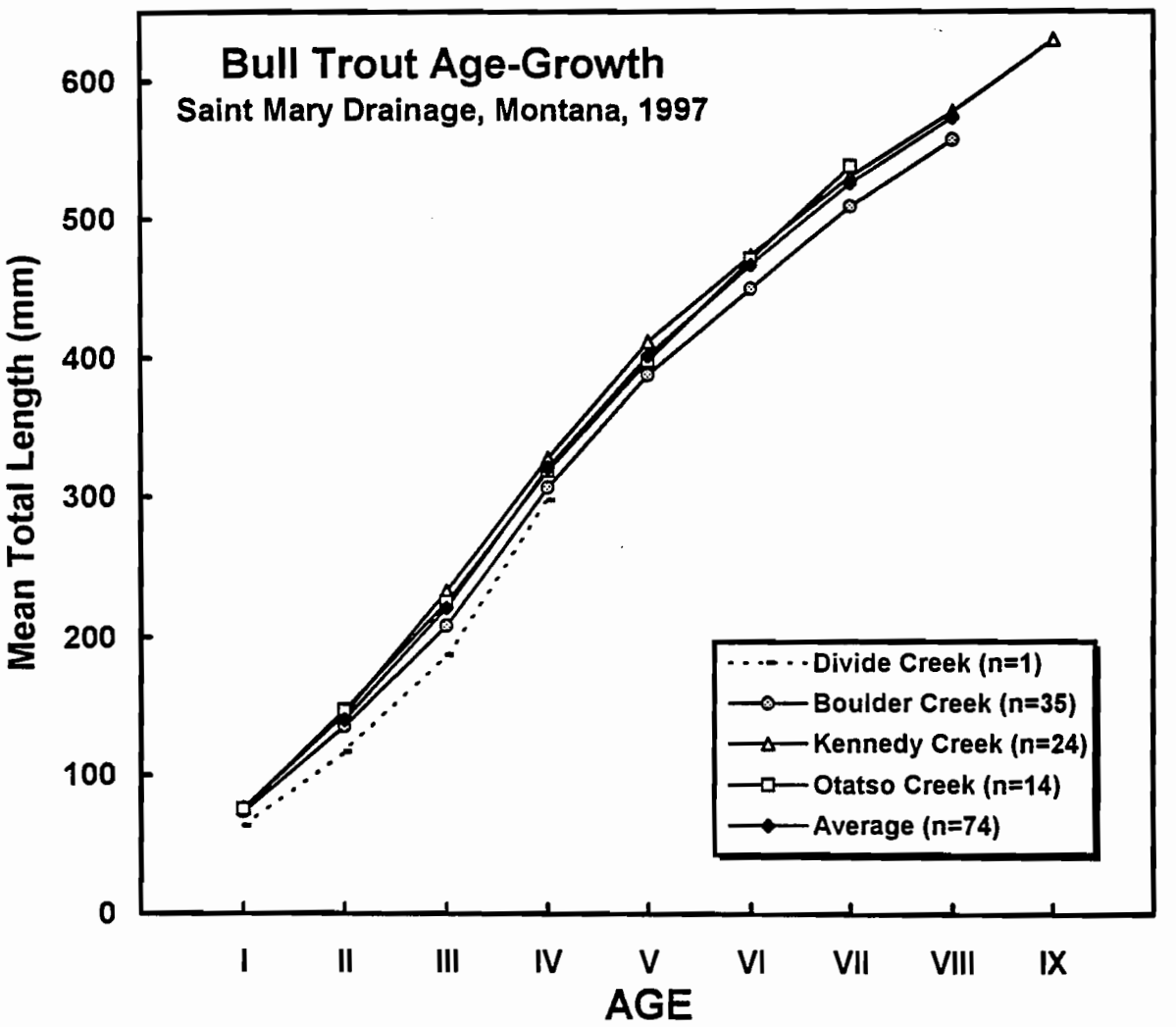

Figure 9. Comparison of bull trout growth rates; Divide, Boulder, Kennedy and Otatso creeks, Saint Mary River drainage, Montana, 1997.

Redd Surveys

Preliminary basin-wide redd surveys were conducted in each of the four tributaries in 1997 to locate spawning areas and potentially establish a baseline for future monitoring of the Saint Mary drainage bull trout populations. No redds were identified in Divide Creek, where only two adults (one male and one female) were captured in the trap. This drainage contained complex habitat, but substrates were dominated by cobble and boulders, and offered few spawning opportunities. An upstream barrier (entirely subsurface flow for approximately 200 m) existed about 3 km within Glacier National Park, 12 km above the confluence with the Saint Mary River. Habitat directly below this barrier, in an area of upwelling dominated by gravel, appeared suitable for spawning but no redds were found. In 1998, no bull trout were captured during summer electrofishing surveys in Divide Creek or at the Divide Creek fish trap. Therefore, redd surveys were not conducted in Divide Creek in 1998.

Ostensibly migratory bull trout utilize lower Otatso Creek for spawning as evidenced by the capture of large adults at the trap in both years. However, no redds were identified during redd surveys in 1997 or 1998. Two migratory barriers in the Otatso Creek drainage prohibit upstream passage of migratory fish (Figure 10). The lowermost barrier is a waterfall (3-m high), approximately 12 km above the confluence with Kennedy Creek and near the boundary of Glacier National Park. The second barrier is a large landslide across Otatso Creek near its head, approximately 3 km above the waterfall. This landslide acts as a seasonal barrier, only permitting passage during high-flow periods. During most of the year, Otatso Creek flows entirely subsurface for nearly 100 m through the slide before resurfacing as springs. Resident bull trout inhabit Slide Lake, formed upstream from the slide, and the stretch of Otatso Creek from the slide downstream to the waterfall. In 1997, two redds were identified in this stream stretch and proved to be the only redds encountered in the drainage downstream from the lake. Downstream from the waterfall, Otatso Creek enters a canyon that has exposed, highly erodible, bear-paw shale walls that add greatly to the sediment load of the stream. Habitat in this lower stretch is less diverse with armored substrates and limited spawning habitat. No redds were identified in lower Otatso Creek in either year.

Spawning areas were identified in Kennedy and Boulder creeks within the boundaries of Glacier National Park (Figure 10) in 1997. About 5 km upstream from the park boundary, directly downstream from Poia Lake, Kennedy Creek enters a high-gradient, boulder-strewn canyon. At the mouth of the canyon, approximately 0.7 km below the lake, the valley widens and gradient declines. In this stretch Kennedy Creek disappears into the gravel-cobble alluvium during low-flow periods in late summer. About 200 m downstream, Kennedy Creek reemerges via groundwater upwelling and flows through a 1.5-km, low-gradient stretch, characterized by braided channels and appreciable beaver activity. In this reach, 23 and 37 bull trout redds ("definite" and "probable") were identified on 15 October 1997 and 13 October 1998, respectively. The number of redds at each location ranged from 1 to 4. "Test-pits" were also identified at many locations. Redds were typically associated with some form of cover (undercut bank, root-wad, or debris jam) and were constructed in substrates ranging from small cobble (<150 mm diameter) to fine gravel (>10 mm diameter) generally along the stream margins. A few redds were also identified directly below beaver dams, in an area of obvious upwelling. Although no bull trout were identified in the area, several cutthroat trout (<400 mm) and mountain whitefish were observed in downstream pools. Suitable spawning habitat appeared to exist downstream from the spawning area in Kennedy Creek but no redds were identified.

Approximately 5 km upstream from the Park boundary, Boulder Creek flows subsurface through gravel-cobble alluvium for about 500 m during low-flow periods in late summer. Bull trout redds were identified in the first 2 km below this seasonal barrier. Habitat characteristics in this stretch are similar to those of the spawning area of Kennedy Creek; wide valley, low gradient, groundwater influence, braided channel, gravel substrate, and beaver activity. Fish were observed in the abundant deep pools and debris jams of the area including small (<400 mm) bull trout, cutthroat trout, brook trout and mountain whitefish. Suitable spawning habitat appeared to exist downstream from the spawning area in Boulder Creek, although no redds were identified. Only 12 redds were identified in Boulder Creek in 1997 compared to 42 in 1998. Surveys were conducted nearly a month later in 1997 (11 Nov) than 1998 (14 Oct) and redds may have been more difficult to distinguish later in the year.

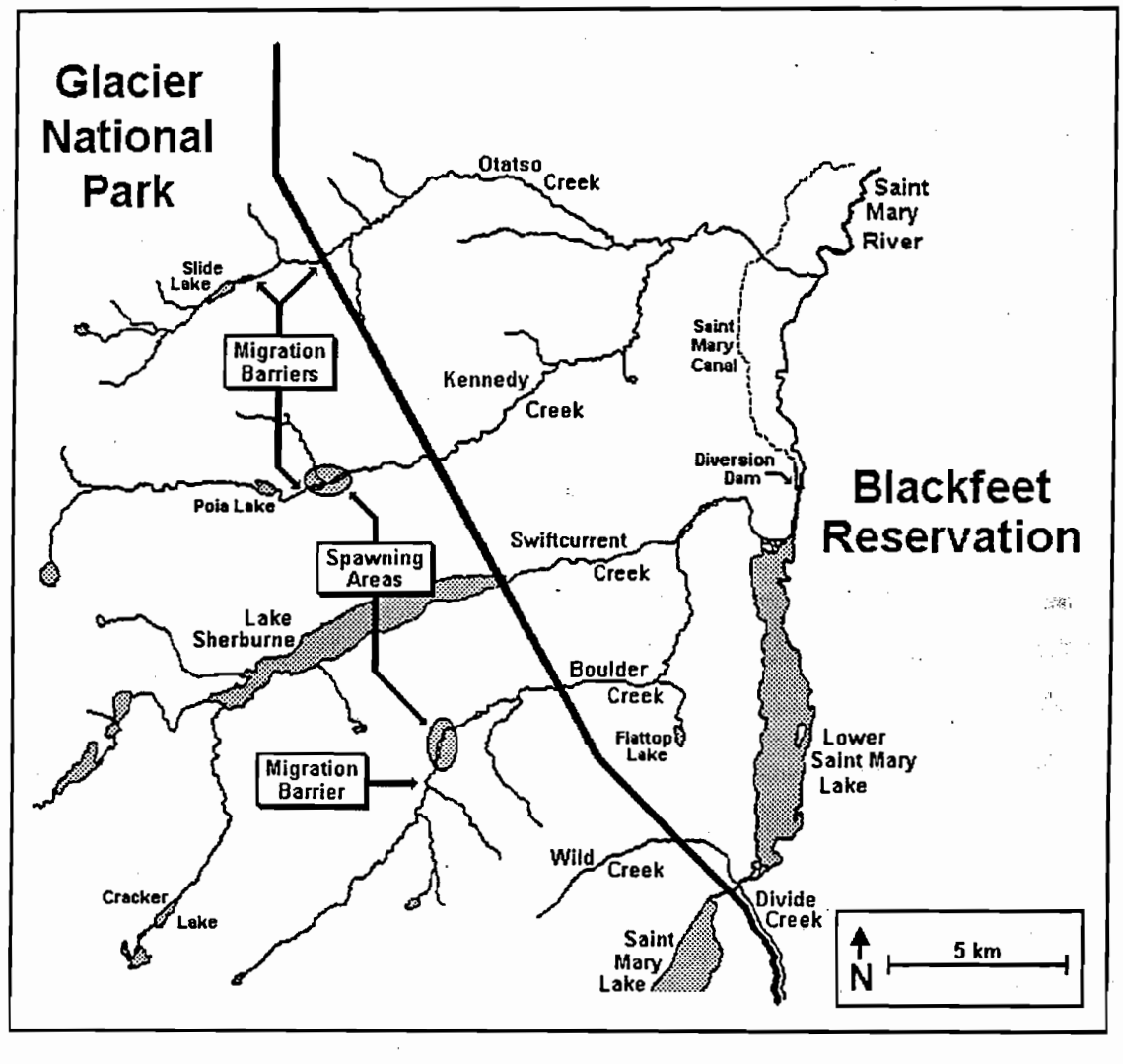

Figure 10. Approximate locations of spawning areas and migration barriers identified during redd surveys in Boulder, Kennedy and Otatso creeks, Oct.-Nov., 1997-98.

DISCUSSION

Overview

Investigations in 1997 and 1998, which included electrofishing surveys, fish trapping, and redd surveys, accomplished the primary objective of this study, i.e., to characterize the remnant bull trout populations that remain in the Saint Mary drainage downstream of Saint Mary Lake in Montana. Baseline inventory information was obtained that can be used to assess population trends and restoration progress.

Summer electrofishing surveys provided definitive information on fish-community composition and bull trout distribution, status, and seasonal movements within the drainage. Electrofishing captured juvenile and adult bull trout in the Boulder, Kennedy, Otatso, and Lee creek drainages, while potentially pure westslope cutthroat trout were captured in Wild Creek. Fish traps operated in tributary streams monitored downstream movements of post-spawn migratory bull trout and provided definitive information on these migratory populations and the relations between movements and stream conditions. Flows remained consistently low and manageable throughout the trapping periods and resulted in high trapping efficiency of adult bull trout. Bull trout were captured at all trap locations. Combined totals of 67 and 121 adult bull trout (>30 cm total length) were captured at the traps in 1997 and 1998, respectively. In addition, juvenile bull trout, cutthroat x rainbow hybrids, brook trout, and mountain whitefish were caught in the traps. Twenty-four (36%) of the 67 adult bull trout captured and marked at the fish traps in 1997 were recaptured in 1998. Eight were recaptured while electrofishing, 19 were recaptured at the fish traps, and three were recaptured by both electrofishing and traps. Altogether, 212 (103 electrofishing and 109 trapping) large bull trout were PIT tagged in 1998. Many large bull trout were captured for the first time in 1998. Spawning areas were identified in Boulder and Kennedy creeks, and the number of redds identified at the spawning areas increased overall in 1998. Thirteen adult bull trout captured at the traps in 1998 were surgically implanted with 400-d radio transmitters. Tracking of these fish, which will begin in January 1998, will provide definitive information on bull trout home ranges and relations between feeding/wintering and spawning habitats.

Spawning Migrations

Timing of upstream migration in the Saint Mary drainage is not precisely known. Adult bull trout migrants were captured near known spawning areas during summer electrofishing surveys in Kennedy Creek (15 and 19 July, 12 August), Boulder Creek (28 July), and Lee Creek (18 August). Because no "blocked" bull trout were observed below the traps during the study, it is assumed that all upstream migration of bull trout occurred prior to installation of the traps in late August. 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 in 1996. However, ripe upstream migrants were reportedly captured as late as 23 September, 1995 (Clayton, 1998, Fox et al. 1996). Adult bull trout in the Flathead drainage generally entered spawning tributaries from July to September, with the majority of upstream migration occurring in August (Fraley and Shepard 1989). These fish remained in the tributaries for a month or more, occupying deeper pools or cover, 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 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). Spent adults generally move out of the spawning tributaries soon after spawning (Fraley and Shepard 1989, Willamette National Forest 1989). The first outmigrating adult bull trout in this study were captured soon after the traps were installed (late August – early Sept.). However, 76% (51) and 88% (107) of the post-spawn outmigrants in 1997 and 1998, respectively, were captured after mean daily stream temperatures had dropped to or below 9.0°C at all trap locations (13 Sept in 1997 and 19 Sept in 1998; Figures 3-6). Spawning appeared to have ended by early October; the last outmigrating adults were captured 2 October in 1997 and 13 October in 1998. However, many of the adult bull trout that were captured and marked upstream from the traps during summer electrofishing surveys in 1998 were not recaptured at the traps during outmigration, suggesting that the spawning period may have extended into late October in 1998. During a 1995-1997 study in the North Fork Belly River, Alberta, the first outmigrants were captured in early September, downstream migration peaked around 20 September and ended by early October (Clayton 1998).

Stream temperatures near 9.0°C appear to be the threshold for initiation of spawning. Fraley and Shepard (1989) reported that bull trout began spawning when stream temperatures dropped below 9-10°C in the Flathead drainage, as did McPhail and Murray (1979) for Mackenzie Creek, British Columbia. Because actual spawning was not observed during this study, the precise time of spawning and corresponding temperatures are not available for the Saint Mary populations. However, the close association between mean-daily stream temperatures near 9°C and outmigration in all four streams suggests a temperature-spawning relationship similar to those reported for other bull trout populations.

Juvenile Emigration

In most river systems, juveniles have been reported to emigrate from natal streams at two to three years of age (Thomas 1992). Although our traps were selective for larger fish, of the 28 juvenile bull trout captured in 1997 for which ages were estimated, 54% (15) were age II and 46% (13) were age III. Similarly, of 246 outmigrating juveniles captured in the Flathead drainage, 49% were age II and 32% were age III; however, ages I (18%) and IV (1%) were also captured (Fraley and Shepard 1989). Similar ages were also reported for emigrating juveniles in Idaho and British Columbia (Bjornn 1961, McPhail and Murray 1979, Oliver 1979). Juvenile residence as long as 6 years, however, has been reported in some areas (Goetz 1989). Ages have not yet been determined for bull trout captured during 1998 summer electrofishing surveys, but total lengths of juvenile fish (<300 mm) ranged from 82-190 mm in Boulder Creek (n=31), 117-186 mm in Kennedy Creek (n=10), 52-137 mm in Lee Creek (n=11), and 89-148 mm in Jule Creek (n=11). These lengths correspond to ages I and II (Table 7 and 8). Juveniles from Otatso Creek are not included because they are resident fish and may exhibit different growth rates.

Juveniles apparently emigrate quickly, using mainly stream margins (Fraley and Shepard 1989, Willamette National Forest 1989) from 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 juveniles and were not installed until late August, the period of juvenile emigration could not be accurately determined. However, in 1997 most (60 %) of the emigrating juveniles in Boulder Creek were captured after 25

September (1 juvenile was captured in each of the Kennedy and Otatso creek traps in 1997). In 1998, most (65%, 66 %, and 71%) of the emigrating juveniles in Boulder, Kennedy, and Otatso creeks, respectively, were captured after 26 September.

If the behavior of emigrating juveniles in Boulder Creek is similar to that of other populations, operation of the Saint Mary water-transfer system could pose a threat to recruitment in this population. From May through September, water releases from Sherburne Dam maintain Swiftcurrent Creek discharge at bankful downstream to Lower Saint Mary Lake. Near the lake, most Swiftcurrent Creek flows are diverted into the Saint Mary Canal by a major diversion dam on the Saint Mary River. Emigration of juvenile bull trout apparently occurs during this high-flow period. Due to abnormally high flows and attendant turbidity levels, and the close proximity between the Swiftcurrent Creek confluence and the diversion, juvenile bull trout may be directed into the canal or over the diversion dam rather than into the lake. This might be especially true for those bull trout using the margins of the stream as a corridor for migration. In any case, these juveniles are potentially removed from the upstream population, as might outmigrating adult bull trout as well. Although fish screens have been proposed as a possible solution to fish losses to the canal, no solutions have yet been proposed for losses over the diversion dam.

Age and Growth

Although bull trout growth rates appear fairly consistent across their range, migratory bull trout in the Saint Mary drainage apparently grow more slowly than most reported populations. In the study area, migrants (age IV+) averaged 495 mm (range, 304-720 mm) and 470 (range, 307-690 mm) in total length in 1997 and 1998, respectively. These averages may be at least partly depressed due to the preponderance of "jacks" in the system. The average fork lengths of adult migrants in the nearby North Fork Belly River, Alberta, were 528 mm (n=42), 551 mm (n=61), and 528 mm (n=66), in 1995, 1996, and 1997, respectively (Clayton 1998). Adult spawners (age V+) in the Flathead system averaged 628 mm in total length (Fraley and Shepard 1989). The largest bull trout recorded during this study, captured in the Kennedy Creek fish trap in 1997, measured 720 mm and weighed 2506 g. This fish was captured again during electrofishing surveys in Kennedy Creek in 1998 and measured 725 mm and weighed 2406 g. The largest bull trout

reported in the Belly River had a fork length of 784 mm (approximately 823 mm total length) and weighed 4005 g (Clayton 1998). The largest documented bull trout was an adfluvial fish from Idaho's Lake Pend Oreille measuring 1025 mm and weighing 14.5 kg (Willamette National Forest).

Based on analysis of 74 scale samples collected in 1997, the average growth rates exhibited by bull trout from the Saint Mary populations appear to be very consistent within the drainage (Figure 9). In the first years of life, the growth rate for Saint Mary bull trout as a whole, is similar to those reported by Fraley and Shepard (1989) for Flathead drainage bull trout (Figure 11). Growth for all populations, including the Saint Mary fish, was generally most rapid between ages III and IV. By age III most bull trout have emigrated from less productive natal streams and have switched to a piscivorous diet. However, unlike the Flathead populations that exhibit relatively constant growth after age IV, growth of the Saint Mary populations slowly declined. The back-calculated annual growth increment for Saint Mary bull trout ranged from 42 to 111 mm. Actual growth increments of 20 fish marked in 1997 and recaptured in 1998, however, only averaged 29.5 mm (range 2 to 66 mm). Similarly, annual growth increments of 22 bull trout recaptured during the 3-year Belly River study ranged from 4 to 55 mm. Annual increments ranged from 60 to 132 mm for Flathead Lake bull trout (Fraley and Shepard 1989) and were similar to those reported for Priest and Upper Priest Lakes, Idaho (Bjornn 1961).

Bull trout generally mature between the ages of V and VII and may spawn annually or in alternate years (Fraley and Shepard 1989, Goetz 1989, McPhail and Murray 1979). In the Flathead system, most bull trout matured at age VI, and ages VI and VII dominated spawning runs (Fraley and Shepard 1989), whereas ages V and VI were most common in the Swan River drainage (Leathe and Enk 1985). In the Saint Mary drainage, ages of migrants varied from IV-IX in 1997 and age V fish were most commonly encountered. Age IV appeared to be represented by precocial males, or "jacks" (354-419 mm), which accounted for 16% (5), 19% (3) and 50% (1) of the migrants in Kennedy, Otatso and Divide creeks, respectively. No age IV fish were captured in Boulder Creek in 1997. In 1998, age IV fish accounted for 19% (12), 39% (15), and 21% (4) of the migrants in Boulder, Kennedy and Otatso creeks, respectively. In the North Fork Belly River, 9% of the spawning run consisted of bull trout from this same age class (Fox et al. 1996).

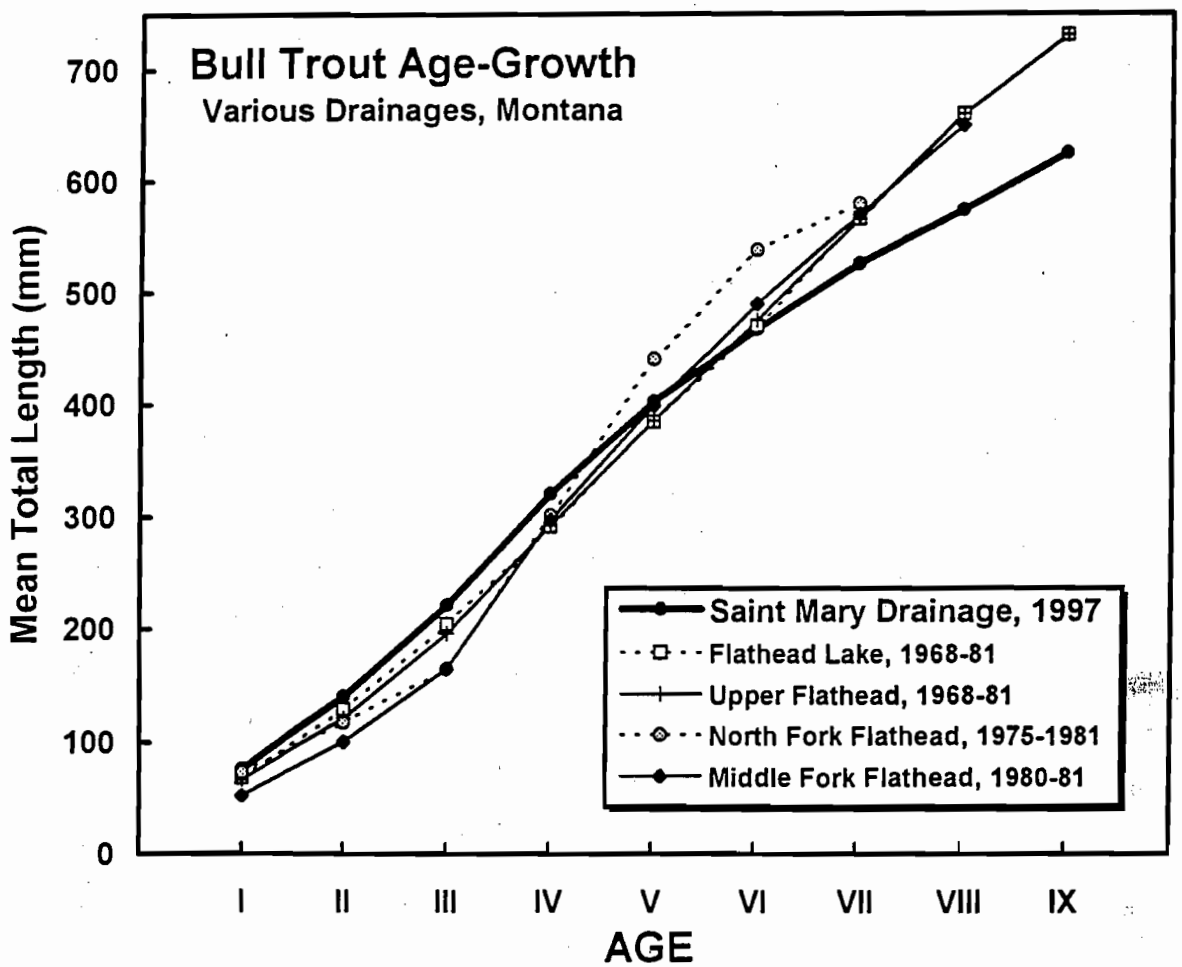

Figure 11. Comparison of bull trout growth rates from the Saint Mary drainage, Montana, and various Flathead drainages, Montana (Fraley and Shepard 1989).

Whether or not jack bull trout participated in spawning is unknown. In the Flathead drainage, Shepard and Graham (1983) reported jacks actively spawning with adult females and feeding on eggs, while McPhail and Murray (1979) noted that precocial males in Upper Arrow Lakes, British Columbia, ascended spawning tributaries while still green and subsequently departed without spawning.

The oldest bull trout encountered in this study was a 665-mm, age-IX fish captured in Kennedy Creek in 1997. A larger fish was also captured in Kennedy Creek in 1997 (720 mm) and again in 1998 (725 mm), but its age could not be estimated. Age IX was also the maximum age reported for Flathead bull trout (Fraley and Shepard 1989). Although scales were not used, Clayton (1998) concluded on the basis of length frequencies that some relatively old (> IX) bull trout inhabit the Belly River drainage.

Redd Surveys

Estimation of abundance of redds has been important in monitoring trends in many salmonid populations. If collected consistently over a sufficient period of time, redd surveys can be helpful in determining the status of bull trout populations and provide a basis to estimate current or anticipated spawner trends (Spalding 1997). It appears that Boulder and Kennedy creeks are the primary spawning tributaries for migratory bull trout in the Saint Mary drainage. Redd surveys determined the location of spawning areas in these two streams, which may be used as index areas for future annual surveys. Both streams showed appreciable increases in bull trout redds in 1998 compared to 1997. Boulder Creek increased from 12 in 1997 to 42 in 1998, while Kennedy Creek showed an increase from 23 to 37. Streamflows were less in 1998 and, therefore, redds may have been more concentrated and visible. However, the increase in redds parallels the increase in the number of adult bull trout captured at the traps in both streams. Clayton (1998) noted a similar situation in the Belly River drainage where, over the course of his three-year study, the number of redds was positively related to the number of bull trout collected in downstream traps.

Although migratory bull trout utilize lower Otatso Creek for spawning purposes (based on the capture of spent adults at the trap), redd surveys in both years have failed to locate spawning areas in this stream. Redd surveys have not been conducted in Lee Creek. However, based on electrofishing surveys and fisherman reports, this stream is also used by large migratory bull trout, which assumably inhabit lower Lee Creek in Alberta, Canada.

Several of the redds identified in Kennedy and Boulder creeks were clean and had "pits and tailspills" characteristic of completed redds, but were small in comparison to other redds in the

area. Although these small redds may have only been "test pits" or incomplete redds of migratory bull trout, it is possible that they were excavated by resident fish.

The spawning areas identified in Boulder and Kennedy creeks contain habitat very consistent with Spalding's (1997) description. She describes typical bull trout spawning habitat as low-gradient, higher-order streams (3rd or 4th order) containing substrates of large gravel and finer materials. Spawning typically occurs in the upstream portions of low-gradient reaches, often in braided-channel areas. Instream upwelling, spring-fed channels, and other areas of groundwater recharge are important. Abundant cover in the form of overhanging vegetation, undercut banks, debris jams, and deep pools are also desirable.

Life History

Bull trout exhibit three distinct life-history patterns; resident, adfluvial, and fluvial. Resident fish spend their entire lives in headwater portions of streams or in geographically isolated areas caused by natural or man-made barriers and are typically much smaller than migratory (fluvial and adfluvial) fish. Growth is similar between forms during their first years of life in headwater streams, but diverges as migratory fish move downstream into larger more productive bodies of water (Rieman and McIntyre 1993). Small bull trout were captured at the traps but age and growth analysis indicated that they were all juveniles (ages II-III) that had back-calculated lengths consistent with the adult migrants. Other studies have found that most juveniles of migratory populations remain in natal tributaries for one to three years before emigrating (Bjornn 1961, Fraley and Shepard 1989, McPhail and Murray 1979, Oliver 1979).

Migratory bull trout populations live in lakes (adfluvial) or larger streams and rivers (fluvial) and undergo spawning migrations into smaller tributaries where spawning and initial juvenile rearing occurs. Historically, migratory bull trout were found throughout the mainstem Saint Mary drainage (Fitch 1994, Fredenberg 1996). Adfluvial populations residing in Saint Mary and Lower Saint Mary lakes probably utilized Divide Creek, Red Eagle Creek and other smaller tributaries within Glacier National Park for spawning and juvenile rearing, whereas fluvial bull trout inhabiting the river likely ascended major tributaries below the lakes, including Swiftcurrent, Boulder, Kennedy, Otatso, and Lee creeks. The numerous abandoned channels and large fluvial fan (delta)

formed at the confluence of the Swiftcurrent drainage indicates that, at times, Swiftcurrent Creek also entered Lower Saint Mary Lake, allowing adfluvial bull trout spawning access to the Swiftcurrent/Boulder drainage as well.

Between 1914 and 1921, the U.S. Bureau of Reclamation constructed several water control structures in the Saint Mary River drainage of the Blackfeet Reservation for the purpose of water transfer to the Milk River Project for irrigation (Wagner and Fitzgerald 1995). A permanent concrete and steel diversion dam, which employs removable boards to raise the water level behind it, was built on the Saint Mary River just downstream from Lower Saint Mary Lake. Water is diverted into an extensive canal system and eventually conveyed 47 km, over the Hudson Bay Divide to the North Fork of the Milk River of the Mississippi River drainage. Swiftcurrent Creek, which at the time flowed into the Saint Mary River, was diked and rerouted to flow into Lower Saint Mary Lake at the lake's outlet, upstream from the diversion dam. A 33-m-high dam, constructed in upper Swiftcurrent Creek above the Boulder Creek confluence, formed Lake Sherburne. In Alberta in 1946, Saint Mary Reservoir was constructed on the Saint Mary River a few km below the confluence with Lee Creek (Fredenberg 1996a).

The effects of these structures on the migratory bull trout populations in the Saint Mary drainage are not well known. The diversion dam, operated from May through September, is a barrier to upstream migration, at least seasonally. It separated the lakes from the remainder of the system, eliminating influence of the fluvial population on the upstream adfluvial populations. The reverse is possible, however, because bull trout passing over the dam from upstream are removed from the upstream adfluvial population. The canal headgates do not incorporate any means of excluding fish. Several fish species are known to enter and reside in the canal during irrigation season and possibly throughout winter, although no bull trout or cutthroat trout have been captured in the canal (Wagner and Fitzgerald 1995). Swiftcurrent and Boulder creeks became inaccessible to bull trout from the river, eliminating spawning runs of fluvial fish in these streams. Sherburne Dam separated upper Swiftcurrent Creek from the system. The construction of Saint Mary Reservoir in Alberta apparently eliminated fluvial bull trout from the river below the reservoir, as well as possible spawning runs in Lee Creek above the reservoir (Fredenberg 1996a).

An adfluvial bull trout population evidently exists in Lower Saint Mary Lake. In 1994, 19 adult bull trout (mean weight 2.1 kg; lengths not measured) were captured in Lower Saint Mary Lake by a commercial lake whitefish gillnetting operation (Blackfeet Tribe, unpublished data, 1994). This population may use Boulder Creek and possibly Divide and Wild creeks for spawning and juvenile rearing. The two migrants captured in the Divide Creek fish trap may have also been adfluvial fish from Saint Mary Lake (upper) or fluvial fish inhabiting the short stretch of the Saint Mary River between the lakes. A 380-mm male bull trout was collected from this stretch of the river during an electrofishing survey in October 1993, and a 69-mm bull trout (young-of-the-year) was captured in Wild Creek about 30 m from its confluence with this stretch of the river (R. Wagner, USFWS, personal communication).

A migratory fluvial population of bull trout inhabits the Saint Mary River below Lower Saint Mary Lake, downstream from the diversion dam. The extent of this remnant population is unknown. No bull trout have been captured from the river in Montana during recent electrofishing surveys (Wagner and Fitzgerald 1995); however, Fredenberg (1996) noted that anglers occasionally report catching bull trout from the river north of the international boundary. Based on redd counts and the number of adults captured at the trap, Kennedy Creek appears to be the primary spawning tributary for this fluvial population. Lower Otatso Creek is also used by migrants (based on the capture of spent adults at the trap); however, redd surveys have failed to locate spawning areas in this stream. Spawning habitat in lower Otatso Creek is limited and due to natural barriers, upper Otatso Creek is not accessible to migrants.

Little is known about the migratory population of bull trout that utilizes upper Lee Creek in Glacier National Park for spawning purposes. It was believed that the spawning run in this stream was eliminated due to irrigation diversions and degraded habitat in lower Lee Creek and the construction of Saint Mary Reservoir just downstream of the Lee Creek confluence in 1946 (Fredenberg 1996a). However, during summer electrofishing surveys in 1998, many large (394 to 592 mm) migratory bull trout were captured in Lee Creek upstream from the international boundary. These fish may be fluvial bull trout that seasonally inhabit the lower stretches of the Saint Mary River or Lee Creek, or they may be adfluvial and reside in Saint Mary Reservoir for much of the year. Although no historic records exist of bull trout being captured from Saint Mary

Reservoir, in October 1994, two bull trout, including a 480 mm female in spawning condition, were caught in a commercial gill net (Fredenberg 1996a).

In addition to migratory populations, resident bull trout are also known to exist in the Saint Mary drainage. Swiftcurrent Creek, a major drainage not included in this study, is isolated from the mainstem Saint Mary drainage and supports bull trout populations. Upper Swiftcurrent Creek was separated from the rest of the drainage early in this century when Sherburne Dam was constructed. Bull trout historically existed in the drainage above the dam but little is known of their status today. Cracker Lake, a small isolated lake high in the Swiftcurrent drainage above the dam, supports an abundant resident population of stunted bull trout introduced around the turn of the century (Fredenberg 1996a, Michels 1996).

Otatso Creek has natural barriers to the upstream movement of fish that isolate its upper reaches from downstream migratory populations. Ostensibly robust resident bull trout populations inhabit the drainage upstream from the barriers. A landslide across Otatso Creek near its head formed Slide Lake, approximately 15 km above its confluence with Kennedy Creek. For much of the year, the stream flows subsurface for nearly 100 m through the slide before resurfacing in the form of springs. During spring runoff, however, the stream also flows over the slide, allowing fish to pass. A resident bull trout population inhabits Slide Lake and spawns in a short stretch of Otatso Creek above the lake. About 3 km downstream from the landslide another barrier, a 3-m high waterfall, isolates another segment of the stream from lower Otatso Creek. This short stretch between the landslide and the waterfall provides a large diversity of habitats that support resident fish. Whether or not the two isolated sections of the Otatso drainage support two different resident populations (stream and lake dwelling) is unknown. Passage between the two is only possible during high flows. During redd surveys in 1997, at least 50 large bull trout (>400 mm) were counted in two large pools directly below the landslide at the upper end of the stream stretch. One fish, 450 mm, was captured by hand. While electrofishing this stretch in July 1998, a few large (432-472 mm) bull trout were also captured. However, most fish were less than 300 mm. Because of the downstream barrier, it is not possible that these large fish were migratory, yet they were too big to be stream-dwelling resident fish. It is tentatively assumed that they were former residents of Slide Lake that entered this downstream stretch during spring runoff. The fish became "stranded"

in this less-productive water when flows receded. Lengths of the large fish were consistent with the lengths (410-510 mm) of 20 bull trout angled in Slide Lake in June 1996 (Michels 1996) and with the lengths (423-572 mm) of several bull trout captured while electrofishing upstream from the lake in 1998, further suggesting that the bull trout were from the same population.

It is suspected that resident bull trout populations exist elsewhere in the Saint Mary drainage. Lee Creek offers good habitat inside Glacier National Park and is believed to support a substantial resident population in its upper reaches (Fredenberg 1996a). During summer electrofishing surveys, bull trout (52-592 mm) were captured upstream from the Chief Mountain Highway inside the park. Two bull trout (175-235 mm) were captured in Middle Fork Lee Creek directly downstream from Chief Mountain Highway and many small bull trout (89-148 mm) were captured in Jule Creek between the highway and the its confluence with Lee Creek. Whether the small bull trout in this drainage are residents or juvenile migratory bull trout rearing in Lee Creek is unknown. Age and growth analysis (not completed) of scales taken from all captured bull trout will aid in making a determination.

The upper reaches of Boulder and Kennedy creeks were examined during redd surveys and found to contain suitable habitat with numerous pools, abundant cover (woody debris, substrate, undercut banks, etc.) and adequate flows to support resident fish. Beaver activity was also evident. Several redds identified in these two streams were clean and had "pits and tailspills," but were small in relation to other redds. These small redds may have been "test pits" or incomplete redds of migratory bull trout; however, it is possible that they were excavated by resident fish. In Boulder Creek, several bull trout (<300 mm) were identified in pools and cover in the vicinity of the spawning area. It is unknown, however, whether these fish were resident or juvenile migratory fish. Similar dilemmas were noted by Fox et al. (1996). They encountered six suspicious redds in a spawning area in the North Fork Belly River near where they had captured nine presumed-resident bull trout (240-355 mm) by angling. They had also identified five suspicious redds in a tributary to the Waterton River where they had caught nine, small (<400 mm) bull trout by angling.

The multiple life-history strategies (resident, fluvial, and adfluvial) exhibited by bull trout represent an important component of diversity within populations (Reiman and McIntyre 1993).

These strategies are important to the stability and persistence of the species, stabilizing populations in highly variable environments and refounding segments of populations that have become extinct. One strategy may dominate under stable conditions but, under variable conditions, another strategy may be favored. Natural selection results in adaptations to local environments and diversity within the larger population. It also creates local populations that do not respond to environmental changes in synchrony with other populations. Dispersal of members among local populations provides a mechanism for supporting weaker populations or refounding those that have become locally extinct. This concept of a regional population of smaller local populations occurring in a range of environments such that the loss of all populations becomes less likely, has been termed a "metapopulation" and reviewed extensively by Hanski and Gilpin (1991) and Rieman and McIntyre (1993, 1995).

Historically, a metapopulation probably existed across the Saint Mary and Belly drainages. The entire watershed was connected with migratory corridors existing between both drainages. This regional population would have exhibited the full compliment of life history strategies, resident, fluvial and adfluvial. In his summary of current and historical bull trout distribution in southwestern Alberta, Fitch (1994) noted that both migratory and resident bull trout populations originally inhabited these drainages. Thomas et al. (1997) concluded that bull trout collected from the Saint Mary and Belly drainages formed a genetically similar group different from other regions of the South Saskatchewan drainages (Appendix F Figure 12). Genetic similarity of groups is a result of migratory populations homing to natal streams to spawn or other mechanisms that tend to isolate reproductive groups. Today, population fragmentation within these drainages has undoubtedly occurred and connectivity between subpopulations no longer exists due to man-made barriers (dams), reduced habitat, and increased water temperatures. Fragmentation, and subsequent isolation, of existing populations, without a mechanism to reconnect them, is a significant threat to the persistence of the species. Isolated populations face serious genetic risk and are less likely to survive.

A key element in recovery of migratory bull trout may be connectivity. The proposed restoration goal for the Oldman River system includes re-establishment of migratory bull trout populations in each of the three major drainages (Belly, Waterton and Saint Mary) in order to

restore connectivity and protect valuable genetic diversity within the population (Fredenberg 1996a). A migratory (fluvial) population is known to exist in the upper Belly River system. Resident fish are believed to inhabit this drainage as well, especially in the North Fork, primarily in Canada. A remnant fluvial population may also exist in the Waterton River system in Canada along with several isolated resident populations (Fox et al. 1996, Fredenberg 1996a). As a result of this study, we now know that migratory (fluvial and adfluvial) and resident bull trout remain in portions of the Saint Mary drainage in Montana, including the Lee Creek drainage in Montana and Alberta. Although metapopulation is no longer applicable in describing the regional population as a whole, this concept may still be appropriate in depicting the drainages themselves, at least for the Saint Mary and Belly river systems.

Management should favor activities that promote dispersal and demographic support between local bull trout populations including:

- Maintaining local populations in close proximity to each other.
- Protecting existing migratory corridors connecting upstream populations.
- Recognizing locally adapted populations as important sources of genetic diversity.

Genetics

"If the genetic integrity of locally adapted populations is to be preserved, they must be characterized relative to geographical references so that informed management decisions can be made" (Groft et al. 1997). The genetics portion of this study was conducted as part of an ongoing project aimed at assessing the amount of genetic variation in bull trout populations from different watersheds east of the Continental Divide in Alberta and Montana. The data will aid in assessment of the status of east slope bull trout populations and will allow collaborative development of genetic-based management schemes (Thomas et al. 1997).

Genetic data already exists for bull trout inhabiting Slide Lake, Cracker Lake and Red Eagle Creek of the upper Saint Mary drainage within Glacier National Park. Thomas et al. (1997) determined that fish from these populations and the Belly River system may form one group of genetically similar bull trout, while fish from other regions of the South Saskatchewan and Bow

River drainages in southern Alberta form another (Appendix F Figure 12). One of our objectives was to obtain bull trout genetic data from the remainder of the Saint Mary system for further comparison with other populations and establish baseline genetic data for the Saint Mary bull trout populations. Baseline data are important for detection of future changes in population gene pools. We also want to determine the extent of genetic variation among Saint Mary bull trout. Lastly, we wanted to determine the extent of hybridization with non-native brook trout. Hybridization between brook trout and bull trout has occurred in other regions (Kitano et al 1994, Leary et al. 1993). Results of bull trout genetic analysis have not yet been completed.

1999 STUDY PLANS

1. **Radiotelemetry:** Continue tracking radio-implanted bull trout. Thirteen mature bull trout captured at the traps in 1998 were surgically implanted with 400-day radio transmitters. Continual tracking of these 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.

2. **Fisheries Surveys:** Continue systematic electrofishing surveys during the summer months (June-August) in representative reaches of the Saint 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, and westslope cutthroat trout status in the Saint Mary River drainage. 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, Divide and Lee (first time) 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 and stream discharge should be periodically measured. Trapping provides definitive information on bull trout populations that use tributary streams including critical information on the movements of bull trout between the Saint 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.

4. **Evaluation of Milk River Irrigation Project:** Conduct systematic electrofishing surveys in representative reaches of Swiftcurrent Creek downstream from Sherburne Dam, the Saint Mary Canal, the Saint Mary River directly above and below the diversion, and Spider Lake (Spider Lake surveys to include gill-netting) to assess the impacts of the irrigation project on fisheries. Impacts potentially include isolation due to dewatering, entrapment in the canal, and barriers to migration. Surveys will begin in late September after the irrigation season has ended and flows have been substantially reduced.

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APPENDIX A

1998 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)

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

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 Blackfeet Fish and Wildlife Department personnel in various procedures

APPENDIX B

Table 9. Fish captured (raw data) during electrofishing surveys in Boulder Creek, Saint Mary River drainage, Montana, 1998.

Boulder Creek - 7/28/98 – Electrofishing												
Bull Trout						CTT x RBT				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		---							
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

Table 10. Fish captured (raw data) during electrofishing surveys in Kennedy Creek, Saint Mary River drainage, Montana, 1998.

Kennedy Creek - 7/15, 7/29, & 8/12 –1998 – Electrofishing													
Bull Trout						CTT x RBT				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 (VI)	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 (VI)	2-1	324	400	1.18	1-9				
	430	648	0.82	CU2 (VI)	2-2	341	434	1.09	1-0				
	182	54	0.90	CU5 (VI)	2-5	284	280	1.22	---				
	184	56	0.90	CU6 (VI)	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								
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 11. Fish captured (raw data) during electrofishing surveys in Otatso Creek downstream from Slide Lakes, Saint Mary River drainage, Montana, 1998.

Otatso Creek (downstream from Slide Lakes) - 7/22/98 – Electrofishing							
Bull Trout					CTT x RBT		
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			
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 Otatso Creek upstream from Slide Lakes, Saint Mary River drainage, Montana, 1998.

Otatso Creek (upstream from Slide Lakes) - 7/21/98 - Electrofishing							
	Bull Trout				CTT x RBT		
	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
	540	938	0.60	3-2	245	140	0.95
	161	36	0.86	3-3			
	157	32	0.83	3-4			
	140	26	0.95	3-5			
	145	30	0.98	3-6			
	146	26	0.84	3-7			
	125	18	0.92	3-8			
	126	22	1.10	3-9			
	135	20	0.81	3-0			
	96	8	0.90	4-1			
	110	12	0.90	4-2			
	101	8	0.78	4-3			
	120	16	0.93	4-4			
	100	6	0.60	4-5			
	101	10	0.97	4-6			
	90	8	1.10	4-7			
	97	8	0.88	4-8			
	84	4	0.67	4-9			
	90	4	0.55	4-0			
	68	2	0.64	---			
	82	4	0.73	---			
	72	4	1.07	---			
	70	2	0.58	---			
	62	2	0.84	---			
	75	4	0.95	---			
	76	4	0.91	---			
	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	---			
MEAN	167.6	118.5	0.85		293.0	236.0	0.89
MIN	62	2	0.55		245	140	0.84
MAX	572	1092	1.10		341	332	0.95

Table 13. Fish captured (raw data) during electrofishing surveys in Wild Creek, Saint Mary River drainage, Montana, 1998.

Wild Creek – Cutthroat Trout 7/27/98 – Electrofishing				
	Length (mm)	Weight (g)	Condition (K)	Scale Card Number
	147	34	1.07	15-1
	104	10	0.89	15-2
	157	40	1.03	15-3
	147	36	1.13	15-4
	138	32	1.22	15-5
	186	74	1.15	15-6
	125	22	1.13	15-7
	148	34	1.05	15-9
	113	14	0.97	15-0
	144	34	1.14	15-8
	140	28	1.02	16-1
	127	20	0.98	16-2
	125	20	1.02	16-3
	55	1	0.60	16-4
	134	24	1.00	16-5
	143	32	1.09	16-6
	130	22	1.00	16-7
	143	32	1.09	16-8
	197	90	1.18	16-9
	133	22	0.94	16-0
	130	22	1.00	17-1
	147	34	1.07	17-2
	124	18	0.94	17-3
	66	2	0.70	17-4
	148	32	0.99	17-5
	124	18	0.94	17-6
	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	---
Mean	124.2	23.7	0.98	
Min	55	1	0.47	
Max	197	90	1.22	

Table 14. Fish captured (raw data) during electrofishing surveys in Lee Creek, Saint Mary River drainage, Montana, 1997.

Lee Creek - 8/18/98 - Electrofishing									
	Bull Trout					CTT x RBT			
	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				
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 15. Fish captured (raw data) during electrofishing surveys in Jule Creek, Saint Mary River drainage, Montana, 1997.

Jule Creek - 8/11/98 - Electrofishing								
	Bull Trout				CTT x RBT			
	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)	Scale Card Number
	148	26	0.80	27-1	140	26	0.95	24-1
	125	14	0.72	27-2	177	54	0.97	24-2
	104	8	0.71	27-3	195	70	0.94	24-3
	120	12	0.69	27-4	162	42	0.99	24-4
	100	8	0.80	27-5	156	34	0.90	24-5
	101	6	0.58	27-6	138	24	0.91	24-6
	99	8	0.82	27-7	152	34	0.97	24-7
	92	6	0.77	27-8	130	22	1.00	24-8
	89	6	0.85	27-9	135	24	0.98	24-9
	91	6	0.80	27-0	130	18	0.82	24-0
	95	6	0.70	—	118	14	0.85	25-1
					122	16	0.88	25-2
					125	16	0.82	25-3
					118	16	0.97	25-4
					100	8	0.80	25-5
					126	18	0.90	25-6
					130	20	0.91	25-7
					118	14	0.85	25-8
					117	14	0.87	—
					125	20	1.02	25-9
					110	10	0.75	25-0
					100	8	0.80	26-1
					84	2	0.34	26-2
					112	6	0.43	26-3
					80	4	0.78	26-4
					109	12	0.93	26-5
					74	4	0.99	26-6
					101	8	0.78	26-7
					110	12	0.90	26-8
					110	14	1.05	26-9
					115	14	0.92	26-0
					86	6	0.94	—
					132	14	0.61	—
					120	14	0.81	—
					118	20	1.22	—
					120	26	1.50	—
					85	6	0.98	—
Mean	105.8	9.6	0.75		121.1	18.5	0.89	
Min	89	6	0.58		74	2	0.34	
Max	148	26	0.85		195	70	1.50	

Table 16. Fish captured (raw data) during electrofishing surveys in Middle Fork Lee Creek, Saint Mary River drainage, Montana, 1997.

Middle Fork Lee Creek - 8/11/98 – Electrofishing								
	Bull Trout				CTT X RBT			
	Length (mm)	Weight (g)	Condition (K)	Scale Card Number	Length (mm)	Weight (g)	Condition (K)	Scale Card Number
	235	100	0.77	28-1	234	108	0.84	28-3
	175	46	0.86	28-2	205	80	0.93	28-4
					150	38	1.13	28-5
					160	40	0.98	28-6
					180	60	1.03	28-7
					115	14	0.92	28-8
					185	58	0.92	28-9
					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
Mean	205.0	73.0	0.81		165.0	46.3	0.96	
Min	175	46	0.77		115	14	0.78	
Max	235	100	0.86		234	108	1.13	

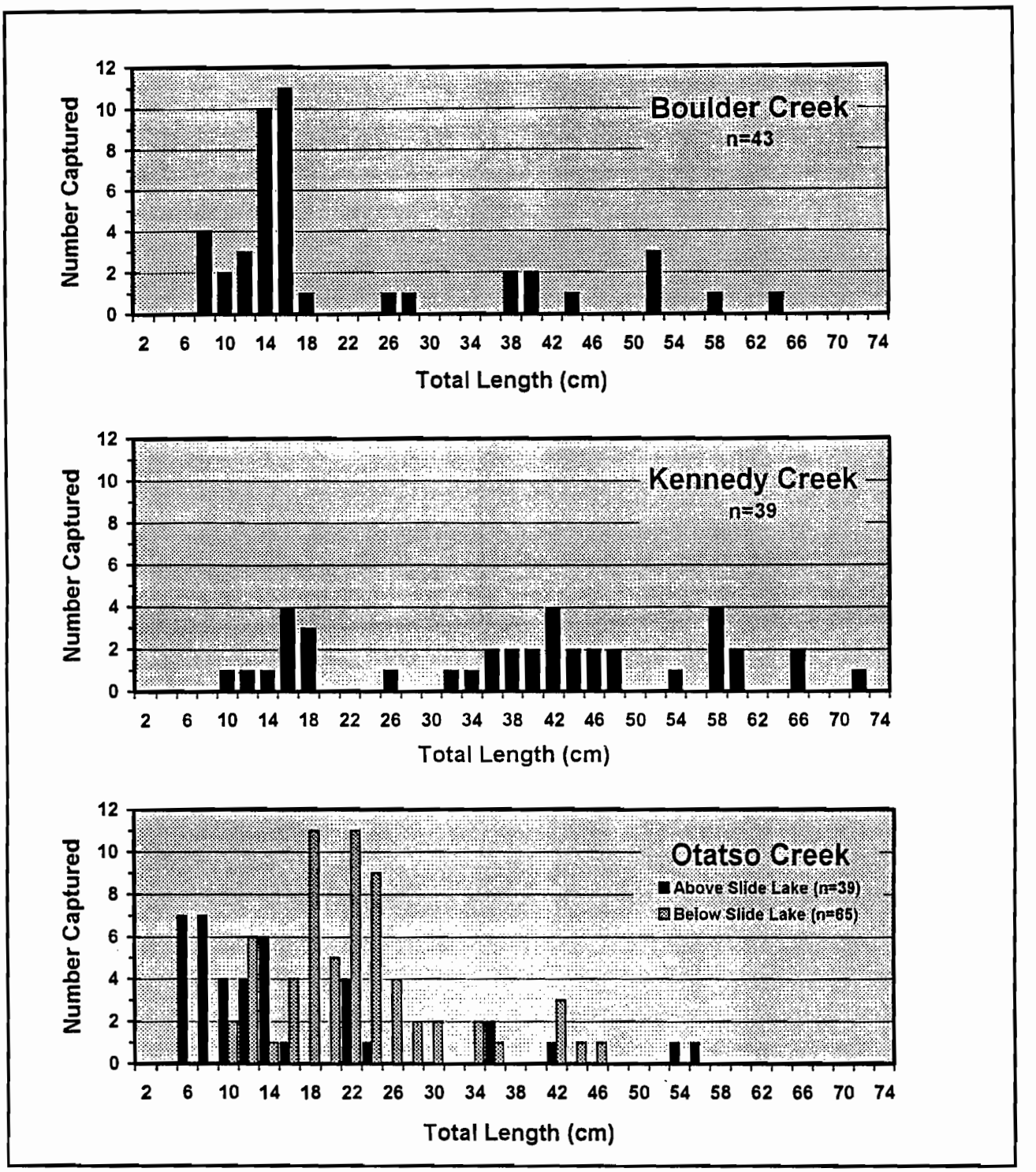


Figure 12. Length-frequency distributions for bull trout captured during electrofishing surveys in Boulder, Kennedy, and Otatso (above and below Slide Lakes) creeks, Saint Mary River drainage, Montana, 1998.

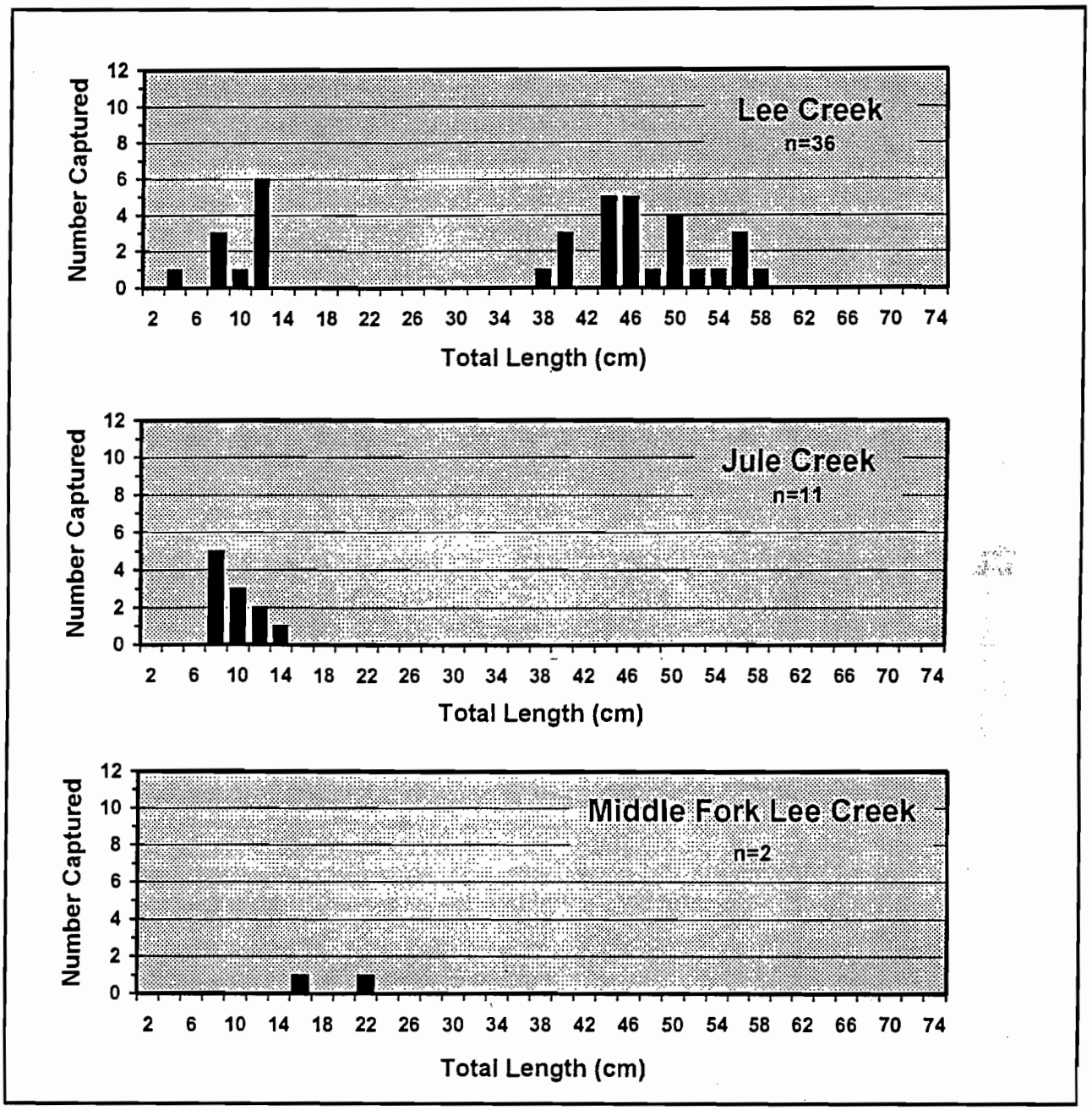


Figure 13. Length-frequency distributions for bull trout captured during electrofishing surveys in Lee Creek, Jule Creek, and the Middle Fork of Lee Creek, Saint Mary River drainage, Montana, 1998.

APPENDIX C

Table 17. Mean Daily Stream Temperatures (°C) for Divide, Boulder, Swiftcurrent, Kennedy, and Otatso Creeks, Saint Mary River Drainage, Montana Aug.- Oct. 1997-98.

Date	Divide Creek		Boulder Creek		Swiftcurrent Creek		Kennedy Creek		Otatso Creek	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
28-Aug	9.7	—	10.5	—	15.7	—	11.7	—	11.7	—
29-Aug	9.9	—	10.6	—	15.5	—	11.8	—	11.5	—
30-Aug	9.6	—	10.3	—	15.5	—	11.6	—	11.1	—
31-Aug	9.5	13.4	10.3	12.8	15.5	16.6	11.8	14.5	11.6	14.5
1-Sep	10.4	13.4	11.2	12.9	15.5	16.7	12.7	14.5	12.2	14.5
2-Sep	10.8	13.5	11.7	13.0	15.4	16.7	13.1	14.6	12.7	14.6
3-Sep	11.3	13.3	11.9	13.0	15.7	16.7	13.7	14.4	13.8	14.3
4-Sep	10.7	12.5	11.2	12.3	15.3	16.6	12.8	13.9	12.8	13.6
5-Sep	9.4	12.3	10.1	12.1	15.0	16.5	11.3	13.4	11.0	13.0
6-Sep	9.5	12.3	10.7	12.1	15.1	16.8	12.3	13.7	11.7	13.3
7-Sep	8.7	12.1	9.5	11.7	14.6	17.1	10.9	13.6	10.3	13.4
8-Sep	9.7	13.1	10.4	12.5	15.0	17.0	11.9	14.8	11.2	14.2
9-Sep	9.2	11.9	10.0	11.5	15.2	16.6	11.4	13.5	10.8	13.2
10-Sep	9.4	11.8	10.1	11.5	15.2	15.6	11.4	13.1	10.9	12.4
11-Sep	9.4	11.2	9.8	10.7	14.8	14.3	11.2	12.2	10.8	11.6
12-Sep	9.0	11.3	9.4	11.0	14.2	14.1	10.3	12.4	10.1	11.8
13-Sep	8.4	11.8	8.8	11.4	13.6	15.9	9.2	12.8	8.9	11.9
14-Sep	9.0	11.0	9.4	10.9	13.6	15.9	10.4	12.2	9.7	11.8
15-Sep	8.5	11.5	9.2	11.1	13.3	16.0	10.5	12.7	9.9	12.0
16-Sep	7.7	11.6	8.3	11.2	12.5	15.8	9.3	12.4	8.6	11.8
17-Sep	7.8	11.1	8.0	11.1	12.1	15.4	9.2	13.3	9.0	12.5
18-Sep	6.0	10.7	6.0	10.4	11.0	15.3	6.7	12.4	6.4	11.9
19-Sep	6.4	8.9	7.0	8.7	11.3	13.8	7.4	9.3	6.2	9.0
20-Sep	7.0	8.1	7.8	7.8	11.4	13.4	8.6	8.5	7.3	7.8
21-Sep	7.3	8.0	8.1	7.9	11.3	13.2	8.9	8.1	7.8	7.0
22-Sep	7.4	8.4	8.0	8.5	11.5	13.4	8.9	9.0	7.7	7.9
23-Sep	8.5	9.9	8.7	9.9	11.9	13.7	9.9	10.9	8.5	9.9
24-Sep	8.2	9.9	8.5	9.6	12.1	12.9	9.6	10.7	8.4	10.1
25-Sep	8.6	8.9	8.9	8.8	12.3	12.5	10.0	9.9	9.0	9.6
26-Sep	8.3	8.6	8.5	8.6	11.9	11.9	9.6	9.3	9.3	8.0
27-Sep	6.6	8.8	6.7	8.6	10.5	11.4	7.2	9.3	6.7	8.0
28-Sep	6.4	9.1	6.8	8.8	9.8	11.4	7.6	9.6	7.0	8.4
29-Sep	8.0	7.6	8.1	7.7	10.0	10.8	8.5	8.5	7.7	7.7
30-Sep	8.2	8.7	8.4	8.8	10.3	11.0	9.4	9.5	8.8	8.3
1-Oct	9.0	8.2	9.1	8.3	10.5	11.1	10.2	9.0	9.8	8.0
2-Oct	8.1	7.3	8.5	7.6	10.3	10.5	9.1	8.3	9.0	8.0
3-Oct	6.4	5.5	6.7	6.0	8.3	8.4	7.1	5.9	6.7	5.5
4-Oct	6.3	5.0	6.7	5.3	7.5	7.0	6.9	4.8	6.4	3.7
5-Oct	5.5	5.2	5.7	5.7	5.6	6.2	5.8	5.5	5.2	4.3
6-Oct	5.3	6.8	5.7	7.1	6.4	5.6	5.8	7.2	4.5	6.2
7-Oct	4.5	6.8	4.9	7.0	3.3	5.6	5.4	7.3	4.5	6.2
8-Oct	4.6	7.2	4.9	7.3	—	6.1	5.5	7.8	4.5	7.3
9-Oct	4.5	6.0	4.8	6.5	—	—	5.4	6.5	4.4	5.8
10-Oct	4.4	4.5	4.8	4.7	—	—	5.3	4.9	4.3	4.2
11-Oct	—	4.7	—	5.3	—	—	—	5.4	—	4.4
12-Oct	—	4.7	—	5.4	—	—	—	5.6	—	4.4
13-Oct	—	4.9	—	5.6	—	—	—	5.8	—	4.7
14-Oct	—	4.5	—	5.1	—	—	—	4.8	—	4.4

APPENDIX D

Table 18. Fish captures (raw data), Divide Creek fish trap, Saint Mary River drainage, Montana, 1997.

DIVIDE CREEK, 1997

A-BLT (2)				J-BLT (0)				CTT x 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

APPENDIX D (continued)

Table 19. Fish captures (raw data), Boulder Creek fish trap, Saint Mary River drainage, Montana, 1997.

BOULDER CREEK, 1997

A-BLT (17)				J-BLT (30)				CTT x 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 20. Fish captures (raw data), Kennedy Creek fish trap, Saint Mary River drainage, Montana, 1997.

KENNEDY CREEK, 1997

A-BLT (32)				J-BLT (1)				CTT x 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 21. Fish captures (raw data), Otatso Creek fish trap, Saint Mary River drainage, Montana, 1997.

OTATSO CREEK, 1997

A-BLT (16)				J-BLT (1)				CTT x 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 22. Fish captures (raw data), Boulder Creek fish trap, Saint Mary River drainage, Montana, 1998.

BOULDER CREEK, 1998

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

414413616B		621	2168	0.905							
4143762010		690	2654	0.808							
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							
—		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 23. Fish captures (raw data), Kennedy Creek fish trap, Saint Mary River drainage, Montana, 1998.

KENNEDY CREEK, 1998

A-BLT (38)					J-BLT (6)				CTT x RBT (6)		
PIT TAG #	1997-Recap V.I. TAG #	LENGTH (mm)	WEIGHT (g)	K	PIT TAG #	LENGTH (mm)	WEIGHT (g)	K	LENGTH (mm)	WEIGHT (g)	K
414411121F		357	356	0.782	4144090D11	279	200	0.921	166	44	0.962
4148102303		394	532	0.870	413B231547	190	52	0.758	255	140	0.844
41436E3261		461	846	0.864	---	233	104	0.822	210	90	0.972
414A5F221E		375	416	0.789	---	237	116	0.871	280	198	0.902
414A71691D		382	440	0.789	---	211	78	0.830	257	154	0.907
41481C5665		424	618	0.811	4144012503	227	92	0.787	219	100	0.952
4144100D3E		355	378	0.845							
41437D0203		471	886	0.848							
414419436C		481	864	0.776							
41440D7648		436	698	0.842							
414413561B		395	550	0.892							
414916347F		384	458	0.809							
41440A785F		373	450	0.867							
414411767F		350	384	0.896							
4144153729		374	422	0.807							
41495D2C02		351	382	0.883							
4144060D39		354	386	0.870							
4144170507		370	408	0.805							
---		316	256	0.811							
41437A3322		401	560	0.868							
41436D793A		415	574	0.803							
4144070F19		383	502	0.894							
4149113634		650	2236	0.814							
4144107271	W13	542	1396	0.877							
4148717245	W28	577	1602	0.834							
41440F5E6A	(lost)	560	1604	0.913							
413A7E0943		482	882	0.788							
414B040901	W42	570	1510	0.815							
4144110E3D		477	798	0.735							
4144160604		462	770	0.781							
4143771B28		451	840	0.916							
4143765014	W31	455	780	0.828							
4144135F7E		435	822	0.999							
41437A3201	W14	534	1320	0.867							
414377383C	W51	552	1306	0.776							
4144184762		367	420	0.850							
413B506C4F		541	1358	0.858							
414408662E		553	1698	1.004							
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 24. Fish captures (raw data), Otatso Creek fish trap, Saint Mary River drainage, Montana, 1998.

OTATSO CREEK, 1998

A-BLT (19)					J-BLT (17)				CTT x RBT (29)		
PIT TAG #	1997-Recap V.I. TAG #	LENGTH (mm)	WEIGHT (g)	K	PIT TAG #	LENGTH (mm)	WEIGHT (g)	K	LENGTH (mm)	WEIGHT (g)	K
41457D585D		307	312	1.078	41436C092A	291	246	0.998	224	108	0.961
413B3C6D41		447	904	1.012	41440F2D79	234	108	0.843	197	66	0.863
4149336A14		424	638	0.837	---	254	142	0.867	157	30	0.775
41437D404E	W82	464	816	0.817	---	172	36	0.707	201	76	0.936
41440D7C3A	W38	615	1562	0.672	---	166	34	0.743	187	58	0.887
41436C6A47		378	420	0.778	---	197	60	0.785	149	24	0.726
4144021951		450	762	0.836	---	191	54	0.775	121	16	0.903
4143796924	W48	524	1148	0.798	41440E1829	238	102	0.757	217	96	0.939
4144DE1C33	W49	461	784	0.800	---	200	60	0.750	210	86	0.929
4144187D6B		358	420	0.915	---	188	50	0.752	203	76	0.909
4144004759		375	510	0.967	---	177	42	0.757	182	56	0.929
414403781C		480	962	0.870	---	193	54	0.751	353	148	0.336
414374484B		606	2108	0.947	---	238	104	0.771	185	58	0.916
414415293F		548	1302	0.791	---	175	44	0.821	266	172	0.914
41440E3D13	W87	438	668	0.795	---	172	36	0.707	220	104	0.977
41437F556E		462	918	0.931	---	190	52	0.758	224	100	0.890
414410745F		425	694	0.904	---	180	50	0.857	212	90	0.945
41436E5516		420	526	0.710					238	128	
41437A092D		335	298	0.793					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

APPENDIX E

Table 25 Adult bull trout implanted with radio transmitters, Saint Mary drainage, Montana, 1998.

Stream		Radio Frequency	Receiver Setting	Pit Tag #	Length (mm)	Weight (g)	Date of Surgery
Boulder	1	30.100	1:00	41456C4B4C	566	1532	17-Sep
	2	30.120	1:20	4144164449	623	1772	29-Sep
	3	30.140	1:40	41437A035F	585	1638	23-Sep
	4	30.160	1:60	4144024207	611	1871	30-Sep
Kennedy	1	30.020	0:20	414377383C	532	1306	30-Sep
	2	30.040	0:40	4144107271	542	1396	27-Sep
	3	30.180	1:80	414B040901	570	1510	28-Sep
	4	30.200	2:00	41440F5E6A	560	1604	27-Sep
	5	30.240	2:40	4148717245	577	1602	27-Sep
	6	30.270	2:70	4149113634	650	2236	27-Sep
Otatso	1	30.060	0:60	414374484B	606	2108	30-Sep
	2	30.080	0:80	414415293F	548	1302	30-Sep
	3	30.220	2:20	4143796924	525	1248	28-Sep

APPENDIX F

Table 26. Mean back calculated total lengths (MBCTL) at annuli and mean growth increment (MGI) between annuli in millimeters of 59 cutthroat trout and 4 rainbow trout captured in Divide, Boulder, Kennedy and Otatso creeks, Saint Mary River drainage, Montana, 1997.

Drainage	Age Class							
	Cutthroat Trout				Rainbow Trout			
	I	II	III	IV	I	II	III	IV
Divide Creek								
MBCTL	71	133						
MGI	71	73						
(n = 19 CTT & 0 RBT)								
Boulder Creek								
MBCTL	69	136	177		--	146		
MGI	69	86	73		--	--		
(n = 21 CTT & 1 RBT)								
Kennedy Creek								
MBCTL	54	126	210	299	45	122		
MGI	54	72	75	75	45	84		
(n = 8 CTT & 2 RBT)								
Otatso Creek								
MBCTL	60	114	200		56	127	246	299
MGI	60	69	83		56	71	119	53
(n = 11 CTT & 1 RBT)								
Combined								
MBCTL	66	130	192	299	49	129	246	299
MGI	66	77	76	75	49	80	119	53
(n = 59 CTT & 4 RBT)								

APPENDIX G

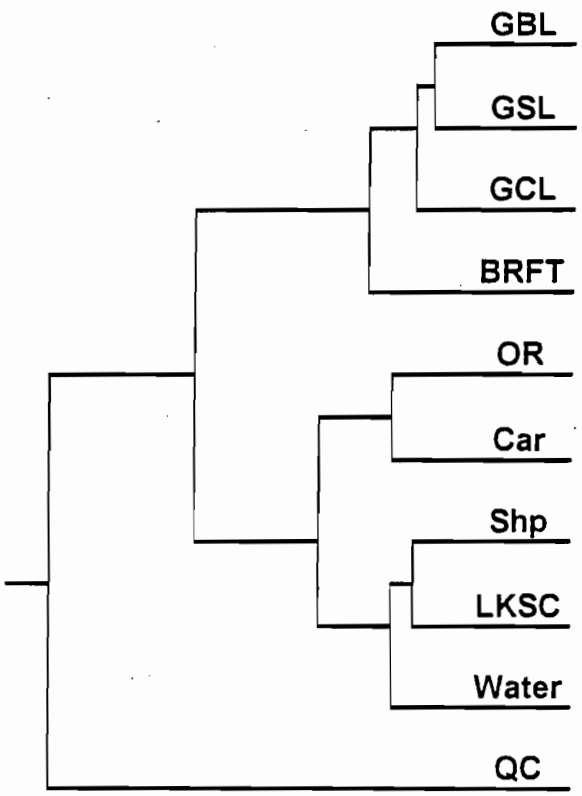
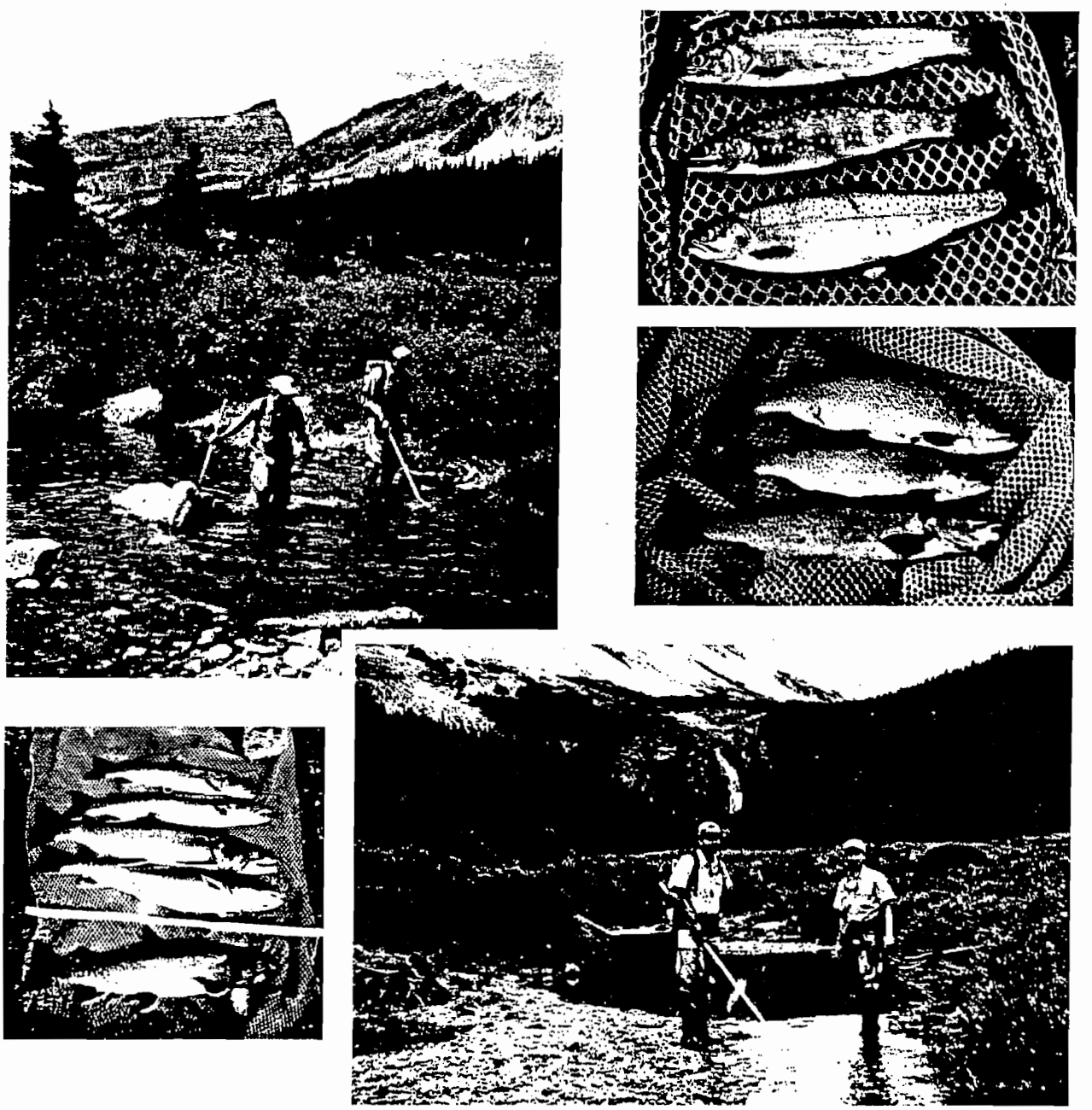
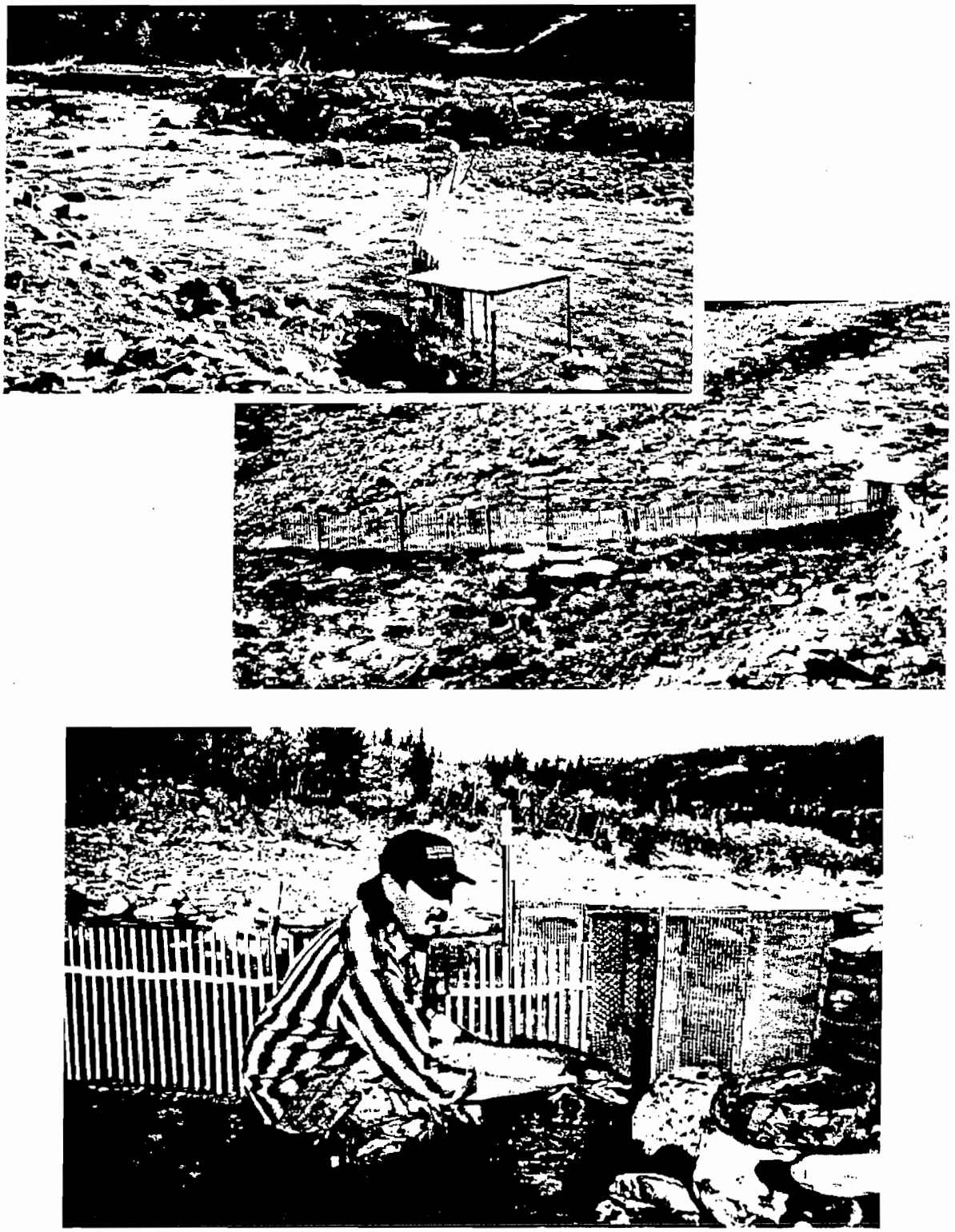


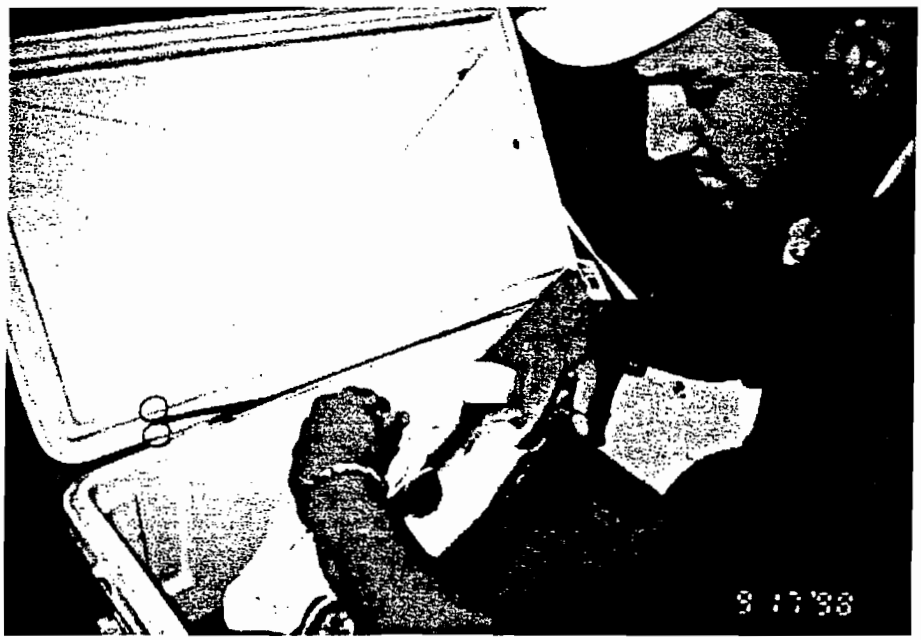
Figure 14. Phenogram representing genetic distances among Glacier National Park (GSL=Slide Lake; GCL=Cracker Lake; GBL=Red Eagle Creek) and Alberta (BRFT=Belly River; OR=Oldman River; Car=Carbondale River; Shp=Sheep River, LKSC=Smith-Dorian Creek and Water=Waterton River). Brook trout from Quirk Creek (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).



Electrofishing Surveys, Saint Mary River drainage, Blackfeet Reservation and Glacier National Park, Montana, summer 1999 (pictured; Jim Mogen and Jarvis Gust, USFWS). Several species of salmonids are shown including bull trout, cutthroat trout, cutthroat-rainbow hybrids and brook trout.



Fish trapping operations, Saint Mary River drainage, Blackfeet Reservation, Montana, fall 1999 (pictured; Sam Juneau, Blackfeet Environmental Department, with large adult bull trout).



Implanting radio transmitters into adult migratory bull trout, Saint Mary River drainage, Blackfeet Reservation, Montana, fall 1999 (pictured; Jim Mogen, USFWS).