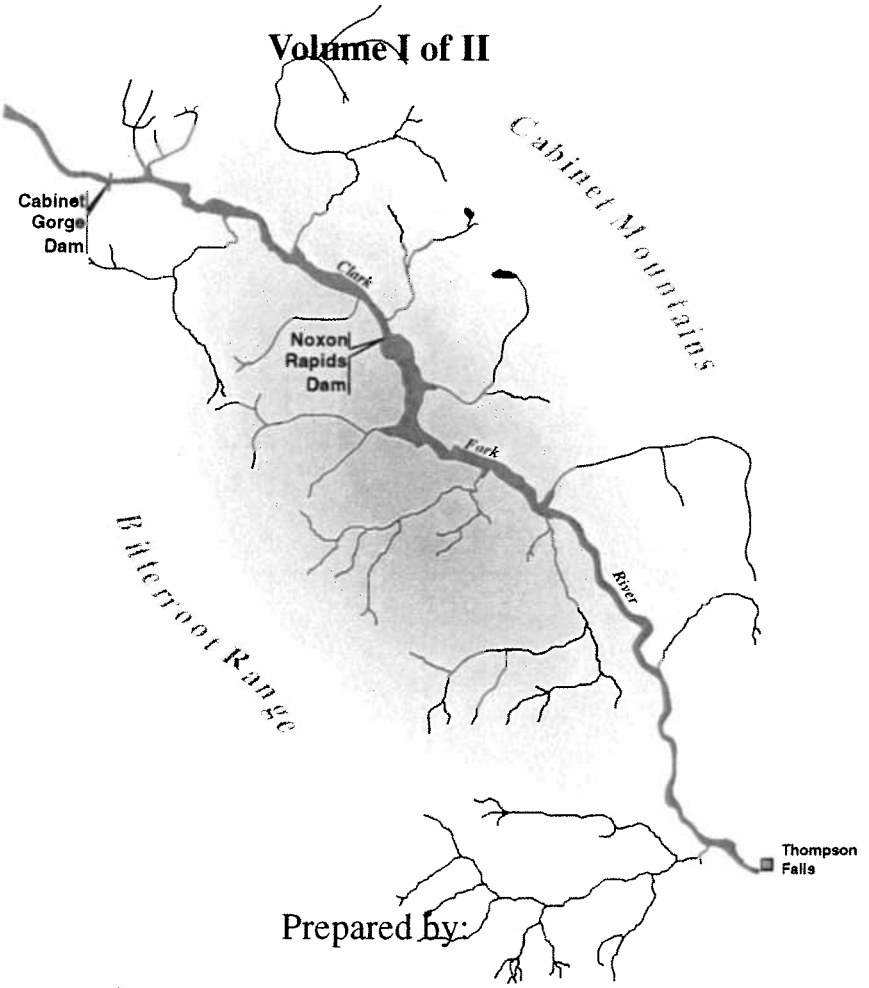
Lower Clark Fork River Tributary Survey

Final Report

for a
Cooperative Challenge Cost Share Project
between:

Washington Water Power Company
United States Forest Service
Montana Department of Fish, Wildlife, and Parks

Volume I of II



Prepared by:

WASHINGTON WATER POWER COMPANY
Spokane, Washington

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Section 1
Summary

In 1992, The Washington Water Power Company entered into a challenge cost-share, lower Clark Fork Tributary Study project with the United States Forest Service and Montana Department of Fish, Wildlife and Parks. The goal of this project was to collect information on historical fishery resources and current habitat characteristics and trout populations in lower Clark Fork River (LCFR) tributaries used by adfluvial fish (migrate between streams and lakes/reservoirs) between Thompson Falls, Montana, and the Cabinet Gorge Dam near Clark Fork, Idaho. Pratt and Huston (1993 *in draft*) presented the information concerning historical fishery resources, focusing primarily on bull trout. The assessment of present day conditions and trout populations is presented in this report. Study objectives included completing a Hankin and Reeves type survey (Hankin and Reeves 1988) which is supplemented with additional habitat, stream productivity, and trout population data. Most of the habitat and fish population data presented in this report were collected on the selected tributary reaches during 1992-1994, with a few exceptions such as looking at long-term trends in brown trout redd counts.

1.1 Fish Habitat

Factors influencing fish habitat in the LCFR tributary system include stream gradient, stream channel type, silvicultural practices, land-clearing, road construction, residential development, and agricultural activities. In general, tributary habitat includes a fairly even mix of fast water and slow water habitat types, although the average pool to riffle ratio is low (approx. 1:2) due to the high gradient nature of the drainage, a lack of pool-forming materials in the streams such as large woody debris (LWD), and previous channel clearing activities.

The hydrology for streams in the tributary system is consistent with high-energy, high flow-event influenced systems. Throughout the drainage, rain-on-snow events capable of producing flows equal to or greater than spring run-off are fairly common. In addition, occurrence of stream intermittency during low flow periods has apparently increased in recent years. Stream reaches in the LCFR tributaries that presently experience intermittent flows are located in alluvial deposition areas and

contain an extremely porous, unstable substrate mix characteristic of intermittent stream systems. However, these substrate conditions represent historic conditions as well, and it therefore appears that changing land use patterns or some other significant hydrologic influence or geologic event are responsible for the increased stream intermittency.

From the standpoint of gross substrate stability, LCFR tributaries that flow from the Bitterroot Mountains to the south are generally unstable in the lower reaches, but stable, with a cobble dominated streambed in the middle and upper reaches. In comparison, tributaries that originate in the Cabinet Mountains to the north also have generally unstable lower reaches, stable mid-reaches but with a slightly larger cobble substrate and instream bedrock and boulder features, and moderately stable upper reaches.

Substrate composition in the tributaries is a diverse mix of substrate size classes. Gravel and rubble are the most evenly dispersed size classes and are the most common substrate types in most of the tributaries. However, gravel concentrations frequently occur in locations where flow conditions or fine sediment deposition result in low suitability for salmonid spawning. Cobble and boulder substrates are common in some tributaries, but their distribution is usually restricted to the upper stream reaches. The smallest substrates types (peagravel, sand/silt) are scarce in many tributary streams or reaches, a reflection of the periodic high flows in the system.

Occurrence of surface fines in the LCFR tributaries is generally quite limited in both distribution and coverage. Where they are found, high levels of surface fines can usually be attributed to adjacent, nearby, or upstream land use activities. High levels of fines also appear to occur naturally in some areas, although this natural occurrence is frequently compounded by ground disturbing land use activities.

Vegetated bank cover along the tributaries ranges from very high coverage to extremely sparse. Riparian vegetation throughout the drainage, with rare exception, has been altered, but most riparian zones are at least marginally functional, providing some overhead stream cover, bank stability, and widely variable sources of LWD. In tributary reaches where the riparian zone is severely altered and in poor condition, stream habitat conditions are poor and fish populations are typically of extremely low abundance or non-existent.

Occurrence of LWD in the tributary system is on average fairly uncommon, with woody materials rare to almost non-existent in most tributary reaches. Low levels of LWD results in reduced channel stability, low pool to riffle ratio, pool instability, and reduced salmonid abundance. There are also a few tributaries with excessive quantities of LWD that border on detrimental.

Water temperature regimes in the individual tributaries reflect the stream order, degree of influence from groundwater inflow, and amount of canopy cover present. Most reaches have water temperature regimes that usually fall within tolerable thermal limits for trout. Low-order tributary reaches located in headwater areas and having significant amounts of canopy cover or groundwater inflow generally have the lowest water temperature regimes. Intermediate order reaches located in stream mid-reaches and having moderate amounts of canopy cover have somewhat higher temperature regimes, and reaches in the lower elevation portions of the drainage with low amounts of canopy cover and little groundwater influence have the highest water temperatures. In some cases, conditions in these lower stream reaches during the warmest summer periods can exceed the known thermal limits for trout.

Spawning habitat for salmonids in the LCFR tributaries is partially limited by low occurrence and patchy distribution of suitable spawning gravel. In many stream reaches where otherwise suitable spawning gravel is abundant, fine sediment is often present in fairly high amounts; although in most of the identified spawning areas predicted embryo survival to emergence for westslope cutthroat trout and bull trout still falls within an acceptable range (11 to 40 percent survival for cutthroats, 14 to 48 percent for bull trout). Furthermore, many of the more extensive areas of suitable spawning gravel are in lower stream reaches, and many of these reaches are also subject to seasonally intermittent flows that make them unavailable to migratory, fall-spawning salmonids.

Suitable rearing habitat for juvenile salmonids in the LCFR tributaries is generally limited by a lack of adequate winter flows, and a lack of cover and velocity refuge features such as:

- stable, unembedded cobble and boulder substrate;
- LWD accumulations;
- undercut banks; and
- side channel areas.

The lack of some or all of these important habitat features in many stream reaches reduces or precludes suitability for juvenile trout, thereby limiting the overall trout production potential of the tributary system.

Primary and secondary productivity in the tributaries, and therefore availability of an invertebrate food base for trout, varies among streams and ranges from very low in the more sterile headwater reaches to relatively high in lower stream reaches influenced by agricultural activities and human habitation.

1.2 Fish Populations

Overall, cutthroat trout (westslope and westslope hybrids) are the most abundant trout species in the surveyed sections of the LCFR tributaries (estimated population 69,543). They are followed by brook trout (est. population 35,625), brown trout (est. population 8,520), and bull trout (est. population 5,856). The species composition, distribution, and abundance of these four species in the LCFR tributary system varies between streams and channel types, and appears to be influenced by a combination of factors including:

- stream channel gradient;
- habitat complexity;
- amounts and availability of suitable spawning habitat;
- amounts and availability of suitable rearing habitat;
- extreme flow events (rain on snow);
- stream intermittency; and
- interspecies competition.

Westslope cutthroat are the only trout species (versus char or other salmonids) native to the Clark Fork drainage and are widely distributed throughout the LCFR tributary system. Cutthroat trout densities are generally highest in mid-reach portions of the tributaries that have a fairly stable channel and larger substrates, contain high amounts of LWD, spawning habitat, and rearing habitat, have moderate water temperature regimes, and low levels of fine sediment deposition and

competition from other species. The cutthroat trout populations consist primarily of resident fish, although a small adfluvial component is also present. Genetic evaluations show cutthroat trout populations in the LCFR tributaries are dominated by pure strain, native westslope cutthroat trout, although there is evidence of hatchery origin westslope cutthroat, Yellowstone cutthroat, and rainbow trout genetics in a few populations.

Bull trout are the only char species native to the LCFR drainage. Historically, bull trout populations are believed to have been found in 86 percent of the tributary habitat (Pratt and Huston 1993 *in draft*), while they are presently found in 59 percent. Bull trout densities are highest in upper, high-order tributary reaches that have fairly stable channels, cobble and rubble substrates, high amounts of LWD, moderate to cold water temperature regimes, and low levels of fine sediment deposition and competition from other species. They are most heavily concentrated within areas where either groundwater inflow is known to exist or where the potential for groundwater influences are very good. Bull trout populations in the tributaries include both resident and adfluvial life forms, often in conjunction with one another. Samples for genetic evaluation of the bull trout population were available only from the East Fork of Bull River (a tributary to Cabinet Gorge Reservoir). Results of the genetic analysis indicate this is a pure bull trout strain. In addition, no genetic differences were found between these fish and bull trout sampled in the West Fork of Fishtrap Creek, a Clark Fork drainage tributary located upstream of both Noxon Rapids and Thompson Falls dams.

Brook trout are not native to the LCFR drainage and were first introduced into the drainage in the mid-1930s. This non-native species is currently found in 96 percent of the drainage. Brook trout densities are greatest in lower stream reaches that are relatively unstable and contain high amounts of spawning and rearing habitat; moderate water temperature regimes; and low levels of fine sediment deposition and LWD. Populations appear to consist of strictly resident fish. Brook trout in the tributaries probably compete with bull trout for spawning and rearing habitat, and with cutthroat trout for rearing, foraging, resting, and concealment habitat. Brook trout are also known to hybridize with bull trout (both are char species) producing sterile offspring; such interactions can lead to dramatic decline or replacement of bull trout populations (Leary et al. 1993).

Brown trout are not native to the LCFR drainage and were first introduced into the drainage in the late 1940s. At present, brown trout populations are found in 75 percent of the surveyed drainage and

are predominately adfluvial in nature. Brown trout densities are greatest in the lower, moderately stable stream reaches that contain high amounts of LWD, spawning habitat, and rearing habitat, relatively warm water temperatures, and low levels of fine sediment deposition. With respect to interspecies competition, brown trout spawn in many of the areas of the LCFR tributaries that are used by bull trout, although generally later in the fall, and may disturb the earlier constructed bull trout redds. Post-emergence competition among bull and brown trout fry is also a possibility in these areas. The level of competition between brown trout and bull, cutthroat, or brook trout otherwise appears quite low, as they tend to occupy different rearing habitats.

Compared to growth rates of trout in other river and stream systems in the region (Carlander 1969), growth in the LCFR tributaries is relatively low for cutthroat, brown, and brook trout, and fairly similar for bull trout. The key influences on trout growth in the tributaries appear to be low water temperature regimes and low primary and secondary stream productivity.

Although typical for the region, water temperature regimes in the LCFR tributaries are quite cool, typically having the most favorable temperatures for trout growth (7 - 18°C; Carlander 1990) only from late-May through early-September. In addition, primary and secondary productivity in the tributaries is low, resulting in limited food availability (especially aquatic invertebrates) which further restricts fish growth rates (Elliot 1985).

Survival rates for trout in the LCFR tributaries vary substantially between streams, and range from well above to well below the rates reported for other river and stream systems in the region (Carlander 1990). Compared to these other systems, the overall average survival rate in the tributaries is relatively high for brook trout, relatively low for brown and bull trout, and fairly similar for westslope cutthroat trout.

Brown trout redd counts have been conducted by MDFWP and WWP on the mainstem Bull River and East Fork of Bull River since 1980. The stream coverage for theses counts was expanded in 1986, and then again in 1993 as part of this study, to where the most recent counts attempt to cover all of the stream reaches known to support brown trout spawning. For the time period between 1980 and 1985 the number of brown trout redds counted in the Bull River averaged 58 redds per year. Between 1986 and 1994, the number of brown trout redds counted in the LCFR tributaries averaged

132 redds per year. Although the scope of the redd counts and total number of redds counted has increased, counts in areas consistently surveyed since 1980 have remained similar, indicating stable spawning populations in those areas.

Systematic bull trout redd counts were attempted for the first time in 1992. These surveys were conducted in the East Fork of the Bull River and were timed to differentiate between bull trout redds and those of later spawning brown trout. In 1993 the bull trout redd counts were expanded to include all stream reaches in the LCFR tributaries known to support adfluvial bull trout spawning. A total of 67 redds were counted in 1993. High flow conditions prevented accurate redd counts in many of the tributaries during 1994 and 1995. Consequently, the redd count database is as yet too limited to allow for analysis of either past or present trends in the adfluvial bull trout spawning runs.

1.3 Recommendations

Protection, restoration, or enhancement efforts in the LCFR tributaries directed at either the habitat conditions or trout populations should be undertaken only after careful analysis of stream specific conditions and the implications of the proposed activity to both biological and hydraulic functions. Depending on restoration and enhancement objectives, the most widespread and feasible opportunities to improve conditions for trout populations in the LCFR tributaries include increasing stream habitat complexity, primarily through additional instream cover and pool creation, stabilization of stream channels, and reducing the impacts of various land use activities.

In 1991, the Montana Legislature passed the Stream Management Zone Law which offers guidelines for riparian buffer zones. These so-called streamside management zones (SMZ) should be considered for all the surveyed tributaries. Over the long-term, effective management and protection of the streamside riparian zones would address much of the need for improved cover, pool, and channel stability characteristics, while also providing an effective buffer to the impacts of land use activities. Streamside planting of trees or shrubs may be needed in areas where a more rapid restoration of degraded riparian zones is desired.

The most widespread opportunities for immediate improvement of fish habitat in the tributaries include placement of large woody debris or other instream cover and pool creating materials or structures directly into the streams. Some additional stream or reach specific management opportunities and alternatives directed at maintaining and enhancing habitat conditions and trout populations in the LCFR tributaries are:

- stream bank stabilization;
- road and culvert improvements;
- enhancement or creation of spawning and rearing habitat;
- addressing stream intermittency;
- removal or control of non-native species;
- additional regulatory protection of rare fish species; and
- population augmentation (highly selective stocking).

Consideration should also be given to the need for more detailed characterizations of site specific habitat conditions and fish populations in areas where intensive management and enhancement activities are contemplated so that results can be documented and activities adjusted accordingly.

Section 2
Introduction

Prior to 1992, no systematic fish habitat or population assessments had been conducted on the tributary system of the lower Clark Fork River (LCFR) located in northwestern Montana and northern Idaho. In 1992, The Washington Water Power Company (WWP) entered into a cooperative challenge cost-share project with the United States Forest Service (USFS) and Montana Department of Fish, Wildlife and Parks (MDFWP) to conduct fisheries investigations on the LCFR tributaries. The goal of this project was to collect information concerning both historical fishery resources and present-day conditions in the tributary system of the lower Clark Fork River (LCFR) drainage between Thompson Falls, Montana, and the Cabinet Gorge Dam, near Clark Fork, Idaho. The project focused on adfluvial trout (fish that spawn in streams but mature in lake environments before returning to streams to spawn), and streams or stream reaches accessible to and currently or recently known to be utilized by them. Pratt and Huston (1993 *in draft*) previously presented the information related to historical fishery resources, focusing primarily on bull trout. This report represents the final report for the WWP - agency challenge cost-share tributary study, and presents the results of extensive stream surveys and characterization of present-day habitat conditions and trout (brown and cutthroat trout) and char (bull and brook trout) populations (hereafter collectively referred to simply as "trout" species unless otherwise noted).

Specific study objectives included:

- conduct a Hankin and Reeves type habitat survey;
- collect additional fish habitat information including hydrology and water temperature, major stream features, evaluation of spawning area substrates, inventory spawning and rearing habitat, and evaluate primary and secondary productivity;
- assess the extent of use of the tributary system by adfluvial trout;
- estimate numbers and describe age, growth, and mortality characteristics of the trout populations in the surveyed tributaries, with emphasis on westslope cutthroat trout *Onchorynchus clarki lewisi* and bull trout *Salvelinus confluentus;*
- evaluate production capability and seeding levels for trout in the tributary system;

- evaluate the distribution and genetic composition of westslope cutthroat and bull trout in the tributaries; and
- develop recommendations for enhancement of habitat conditions and trout populations in the tributary system.

Section 3
Study Area

The lower Clark Fork River flows approximately 115 km (71 mi) from Thompson Falls, Montana to its confluence with Lake Pend Oreille near Clark Fork, Idaho, including the approximately 97 km (60 mi) of Noxon and Cabinet Gorge Reservoirs. The generally westerly flowing LCFR is bounded by the Bitterroot Range to the south and the Cabinet Mountains to the north (Figure 3-1), and much of the drainage is located in the Kootenai, Kaniksu, and Lolo National Forests; it covers about 12,841 km^2 (4,939 mi^2) and contains 624 km (390 mi) of tributary streams.

The habitat and trout population assessments focused on LCFR tributaries or tributary reaches believed to support adfluvial westslope cutthroat or bull trout populations. As a result, the study area included sections of the East Fork of Blue Creek, Elk Creek mainstem and the East and West Forks of Elk Creek, Bull River mainstem and the East, North, South, and Middle Forks of Bull River, Pilgrim Creek, Rock Creek mainstem and the West Fork of Rock Creek, Swamp Creek, Marten Creek mainstem and the North and South Branches of Marten Creek, Vermilion River, Graves Creek, Prospect and Crow Creeks (a Prospect Creek tributary).

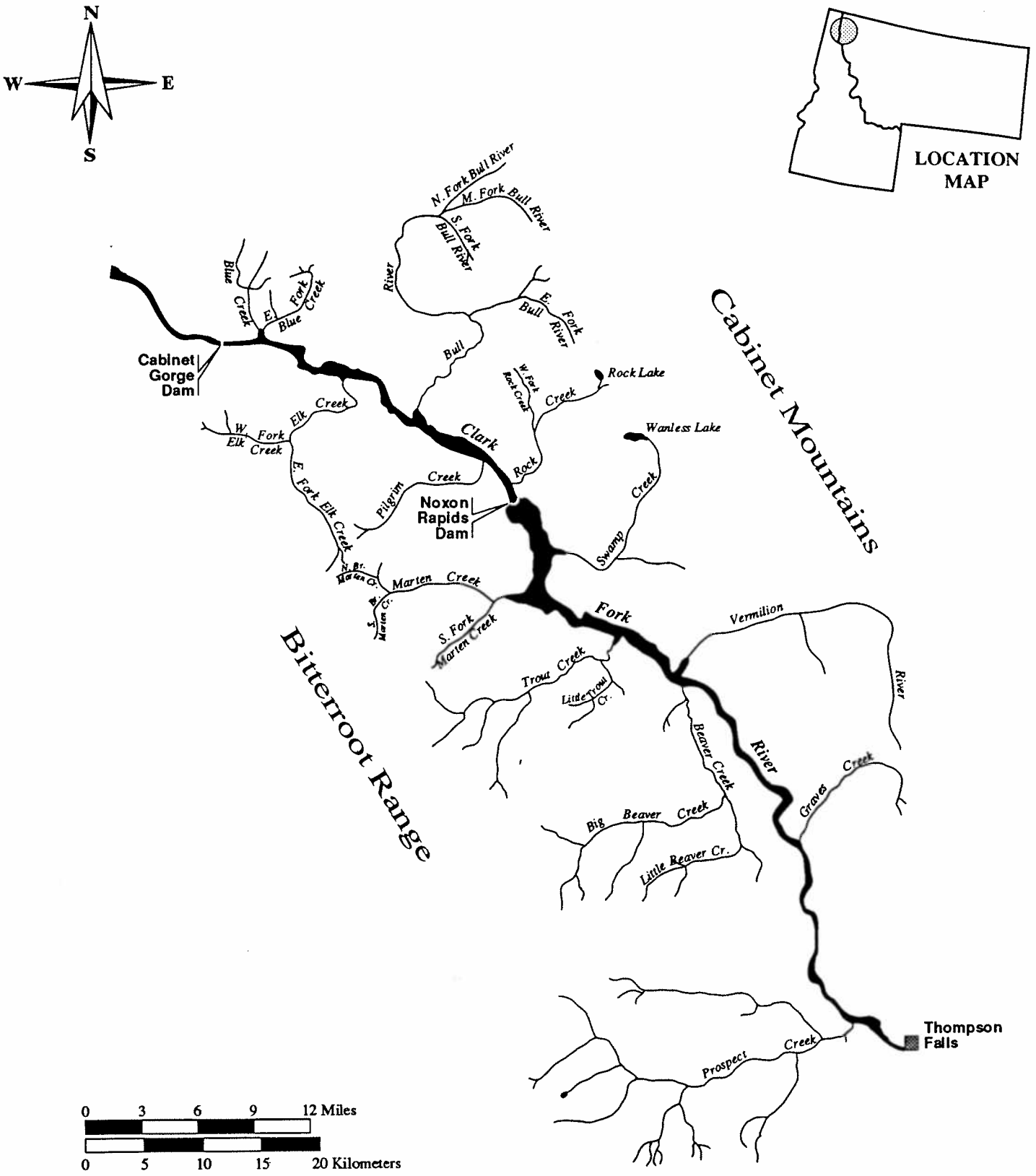

Figure 3-1. Map of the lower Clark Fork River drainage showing major and minor tributaries.

Section 4
Methods

Study methods used during the course of the LCFR Tributary Survey, challenge cost-share project, are summarized below. However, not all evaluations, and therefore study methods, could be conducted on all the surveyed stream sections. A summary of the specific evaluations conducted on each individual stream section is presented in Table 4-1.

4.1 Historical Fishery Resources

Historical status of fish resources in the lower Clark Fork River drainage with an emphasis on adfluvial bull trout was documented through the review of data from U.S. Fish Commission reports, USFS reports, and MDFWP reports and records; interviews with long-time local residents; local newspaper articles; and other available historical accounts and documents. The results of those efforts are presented in Pratt and Huston (1993 *in draft*), Status of Bull Trout (*Salvelinus Confluentus*) in Lake Pend Oreille and the Lower Clark Fork River: DRAFT.

4.2 Fish Habitat

The fish habitat assessment consisted of six components:

- a Hankin and Reeves type stream habitat survey;
- an assessment of stream hydrology and water temperatures;
- a sediment survey;
- an assessment of fall-spawning salmonid habitat availability;
- an assessment of salmonid rearing habitat availability; and,
- an evaluation of primary and secondary productivity in the streams.

Table 4-1. Stream specific evaluations. Lower Clark Fork River drainage, Montana. Tributary survey 1992-1994.

TRIBUTARY	BULL TROUT P/A	HABITAT	RASI	STREAM FEATURE	ELECTROFISH	SNORKEL	AGE & GROWTH	ELECTROPHORETIC	SEDIMENT	LWD	SPAWNING HABITAT	REARING HABITAT	REDD COUNT	HYDROLOGY	TEMPERATURE	PERIPHYTON	INVERTEBRATES
Bull River	P	•	•	•		•			•	•	•	•	•	•	•	•	•
E. Fork Bull River	P	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
N. Fork Bull River	A	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•
S. Fork Bull River	P	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•
M. Fork Bull River	A	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•
E. Fork Blue Creek	A	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•
Elk Creek	A	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•
E. Fork Elk Creek	A	•	•	•	•	•	•		•	•	•	•		•	•	•	•
W. Fork Elk Creek	A	•	•	•	•	•	•		•	•	•	•		•	•	•	•
Pilgrim Creek	A	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Rock Creek	P	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
W. Fork Rock Creek	P	•		•	•	•	•		•	•	•	•		•	•	•	•
Swamp Creek	A	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Marten Creek	A	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
N. Branch Marten Creek	A	•	•	•	•	•			•	•	•	•				•	•
S. Branch Marten Creek	A	•	•	•	•	•			•	•	•	•				•	•
S. Fork Marten Creek	A	•	•	•	•	•		•	•	•				•	•	•	•
Graves Creek	P	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•
Vermillion River	P	•	•	•		•		•	•	•	•	•	•	•	•	•	•
Beaver Creek	A	•				•		•	•	•				•	•	•	•
Little Beaver Creek	A	•	•	•	•	•		•	•	•				•	•	•	•
Prospect Creek	P	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
N. Branch Prospect Creek	A	•	•	•		•			•	•						•	•
S. Branch Prospect Creek	A	•	•	•		•			•	•						•	•
Crow Creek	P	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•
Clear Creek	A	•	•	•		•			•	•				•	•	•	•
N. Fork E. Fork Bull River	P							•									
Berray Creek	A	•						•									
Copper Creek	P							•									
S. Fork Pilgrim Creek	A	•	•														
W. Fork Pilgrim Creek	A	•	•					•									
McNeely Gulch	A	•	•														
Blossom Creek	A	•	•					•									
Twentyfour Mile Creek	P	•															
Wilkes Creek	A													•	•		
Cooper Creek	A							•						•	•		
White Pine Creek	A							•						•	•		
Mckay Creek	A							•						•	•		
Stevens Creek	A													•	•		
W. Fork Blue Creek	A							•									
Big Eddy Creek	A																
Dead Horse Creek	A							•									
Blacktail Creek	A																
Napoleon Gulch	A							•									
Star Gulch	A							•									
Hamilton Gulch	A							•									
Dry Creek	A							•									
Snake Creek	A																
Soldier Creek	A																
Government Creek	A							•									
Deep Creek	A							•									
Trout Creek	A							•									
Tuscor Creek	A							•									
W.F. Dry Creek	A							•									
Evans Gulch	A							•									

• Work Accomplished P = Present A = Absent

4.2.1 Habitat Survey

The Hankin and Reeves type fish habitat survey evaluated the following:

- habitat composition;
- substrate composition;
- surface fines;
- riparian vegetation; and
- large woody debris.

A slightly modified "Hankin and Reeves" stream survey methodology (Hankin and Reeves 1988) was used. Tributaries were divided into reaches defined by gradient and channel confinement characteristics. Reaches were initially identified using topographic maps and were confirmed by stream survey field crews based on the Rosgen Channel Classification Scheme (Rosgen 1993). River mile (RM) designations for stream reaches are based on in-field measurements by the field crews.

Habitat composition was determined by dividing stream reaches into individual habitat units classified by habitat type (Table 4-2). Variables describing the habitat unit (Table 4-3) were visually estimated by the field crew leader. Field crews then verified habitat unit variables in systematically measured sub-samples of each habitat type. The number of habitat units selected for verification was based either on the level of variation among the samples or on a minimum of one out of each six units for each habitat type. Measured habitat unit variables were compared with the visual estimates and a correction factor was determined. This correction factor was applied to the entire reach data set for the habitat type, and the corrected data set was used in describing fish habitat. Photographs were also taken of each verified habitat unit and archived for future reference.

Habitat composition and parameters describing habitat characteristics were compared between streams and among stream channel types on a stream-by-stream and drainage-wide basis. Statistical comparisons used analysis of variance (ANOVA) and Student's t-Test (Zar 1984). Relationships between variables were evaluated using correlation analysis (Zar 1984).

Table 4-2. Habitat classification codes, habitat types and descriptions. Lower Clark Fork River Drainage, Montana. Tributary survey, 1992-1994.

Code	Habitat type	Description
PD	Pool, dammed	Pool formed by a channel obstruction.
PS	Pool, scour	Pool formed by the lateral scouring of water.
PP	Pool, plunge	Pool formed by the scouring action of falling water.
GLD	Glide	Water is shallower than a run and has low to moderate velocities and no surface agitation. Channel is uniform U-shape with a wide bottom.
RUN	Run	Water is deep and fast (>0.30 m/sec) with little surface agitation and few major flow obstructions.
LGR	Low gradient riffle	Water flows swiftly over completely of partially submerged obstructions to produce surface agitation (gradient <4%).
HGR	High gradient riffle	Water flows swiftly over completely or partially submerged obstructions to produce surface agitation (gradient >4%).
POP	Pocket pool	Series of small (<30% of the habitat unit) low-velocity pools formed behind channel obstructions within fast water habitat types.
CAS	Cascade	Swift current, exposed rocks or boulders, high gradient, considerable turbulence and surface agitation, and consisting of a stepped series of drops.

Table 4-3. Habitat variables estimated and measured. Lower Clark Fork River Drainage, Montana. Tributary survey, 1992-1994. 1992-1994.

Variable	Description
Thalweg length	Length of the habitat unit along the thalweg.
Average width	Width of the habitat unit at a specific point representative of the Average width.
Average water depth	In fast water habitats, average depth at 1/4, 1/2, and 3/4 the distance along the average width transect. In pool, average depth at 1/3 and 2/3rds the distance along the thalweg line midway between the pool maximum depth and the pool tail crest.
Maximum pool depth	Deepest point in the habitat unit.
Bank length	Length of bank at water level and bank-full elevations.
Bank stability	Length of bank actively eroding or composed of unstable materials.
Vegetated bank	Length of bank covered by vegetation.
Undercut bank	Length of undercut bank.
Surface fines	Percentage of surface fines (particles <6.35 mm) in pool tails and low gradient riffle habitat units. Composite estimate of randomly selected and evaluated locations within the habitat unit.
Vegetation class	Length of habitat unit by vegetation class: sedge/rush (SR) grass/forbs (GF) riparian shrub (RS) upland shrub (US) riparian tree (RT) upland tree (UT) bare ground (BG)
Substrate composition	sand/silt (<0.2 cm) peagravel (0.2 - 0.6 cm) gravel (0.6 - 7.5 cm) rubble (7.5 - 15.0 cm) cobble (15.0 - 30.0 cm) boulder (>30.0 cm) bedrock
Large woody debris	Number of individual pieces (>0.1 m in diameter) within the bankfull channel Number of aggregates (two or more pieces, each which qualifies as an individual piece). Root-wads attached to logs <3.0 m in length.

4.2.2 Hydrology and Water Temperature

During 1994, stream flow and water temperature was monitored in several tributaries (see Table 4-1) at permanent transects marked with a rebar stake.

Depth and water velocity were generally measured once a month at 0.5 m (1.6 ft) intervals along the transect. Water velocity was obtained at 0.6 of total depth using a Marsh-McBirney Model 201 Portable Water Flowmeter. Drainage area based flow curves were developed and used to estimate stream flows where actual flow measurements were not available. Temperatures were monitored at 1.2 hour intervals using an Onset Instruments Corporation, HOBO™ Model XT Temperature Logger. Additional temperature readings were obtained using hand held thermometers.

4.2.3 Sediment Survey

The sediment survey consisted of three components:

- a major stream features survey (MDFWP 1983);
- an evaluation of spawning area substrate composition (MDFWP 1983); and
- a Riffle Stability Index (RSI) assessment (Kappesser 1993).

Major Stream Features Major stream features include sediment sources, debris accumulations, adjacent land uses, gradient changes, rearing habitat, potential spawning areas, beaver activity, etc. Major features were located while walking down the stream channel and counting the number of paces from the starting point (MDFWP 1983). Along with reach and habitat classification, this information was used to prepare a narrative description and general characterization of the surveyed tributaries.

Spawning Area Substrate Composition Assessment of spawning area substrate consisted of using standard 15.2 cm (6 in) hollow core samplers (McNeil and Ahnell 1964) to collect four samples across each of three transects at identified spawning sites. Coring sites were located along the transects by visually dividing the width of the spawning area into four equal cells, with one core sample taken from a randomly selected site in each cell. Attempts were made to collect minimum

individual core samples of 10,000 grams, although subsurface substrate conditions (i.e. bedrock or clay layers) occasionally precluded this.

Core samples were oven dried and sieve separated into 13 size classes (Table 4-4). Material retained on each sieve was weighed and recorded. These data were analyzed using a computer program developed by MDFWP specifically for McNeil core samples. Each set of samples was described using the median percentage of the samples smaller than 6.35 mm (0.25 in) in diameter (Bjornn 1968, 1969a, 1969b; Bjornn et al. 1977; Tappel and Bjornn 1983, Weaver and Fraley 1991). Embryo survival to fry emergence for westslope cutthroat and bull trout was estimated based on equations from Weaver and Fraley (1991).

Riffle Stability Index The Riffle Stability Index (RSI) methodology (Kappesser 1993) was used to describe the degree of deposition and stability of gravel and cobble within the stream channel. Stream reaches were assigned a channel type (using measured parameters of entrenchment, width to depth, gradient and particle size) then classified using the methodology outlined by Rosgen (1993).

Within each distinct channel reach, three riffles were measured for particle size distribution using the Wolman pebble count procedure (Wolman 1954). The mobile particle size was then indexed against the mean grain size of the Wolman pebble count using the RSI computer application from the USFS, Region One. This application calculated a RSI value from 1 to 100 for each surveyed site. To remain consistent with the methodology, RSI sites were not established in highly confined, relatively steep "A" type channels or in channels with only sand or silt substrates.

4.2.4 Spawning Habitat Availability

Spawning habitat for fall-spawning salmonids was quantified by measuring potential spawning areas identified as part of the major stream features survey. Potential spawning areas were identified based on the presence of suitable habitat characteristics for substrate size, water depth, and velocity as outlined in the habitat suitability index curves (HSI) developed by the USFWS (Hickman and

Table 4-4. Size classifications for core samples. Lower Clark Fork River Drainage, Montana. Tributary Survey, 1992-1994. (Weaver 1993)

76.1 mm	(3.00 in.)
50.8 mm	(2.00 in.)
25.4 mm	(1.00 in.)
18.8 mm	(0.74 in.)
12.7 mm	(0.50 in.)
9.52 mm	(0.38 in.)
6.35 mm	(0.25 in.)
4.76 mm	(0.19 in.)
2.00 mm	(0.08 in.)
0.85 mm	(0.03 in.)
0.42 mm	(0.016 in.)
0.063 mm	(0.002 in.)
Pan	(<0.002 in.)

Raleigh 1982, Raleigh 1982, Raleigh et al. 1986) or identified by other authors (Thompson 1972; Smith 1973; and Hunter 1973). Based on these sources, suitable spawning habitat was broadly defined as:

- water depth > 0.2 m (0.7 ft);
- velocity 0.20 - 0.70 m/sec (0.7 - 2.3 ft/sec); and
- substrate size 0.6 - 8.0 cm (0.2 - 3.1 in).

Estimates of the total number of spawning salmonids a stream could accommodate were obtained by dividing the area suitable for spawning by four times the average redd size (Burner 1951, cited in Reiser and Bjornn 1979). Average redd size was determined by measuring the total length of observed redds (upper edge of pit to lower edge of tail spill) and the average of several equidistant widths.

4.2.5 Rearing Habitat Availability

Similar to spawning habitat surveys, salmonid rearing habitat was quantified by locating and measuring stream areas that contained an appropriate combination of suitable habitat parameters. Concealment cover (Contor 1989, Smith 1992, Smith and Griffith 1994) and low water velocities (Contor 1989, Cunjak and Power 1986), which are key attributes of winter rearing habitat for juvenile salmonids, were evaluated. Salmonid rearing habitat is often of most limited occurrence during the winter months. Rearing habitat was defined as mainstream or side channel habitat areas containing undercut banks (Bustard and Narver 1975a), unembedded cobble or boulder substrate (Chapman and Bjornn 1969), or woody debris (Bustard and Narver 1975b), with adjacent water velocities <0.15 m/sec (0.5 ft/sec) (Bustard and Narver 1975a, Contor 1989) and a water depth > 0.2 m (0.7 ft).

4.2.6 Productivity

Stream primary productivity was determined through evaluation of periphyton accumulation. Procedures were based on techniques 1003C and 1002G for analysis of periphyton samples for chlorophyll and biomass as presented in the 18th Edition of Standard Methods for the Examination of Water and Wastewater (APHA 1992). Sample sites were located in each stream reach and estimates of the chlorophyll:biomass ratio (Autotrophic Index), percent organic accumulation, and percent chlorophyll_a were used in the evaluation.

Secondary productivity was assessed through evaluation of the composition, abundance, and distribution of benthic macroinvertebrate populations within the stream. Sample sites were located in the lower end of each stream reach. Three samples were obtained along a cross-stream transect using a 30 cm x 30 cm (12 x 12 in) Serber sampler. Specimens were preserved in a 70 percent solution of ethanol and returned to the lab for processing. Macroinvertebrate taxa were enumerated and identified to the lowest practical taxonomic unit. Shannon's Diversity Index (SDI) was calculated to determine invertebrate species diversity (Schemnitz 1980).

4.3 Fish Populations

The fish population assessment consisted of four components:

- an evaluation of trout abundance and habitat utilization;
- an assessment of age, growth, and mortality;
- a determination of the genetic composition of rare fish populations (westslope cutthroat and bull trout); and
- an assessment of fall, adfluvial trout spawning activity (bull and brown trout).

4.3.1 Abundance and Habitat Utilization

Trout populations were assessed using a combination of electrofishing and snorkeling techniques. Electrofishing techniques were used only on reasonably accessible tributary reaches. Estimates of

fish populations and species composition based on electrofishing were obtained using a multiple-pass removal method adopted by MDFWP (Shepard and Graham 1983b). Captured fish were measured, weighed, and identified to species prior to release. Scale samples were obtained from a representative sample of each species to determine age and growth characteristics. Standing stock for bull, westslope cutthroat, eastern brook, and brown trout were estimated as outlined in Hankin and Reeves (1988).

Snorkel count estimates of fish abundance were conducted in all surveyed stream reaches by divers trained in underwater census techniques (Platts et al. 1983; Schill and Griffith 1984). Samples were obtained at night with divers moving in an upstream direction. A single pass was conducted for each sample. Sampling was not attempted if visibility was less than 2 m (6.5 ft). Fish were counted, identified to species, and classified according to habitat selection. Initial population estimates were based on the total snorkel counts.

To address logistical problems and sampling bias associated with using a combination of electrofishing and snorkeling techniques, both methods were used on accessible tributary reaches. The results were compared and correlations between the two techniques were developed (Hankin and Reeves 1988). The resulting correlations were then used to adjust snorkel count estimates to a comparable standard at study sites where it was not possible to electrofish.

During the early phases of the study in 1992, fish densities calculated as fish/m^2 of wetted habitat were strongly influenced by stream flow. Variable stream flows during spring, summer, and fall resulted in changes in stream area estimates, and therefore fish densities, but with no corresponding change in fish abundance. Because of this, fish density estimates are presented as fish/m of stream length. The conventional fish/m^2 data have also been included in the data set to facilitate comparison with other studies.

4.3.2 Age, Growth and Mortality

Scale samples and associated fish lengths were obtained from westslope cutthroat, brook, brown, and bull trout collected during electrofishing. Scale samples were taken from between the dorsal fin and lateral line (Neilson and Johnson 1983). Scales were pressed on glass or acetate slides and the

impressions were viewed on a microfiche reader for aging purposes. Distances between the focus and annulus were measured to compute age at length. A direct relationship between scale and body growth throughout the life of a fish was assumed (Everhart and Youngs 1981, Nielson and Johnson 1983). Growth rates were compared among streams in the drainage and to other systems in the region.

Instantaneous mortality (Z) was determined for trout sampled in adequate numbers and was evaluated using catch curves (Ricker 1975). Catch curves were constructed by graphing the natural log (ln) of the catch as a function of age, and instantaneous mortality was then estimated by the absolute value of the slope of the descending right limb. Instantaneous mortality was used to determine annual survival (S) and annual mortality (A) using equations from Ricker (1975).

4.3.3 Rare Fish Genetics

Hook and line, electrofishing, and concussion sampling were used to collect westslope cutthroat trout and bull trout for genetic analysis. The number of fish collected was based upon the acceptability of removing fish from the population and the level of significance believed necessary to accurately determine the genetic status of the population being sampled. Specimens were sent to the Wild Trout and Salmon Genetics Laboratory at the University of Montana for electrophoretic testing. Genetic status was determined using horizontal starch gel electrophoresis for the appropriate genetic enzymes and loci (see Appendix A).

4.3.4 Adfluvial Fish Spawning

Use of the tributary system by adfluvial stocks of brown and bull trout was evaluated through the use of redd counts in both known and potential spawning areas. Redd counts were conducted by walking and/or floating the stream section on several occasions during the fall spawning period, and were timed to theoretically allow for differentiation between bull trout and brown trout redds. The number and location of observed redds was recorded. Redd count surveys for bull trout began when maximum stream temperatures dropped below 8° C (46° F). Survey efforts then continued into the

brown trout redd counts, which began when maximum stream temperatures dropped below 3 - 5° C (37 - 41° F) and continued until spawning activity ceased.

Section 5
Results and Discussions

5.1 LCFR Tributary System Summary

5.1.1 Fish Habitat

Fish habitat in the surveyed tributaries of the LCFR consists of:

- a diverse mix of habitat types with a somewhat low pool to riffle ratio;
- a substrate composition dominated by gravel and rubble;
- generally low amounts of fine sediments;
- generally functional although altered riparian zones;
- a riparian vegetation mix consisting primarily of low and mid-cover vegetation types; and
- low amounts of large woody debris (LWD).

Approximately one-fifth of the surveyed stream channels experience intermittent flows during low water periods which, along with low habitat complexity, a lack of concealment cover and water velocity refugia, and somewhat limited availability of high quality salmonid spawning and rearing, limits the overall suitability of the tributaries for both migratory and resident salmonids.

Habitat Survey

Habitat Composition - Habitat composition in the tributaries consists of 24 percent high gradient riffle, 20 percent low gradient riffle, 18 percent pool, 18 percent run, 9 percent glide, 8 percent cascade, and 3 percent pocket water habitat types (Appendix B, Figure B-1). Major influences on habitat type composition include stream gradient, stream channel type, sivicultural practices, land-clearing, road construction, and agricultural activities.

In general, habitat in the LCFR tributaries is a fairly even mix of fast water habitat (high gradient riffle, low gradient riffle, cascade, and pocket water) (55%) and slow water habitat (pool, glide, and

run) (45%). This habitat mix and the substantial proportion of fast water habitat results primarily from the high gradient nature of the surveyed tributaries. Many are first-order, high-mountain headwater streams, and a high proportion of fast water habitat types is expected.

The average pool to riffle ratio in the tributary system is approximately 1:2. This is lower than the 1:1 pool to riffle ratio generally considered characteristic of high quality trout streams. This low pool to riffle ratio is partially a result of the high gradient nature of the drainage, however, even in the lower tributary reaches where the stream gradient is not as severe, the pool to riffle ratio remains near 1:2 because of land use activities, channel clearing, and a general lack of pool-forming materials such as LWD.

Habitat composition in the LCFR tributaries varies with stream channel type. Tributary reaches with high gradient, stable, confined, "A" type channels (Rosgen 1993) contain high amounts of cascade, high gradient riffle, and pool habitat and a low amount of glide habitat (Tukey test, $P < 0.05$) (Appendix B, Figure B-2). Reaches with intermediate gradient, unstable, moderately confined, "B" type channels contain a high amount of high gradient riffle and cascade habitat types and low amounts of glide and pocket water habitat types (Tukey test, $P < 0.05$) (Appendix B, Figure B-3). Low gradient, unstable, unconfined, "C" type channels contain a high amount of low gradient riffle and run habitat types and low amounts of cascade and pocket water habitats (Tukey test, $P < 0.05$) (Appendix B, Figure B-4). Intermediate to low gradient, very unstable, unconfined, "D" type channels contain high amounts of high gradient riffle and pool habitat types (Tukey test, $P < 0.05$) (Appendix B, Figure B-5) and no glide or pocket water habitat. Reaches with extremely low gradient, meandering, highly stable, unconfined, "E" type channels contain high amounts of glide and pool habitat types and low amounts of fast water habitat types (Tukey test, $P < 0.05$) (Appendix B, Figure B-6).

Substrate Composition - Substrate composition in the tributary system is a diverse mix of substrate size classes. Gravel and rubble are the most common substrate classes, comprising about half of the overall substrate composition (Appendix B, Figure B-7). However, in many tributaries, gravel suitable for salmonid spawning is not very abundant. Concentrations of cobble and boulder substrate materials, key components of salmonid rearing and overwinter habitat, are common substrate components in some tributaries, but their distribution is often restricted to the upper tributary

reaches. Silt, sand, and peagravel substrates, while common in a few tributary reaches or in smaller areas within a reach, are uncommon in the tributaries overall.

Surface Fines - Surface fines, while present in high amounts in some tributaries or individual reaches, are generally low or moderate in occurrence in most of the surveyed tributary reaches. Presence of surface fines averages 14 percent overall, and ranges from a low of 3 percent in the North Fork of the Bull River to a high of 30 percent in the Bull River mainstem (Appendix B, Figure B-8). Statistically significant differences in percent surface fines were found among the tributaries (ANOVA, $P < 0.001$), and also between slow water (24%) and fast water (9%) habitat types (t-Test, $P < 0.001$). For the purposes of this report, tributaries with percent surface fines less than 12 percent are considered to have relatively low amounts of surface fines while tributaries with values greater than 16 percent are considered to contain relatively high amounts. Where high levels of fine sediment do occur, it can in most cases be attributed to land use activities. High levels of fine sediment also occur naturally within the tributary system, but where natural sources exist, input into the stream is frequently compounded by ground disturbing land use activities.

Riparian Vegetation - Riparian vegetation along the tributaries, with rare exception, has been altered to some degree. However, although altered in nature, a significant portion of the riparian zones are still functional in that they continue to provide stream channel cover and bank stabilization. However, in tributary sections where the riparian zone is largely non-functional (Rock Creek, Prospect Creek, and Vermilion River) overall tributary habitat conditions are poor and fish populations generally low or non-existent.

Riparian vegetation composition along the tributaries consists primarily of grasses and forbs, riparian shrubs, riparian trees, and upland trees (Appendix B, Figure B-9). Tributary reaches can generally be classified as having one of three general riparian vegetation cover types:

- low-cover vegetation (sedge/rush and grass/forbs),
- mid-cover vegetation (riparian and upland shrub), or
- upper canopy vegetation (riparian and upland tree).

Presence of vegetative bank cover (floodplain/riparian vegetation) averages 77 percent for the tributaries, ranging from 33 percent in Rock Creek to 95 percent in the South Branch of Marten Creek (Appendix B, Figure B-10). Statistically significant differences between tributaries in the amount of vegetative bank cover were found (ANOVA, $P < 0.001$). For the purpose of this report, tributaries with vegetative bank cover values less than 64 percent are considered to have relatively low amounts of bank cover while tributaries with values greater than 90 percent are considered to contain relatively high amounts.

Large Woody Debris - Amounts of large woody debris (LWD) in the tributary system are generally quite low. Large woody debris is an important habitat component for stream channel stabilization, pool creation/structure, and salmonid concealment cover. Low levels of LWD results in loss of channel stability and reduced pool to riffle ratio, pool stability, and salmonid abundance. Length, diameter and aggregations of the LWD are important considerations.

Single pieces of LWD <3.0 m in length average 9.8 pieces/100 m of stream and range from 0.6/100 m in the Vermilion River to 37.2/100 m in the South Branch of Marten Creek (Appendix B, Figure B-11). Size distribution for LWD <3.0 m in length and with a diameter <25 cm, 25 - 60 cm, and >60 cm is 57 percent, 26 percent, and 18 percent respectively. Statistically significant differences in the amount of LWD <3.0 m were found among the tributaries (ANOVA, $P < 0.001$).

Single pieces of LWD >3.0 m in length average 11.5 pieces/100 m of stream and range from 0.4/100 m in the Vermilion River to 37.8/100 m in the North Fork of Bull River (Appendix B, Figure B-12). Size distribution for LWD <3.0 m in length and <25 cm, 25 - 60 cm, and >60 cm in diameter is 43 percent, 25 percent, and 32 percent respectively. Statistically significant differences in the amount of LWD >3.0 m were found among the tributaries (ANOVA, $P < 0.001$).

Aggregations of LWD average 1.4 aggregates/100 m of stream and range from 0.1/100 m in the Vermilion River to 6.2/100 m in the South Branch of Marten Creek (Appendix B, Figure B-13). There was no statistically significant difference in the density of LWD aggregates among tributaries (ANOVA, $P < 0.20$).

Distribution of root-wads average 2.9 root wads/100 m of stream and range from no root-wads in the North Branch of Marten Creek to 9.8/100 m in the North Fork of Bull River (Appendix B, Figure B-14). There was no statistically significant difference in the density of root-wads among tributaries (ANOVA, $P < 0.20$).

Hydrology and Water Temperature

Hydrology - Average discharge of surveyed tributaries ranged from 0.27 m^3/sec to 2.92 m^3/sec (Appendix C, Table 1). However, during many years, approximately 20 percent of the total stream length in the surveyed tributaries is dry from mid-summer through spring run-off (Appendix B, Figure B-15), and often this is occurring in the lower stream reaches.

The hydrology of streams in the tributary system is consistent with high-energy, flow-event influenced systems. A large portion of the tributaries are classified as moderate to high gradient and have a tendency to be strongly influenced by periodic high flow events. Rain-on-snow events capable of producing flows equal to or greater than spring run-off are fairly common (i.e. eight rain on snow events occurred in the Rock Creek Drainage during the winter of 1994). These high flow events contribute to channel instability through the periodic movement and shifting of stream channel components that would otherwise be considered stable.

Stream intermittency in the tributary system is a recent artifact. Interviews with long time residents of the area indicate that until the late 1950's or early 1960's many of the tributaries that are now intermittent had surface flow on a year around basis (Pratt and Huston 1993). Tributary reaches that presently experience intermittency are located in alluvial depositional areas and contain an extremely porous, unstable substrate mix. Although these substrate characteristics are typical for intermittent stream systems, they are not recent developments but represent historic and long-standing geologic conditions. Consequently, it appears that changing land use patterns (wildfire events, livestock grazing, irrigation, timber harvest, road and residence construction) or some significant geologic event have altered stream hydrology to the point that tributaries with the potential to be intermittent, have increasingly become so.

Water Temperature - Average measured water temperature in the tributary system was 6.8° C (44° F) (Appendix C, Table C-2), ranging from a minimum of -0.04° C (32° F) (Appendix C, Table C-3) to a maximum of 26.8° C (80° F) (Appendix C, Table C-4). Water temperature regimes for tributaries in the LCFR drainage are typical for the stream type and the amount of canopy cover present. Low-order streams located or originating in tributary headwaters and having significant amounts of canopy cover or ground water inflow (East Fork of Bull River, North Fork of Bull River, Middle Fork of Bull River, and Graves Creek) have fairly low temperature regimes (average <6.0° C; 43° F). Intermediate-order streams located in tributary drainage mid-reaches and having moderate amounts of canopy cover (South Fork of Bull River, East Fork of Blue Creek, Pilgrim Creek, Rock Creek mainstem, West Fork of Rock Creek, and Swamp Creek) have slightly higher water temperature regimes (average 6.0 - 7.0° C; 43 - 45° F). Large, high-order streams and rivers located in the lower sections of tributary drainages and having low amounts of canopy cover (i.e. the lower mainstems of Bull River, Elk Creek, Marten Creek, Vermilion River, and Prospect Creek) typically have the highest water temperature regimes (average >7.0° C; 45° F).

Sediment Survey

Major Stream Features - Tributaries that flow into the LCFR from the Bitterroot Mountains to the south typically contain a gravel substrate and an open and grazed riparian area in the lower tributary reaches and forested riparian area in upper reaches. The stream bank cover is usually grass and shrub mixed with scattered conifers in the lower reaches and closed-canopy, conifer forest in the upper reaches. Evidence of wildfire, riparian area roads, and timber harvest activities are frequently evident along these tributaries.

Tributaries that flow from the Cabinet Mountains to the north generally have a slightly larger cobble substrate than tributaries flowing from the south side of the drainage. The riparian zone has generally been disturbed by human activities, and is typically very open in the lower reaches and steep and erosive in the upper reaches. There are noteable differences however, with the upper reaches of the Bull River drainage and Swamp Creek flowing from within the Cabinet Mountains Wilderness Area; while Blue Creek, Graves Creek, and the Vermilion River have vehicle accessible headwater areas subject to timber harvest activities.

Spawning Area Substrate Composition - On a tributary-wide basis, areas with gravel substrates suitable for salmonid spawning generally have fine sediment in amounts that are considered at least marginally acceptable for spawning and embryo survival (Weaver and Fraley 1991). The median percent fine sediment for spawning substrate in the surveyed tributaries is 33 percent, ranging from 23 percent in the South Branch of Marten Creek to 46 percent in the West Fork of Elk Creek (Appendix B, Figure B-16). Differences among tributaries in the percentage of fine sediment in the spawning substrate are not statistically significant (ANOVA, $P < 0.50$). However, in tributaries where spawning gravels are more abundant, fine sediment is frequently present in amounts that are considered detrimental to salmonid spawning success. On the other hand, in tributaries where suitable spawning gravels are more limited in occurrence, fine sediment is typically present at acceptable to very low levels.

Predicted Embryo Survival - Based on the amount of fine sediment in the spawning areas, predicted embryo survival to emergence for westslope cutthroat trout averages 28 percent and ranges from 11 percent in the West Fork of Elk Creek to 41 percent in the South Branch of Marten Creek (Appendix B, Figure B-17). For bull trout, the average predicted embryo survival to emergence is 32 percent, ranging from 14 percent in the West Fork of Elk Creek to 46 percent in the South Branch of Marten Creek (Appendix B, Figure B-18).

Riffle Stability Index (RSI) - High RSI values (>65) indicate that a stream is experiencing substrate mobility and is unstable, mobile particle movement progressively increasing with higher RSI values. RSI values that are very low (0 to 35) indicate extreme substrate stability, boulder or bedrock channels, or previous downcutting of a channel which has already removed mobile substrate materials. RSI values between 35 and 65 usually indicate a stream where mobile particle input and transport are essentially in equilibrium.

The tributaries that flow from the Bitterroot Mountains generally have a stable, gravel substrate with low RSI values in the lower reaches; unstable, cobble dominated substrate with high RSI values in the middle and upper reaches (Appendix C, Table C-5).

The tributaries that flow from the Cabinet Mountains to the north tend to have unstable lower reaches and moderately stable upper and middle reaches. These tributaries appear to be of different

base-geology than those tributaries flowing from the south side of the drainage, and generally have high RSI values in the lower reaches, moderate RSI values in the mid-reaches, and low RSI values in the upper reaches (Appendix C, Table C-6).

Spawning Habitat Availability Habitat in the LCFR tributaries for fall-spawning salmonids is limited by a lack of suitable spawning gravels and stream intermittency. The high-energy nature of flows in the tributaries (especially in the upper reaches) frequently prevents the accumulation of suitable substrate materials in areas otherwise suitable for salmonid spawning. The most extensive spawning areas are primarily in the lower stretches of the tributaries. However, many of these areas are also subject to seasonally intermittent flows that can make them unavailable to fall-spawning salmonids.

Availability of spawning habitat in the tributaries averages 0.062 m^2/m of stream, ranging from 0.022 m^2/m in the mainstem of Marten Creek to 0.164 m^2/m in Graves Creek (Appendix B, Figure B-19). For the purpose of this report, tributaries with spawning habitat availability of less than 0.052 m^2/m of stream are considered to have relatively low amounts of spawning habitat while tributaries with more than 0.072 m^2/m are considered to have relatively high amounts.

Rearing Habitat Availability Rearing habitat for juvenile salmonids in the tributary system is restricted by a general lack of suitable concealment cover, adequate winter flows, and water velocity refugia. Correlation analysis indicates a positive relationship ($r = 0.64$) between the amount of available rearing habitat and fish abundance in the LCFR tributaries.

Availability of salmonid rearing habitat averages 0.48 m^2/m of stream, ranging from a low of 0.15 m^2/m in the Vermilion River to a high of 0.80 m^2/m in the West Fork of Elk Creek (Appendix B, Figure B-20). For the purpose of this report, tributaries with rearing habitat values less than 0.40 m^2/m are considered to have relatively low amounts of rearing habitat while tributaries with values greater than 0.56 m^2/m are considered to contain relatively high amounts.

Productivity

Primary Productivity - Primary productivity in the tributaries ranged from very low in sterile headwater streams to much higher levels in tributaries influenced by agricultural activities and human habitation. Periphyton accumulation was monitored during mid-summer for 35 days. The average autotrophic index (chlorophyll:biomass) for the tributary system is 7.62, ranging from 0.14 in mainstem Marten Creek to 22.55 in the East Fork of Bull River (Appendix B, Figure B-21). Average chlorophyll content of periphyton samples is 1.94 mg/m^2, ranging from 0.31 mg/m^2 in the mainstem of Marten Creek to 5.94 mg/m^2 in Elk Creek (Appendix B, Figure B-22). Net productivity in the tributary system averages 0.30 mg/m^2/day, ranging from 0.07 mg/m^2/day in the West Fork of Rock Creek to 0.75 mg/m^2/day in Prospect Creek (Appendix B, Figure B-23).

Secondary Productivity - Benthic macroinvertebrate populations in the LCFR tributaries consist primarily of members from the order Ephemeroptera (52%) followed by Diptera (18%) and Plecoptera (12%) (Appendix B, Figure B-24). Invertebrate densities average 642 organisms/m^2, ranging from a low of 188/m^2 in the Vermilion River to a high of 1,138/m^2 in the West Fork of Elk Creek (Appendix B, Figure B-25). Invertebrate species richness averages 18 species per surveyed tributary, ranging from 8 species in the East Fork of Blue Creek to 27 species in the West Fork of Elk Creek (Appendix B, Figure B-26). The invertebrate species diversity index (SDI) averages 2.217, ranging from 1.060 in the West Fork of Rock Creek to 2.862 in Elk Creek (Appendix B, Figure B-27).

5.1.2 Fish Populations

Abundance and Habitat Utilization Cutthroat trout, dominated by pure westslope cutthroat strain populations, are the most abundant (population estimate 69,543) of the four trout and char species evaluated (all four species are subsequently referred to as "trout", unless noted otherwise), followed by brook trout (population estimate 35,625), brown trout (population estimate 8,520) and bull trout (population estimate 5,856) (see Appendix C for confidence intervals associated with population estimates and for more detailed breakdowns of estimated fish populations).

In general, trout populations in the LCFR tributaries are limited by a combination of site specific habitat features including low habitat complexity, limited availability of suitable spawning and

rearing habitat, and stream intermittency. Tributaries with greater habitat complexity, unsedimented spawning gravels, significant amounts of LWD, unembedded cobble substrate, and adequate year-round flows have higher fish densities and a more diverse species mix than tributaries without these components. Other factors to consider include inter-species competition, water temperatures, and stream productivity.

Westslope Cutthroat Trout - Westslope cutthroat trout are the only trout species (vs. char species) native to the LCFR drainage and are widely distributed throughout the tributary system. Cutthroat trout populations consist primarily of resident life form fish, although the presence of low numbers of adult cutthroat in the reservoirs (NDT 1994, WWP 1995) indicates the existence of a small adfluvial component. Cutthroat trout densities average 0.484 fish/m of stream, ranging from 0.014 fish/m in the West Fork of Elk Creek to 1.269 fish/m in Pilgrim Creek (Appendix B, Figure B-28). Significant differences in cutthroat trout densities were found (ANOVA, $P < 0.001$), although most tributaries have fairly high densities. Densities are particularly high in mid-reach sections that are stable and contain high amounts of LWD, spawning, and rearing habitat; have moderate water temperature regimes; and low levels of fine sediment deposition and inter-species competition.

Bull Trout - Bull trout are the only char species native to the lower Clark Fork River drainage. Historically, bull trout populations are believed to have occurred in 86 percent of the tributaries (Pratt and Huston 1993) and at this time are still found in 59 percent of that habitat. Bull trout populations in the tributaries are either strictly resident in nature or contain a resident life-form component along with an adfluvial one.

Bull trout densities in the LCFR tributaries average 0.083 fish/m of stream, ranging from 0.003 fish/m to 0.284 fish/m (Appendix B, Figure B-29). Bull trout densities are highest in Graves Creek and lowest in the Bull River mainstem (Tukey test, $P < 0.05$). Bull trout densities are also generally highest in headwater reaches that are stable and contain high amounts of LWD, spawning habitat, and rearing habitat; have moderate water temperature regimes; and low levels of fine sediment deposition and inter-species competition. Bull trout are most abundant within tributary sections where either ground-water inflow is known to exist or the potential for ground-water influences is very good.

Brown Trout - Brown trout are not native to the LCFR drainage and were first introduced in the late 1940's. At present, brown trout occur in 75 percent of the surveyed tributaries and are predominately adfluvial in nature. Brown trout densities average 0.092 fish/m of stream, ranging from 0.006 fish/m in Graves Creek to 0.262 fish/m in Elk Creek (Appendix B, Figure B-30). Densities are greatest in lower, moderately stable tributary reaches that contain high amounts of LWD, spawning habitat, and rearing habitat; have warm water temperature regimes; and low levels of fine sediment deposition.

Brook Trout - Brook trout are also not native to the LCFR drainage and were first introduced in the mid-1930's. Brook trout populations now occur in 96 percent of the tributaries and appear to consist of strictly resident life form fish. Brook trout densities average 0.293 fish/m of stream, ranging from 0.002 fish/m to 1.323 fish/m (Appendix B, Figure B-31). Statistically significant differences were found in brook trout densities in the tributaries (ANOVA, $P < 0.001$), with a fairly even split between tributaries with high brook trout densities and those with low densities. Densities are greatest in lower tributary reaches that are unstable and contain high amounts of spawning and rearing habitat; have moderate water temperature regimes; and low levels of fine sediment deposition and LWD.

Age, Growth and Mortality Age, growth, and mortality characteristics are important components to understanding the population dynamics of fish stocks. Reproductive capability, stock strength and resiliency, and the impacts of fish harvest are all closely tied to age, growth and mortality characteristics.

The growth of trout can be influenced by the amount and size of available food; the number of fish using the same resource; water temperature, dissolved oxygen, water conductivity, and total dissolved solids (TDS); and the size, age, and sexual maturity of the fish (Carlander 1969, Everhart and Youngs 1981). The growth rate for trout in the LCFR tributaries is limited by a combination of low water temperature regimes and low stream productivity.

The most favorable water temperatures for trout growth are between 7.0 and 18.0° C (44.5° F and 64.5° F) (Carlander 1969). Within this range, trout growth tends to be faster in warmer water; fish inhabiting streams with a cold temperature regime tend to grow at a slower rate than fish in streams containing warmer, yet still suitable temperatures. Typical for the region, water temperature regimes in most of the LCFR tributaries are somewhat cool, providing favorable temperatures for trout

growth only from late-May through early-September. It also appears that there are several tributaries in the drainage which are unlikely to attain temperatures much greater than 8.0° C in even the warmest years.

In addition, positive correlations between food availability and trout growth have been reported (Elliott 1985). In the LCFR tributaries, the abundance and relative quality of aquatic invertebrates as a food source for stream dwelling trout is low, and probably further limits trout growth.

Westslope Cutthroat Trout - Cutthroat trout in the LCFR tributaries frequently attain age III+, although few appear to reach age IV+ and very few age V+. No cutthroat trout were sampled that exceeded age V+. Longevity of cutthroat trout in the LCFR tributaries is relatively low when compared with other systems (Carlander 1969).

The highest rates of growth for westslope cutthroat trout in the tributaries are for age I+ fish which average 66 mm (2.6 in) in length (Appendix B, Figure B-32) and range from a low of 61 mm (2.4 in) in the Middle Fork of the Bull River to a high of 73 mm (2.9 in) in the East Fork of Blue Creek (Appendix B, Figure B-33). This growth rate is relatively low when compared with other nearby stream systems, where growth of age I+ cutthroat trout has been reported to average 86 mm (3.4 in) (Carlander 1969).

Cutthroat trout annual survival from age I+ to age V+ averages 24 percent for the tributaries, ranging from a low of 13 percent in the East Fork of Blue Creek to a high of 55 percent in the Middle Fork of the Bull River (Appendix B, Figure B-34). This is slightly higher than the 20 percent survival that was reported in Priest Lake tributaries (Carlander 1969).

Bull Trout - Bull trout populations in the LCFR tributaries consist of both adfluvial and resident life forms. Adfluvial bull trout typically rear in the tributary system until age III+ then migrate to the reservoirs where they remain until they reach maturity (Pratt and Huston 1993). After reaching maturity between age IV+ and VI+ adfluvial bull trout return to the tributaries to spawn (Pratt and Huston 1993). In contrast, resident bull trout live out their lives within the tributary system. Resident bull trout, and/or precotial (early maturing), adfluvial males in the LCFR tributaries were

seen to mature at age III+ and IV+, at an average length of 230 mm (9.2 in) and a minimum of 206 mm (8.3 in). No sexually mature female bull trout were found.

Highest rates of growth for bull trout in the LCFR tributaries are for age I+ fish, which average 72 mm (2.9 in) (Appendix B, Figure B-35) and range from a low of 65 mm (2.6 in) in the East Fork of the Bull River and West Fork of Rock Creek to a high of 84 mm (3.4 in) in Swamp Creek (Appendix B, Figure B-36). This growth is similar to that reported for other nearby systems (Carlander 1969).

Due to the adfluvial component of bull trout populations in the tributaries, bull trout survival is only estimated to the assumed age of adfluvial out-migration at age III. Because of this imposed cut-off and the low sample size of age I+ fish, the bull trout survival estimates are based on age II+ and age III+ fish. Bull trout survival from age II+ to age III+ averages 30 percent in the tributaries, ranging from a low of 17 percent in Prospect Creek to a high of 62 percent in Graves Creek (Appendix B, Figure B-37). These survival rates of are lower than the 72 percent survival reported for age III bull trout in the Priest Lake tributaries (Carlander 1969).

Brown Trout - Brown trout in the LCFR tributaries frequently attain age III+, with a few reaching age IV+, and fewer still reaching age V+. Although large, presumably older brown trout are known to enter the tributaries, none of the brown trout sampled as part of this study exceeded age V+. Longevity of brown trout in the LCFR tributaries is similar to that reported for other systems (Carlander 1969).

The highest rate of growth for brown trout in the LCFR tributaries is for age I+ fish which average 71 mm (2.8 in) in length (Appendix B, Figure B-38) and range from a low of 61 mm (2.4 in) in the East Fork of the Bull River to a high of 81 mm (3.2 in) in Marten Creek (Appendix B, Figure B-39). Growth of brown trout in the LCFR tributaries is relatively low when compared to other systems, where the average size of age I+ brown trout was reported to be 97 mm (3.9 in) (Carlander 1969).

Brown trout annual survival averages 30 percent for the LCFR tributaries, ranging from a low of 21 percent in the East Fork of the Bull River to a high of 39 percent in Swamp Creek (Appendix B, Figure B-40). This is lower than other systems, with survival of stream-dwelling brown trout in

other Montana streams reported to be 40 percent, and survival as high as 50 percent reported for the Logan River in Utah (Carlander 1969).

Brook Trout - Longevity of brook trout in the tributaries is similar to that of other systems in the region (Carlander 1969), with few exceeding age IV+ and very few reaching age V+. In general, brook trout are a short-lived species, with few fish in any system ever exceeding five years of age.

The highest rates of growth for brook trout in the tributaries is for age I+ fish which average 66 mm (2.6 in) in length (Appendix B, Figure B-41) and range from a low of 51 mm (2 in) in the North Fork of the Bull River to a high of 80 mm (3.2 in) in Marten Creek (Appendix B, Figure B-43). This is relatively low when compared with other systems, with growth rates for age I+ brook trout from other Montana streams reported to average 76 mm (3 in) (Carlander 1969).

Annual survival of brook trout in the tributaries averages 26 percent, ranging from a low of 15 percent in the East Fork of Elk Creek to a high of 42 percent in Prospect Creek (Appendix B, Figure B-43). This compares to the 21 percent survival of brook trout reported for Prickly Pear Creek, Montana (Carlander 1969).

Rare Fish Genetics

Westslope Cutthroat Trout - Since 1984, genetic analyses has been conducted on more than 50 samples of cutthroat trout collected from tributaries to Noxon and Cabinet Gorge Reservoirs. This includes 28 samples collected in 1992 through 1994 from seven tributary drainages in Cabinet Gorge Reservoir and five in Noxon Reservoir (multiple samples were collected in some drainages and additional drainages have also been sampled and analyzed in earlier work) (Pers. Comm., J. Huston 1995; MDFWP 1995; Sage 1993). Results from the 1992 - 1994 samples show pure aboriginal westslope cutthroat trout dominate the samples and are scattered throughout the LCFR tributary system. Twenty of the twenty-eight samples appear to represent pure aboriginal stock and two more had 2 percent or less foreign genes and are therefore considered pure for management purposes. Only six samples were classified as hybridized stocks containing more than 2 percent foreign genes; evidence of both Yellowstone cutthroat trout (*O. Bouvieri*) and rainbow trout (*O. Mykiss*) genetic influences were found in the hybridized samples. (Appendix C, Table C-8 and C-9).

Bull Trout - Due to the sensitive status of bull trout populations, samples for electrophoretic analysis were taken only from the East Fork of the Bull River. Results indicate that this population consists of genetically pure, aboriginal strain bull trout. The genetic composition of the bull trout population in the East Fork of Bull River has also been compared to the population in the West Fork of Fishtrap Creek, a tributary of the Thompson River which enters the Clark Fork River above the Thompson Falls Dam. Results of this comparison indicate that there is no evidence of genetic differences between these two populations (Leary 1994).

Adfluvial Fish Spawning Fall redd surveys of tributaries of Noxon and Cabinet Gorge Reservoirs have increased in scope and intensity over the past decade. Surveys are timed to differentiate between brown trout and bull trout redds, based on the generally held belief that bull trout start redd construction when stream temperatures fall to 10° C (50° F) and are finished when temperatures drop to approximately 4° C (40° C). These temperatures typically occur from late September through late October. Previous redd count surveys in the tributaries indicated that brown trout started redd construction when stream temperatures drop below 4° C (40° C). These temperatures generally occur in the tributary system during late November to mid-December. However, recent attempts to verify that redds counted during late September through late October are made by bull trout suggest that these redds may in fact have been made by brown trout; no spawning bull trout were found in the spawning areas at this time but brown trout were present.

Redd counts for brown and bull trout in the LCFR drainage can be affected by frequent high-water events. The high flows and increased turbidity associated with these events can obliterate or make it impossible to see redds. In addition, unseasonably warm or cold weather can delay or accelerate spawning thereby resulting in inaccurate counts. Because of this, the redd count data should be viewed as indicative of generalized trends and not as a complete enumeration of total spawning activity. Also, as explained above, it is possible that past redd counts have over-estimated the number of bull trout redds.

Brown Trout - Brown trout redd counts have been conducted on the Bull River mainstem and East Fork of Bull River since 1980. These counts were expanded to include Prospect Creek, Vermilion River, and mainstem of Marten Creek in 1986, and expanded again in 1993 to include the South

Fork of Marten Creek, Rock Creek mainstem, West Fork of Rock Creek, Pilgrim Creek, Elk Creek, Graves Creek, and Swamp Creek.

Between 1980 and 1985 the number of brown trout redds counted in the Bull River mainstem and East Fork averaged 58 redds per year, ranging from a low of 34 in 1980 to a high of 84 during 1982. In some of the surveyed tributaries, shelf and anchor ice was abundant in 1983 and 1984 obscuring an unknown number of redds (Huston 1985). Consequently, redd counts for the years of 1980-82 may not be directly comparable to the 1983 and 1984 counts. However, in stream sections where anchor ice was not present the number of redds counted is similar between years, possibly indicating a stable population of spawning brown trout throughout this period (Appendix C, Table C-10).

From 1986 through 1995, high flow conditions prevented conducting redd counts for brown trout during 1989, 1990, and 1995, and although counts were conducted in 1994, the count data is believed to be biased towards a lower than actual number due to high flow conditions. From 1986 through 1988, the brown trout redd count averaged 151 per year. From 1991 through 1993 the number of brown trout redds averaged 133 per year (Appendix C, Table C-10).

Bull Trout - Systematic bull trout redd counts were attempted in the LCFR tributaries for the first time in 1992, in the East Fork of the Bull River. In 1993, the redd counts were expanded to include all streams known to contain bull trout populations. During the first year (1993) of tributary-wide bull trout redd counts; 67 redds were counted. Although high flow conditions prevented accurate counts in many of the tributaries, partial counts during 1994 found 33 redds. Redd counts were not conducted during 1995 due to high flow conditions (Appendix C, Table C-11).

5.2 Mainstem of Bull River

The mainstem of the Bull River flows approximately 28 km (17.7 mi) from the southwestern slopes of the Cabinet Mountains Wilderness Area to its confluence with Cabinet Gorge Reservoir approximately 8 km (5 mi) east of Noxon, Montana (Figure 5-1). The Bull River drainage covers about 35,840 ha. Major tributary streams in the drainage include the East, North, Middle, and South Fork of Bull River. Minor tributaries include Basin, Copper, Dry, and Berray Creek. Average elevation drop for the Bull River mainstem is about 2.5 m/km. From the junction of the South Fork

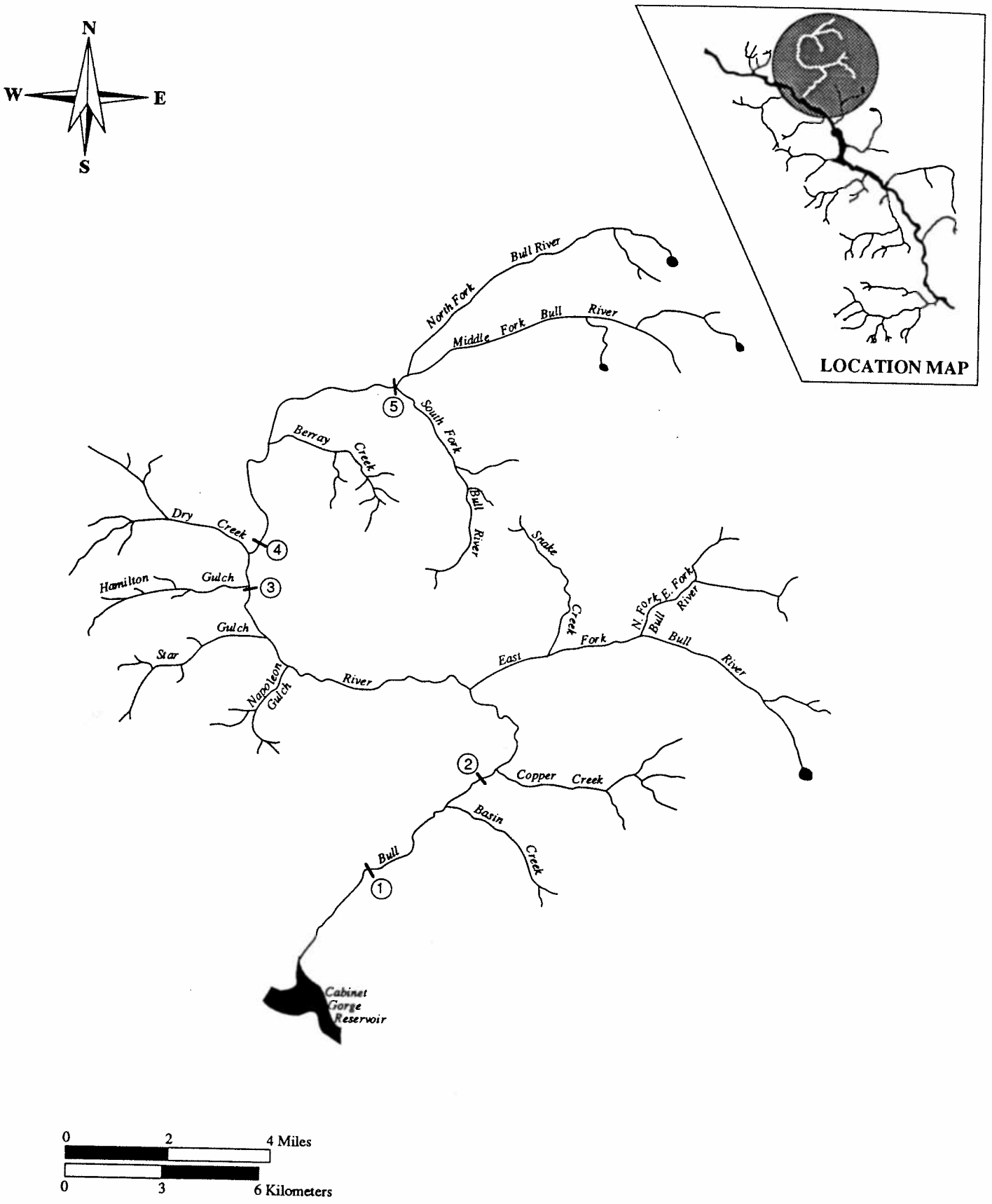

Figure 5-1. Map of the Bull River drainage showing major tributaries and reach breaks.

and North Fork downstream to the spring area near Berray Creek, the average drop is approximately 3.4 m/km; from the spring area to the mouth of the East Fork the drop is about 1.1 m/km; and from the East Fork downstream to Cabinet Gorge Reservoir about 2.4 m/km.

5.2.1 Fish Habitat

Fish habitat on the Bull River mainstem contains a fairly homogeneous mix of habitat that lacks complexity and consists primarily of glide and run habitat types. The substrate is dominated by a mix of cobble and rubble in high gradient sections and sand/silt in low gradient sections. There are high amounts of fine sediments in many areas, a functional but altered riparian zone, a riparian vegetation mix consisting primarily of low and mid-cover vegetation types, and low amounts of large woody debris.

Habitat Survey During the 1993 field season we conducted a complete "Hankin and Reeves" assessment on the Bull River mainstem from the confluence at the South Fork of Bull River (RM 17.7) to the mouth at Cabinet Gorge Reservoir. Due to the size of individual habitat units in this tributary, length data for each habitat unit was measured using a Ranging® 400 optical rangefinder.

Habitat Composition - Fish habitat on the Bull River mainstem consists primarily of glide and run habitat types. Reach one is predominately run habitat; reach two contains high amounts of run and glide habitats; reach three is dominated by glide habitat; reach four contains a mix of run, low gradient riffle, and pool habitats; and reach five is primarily pool, low gradient riffle, and run habitat types (Appendix B, Figure B-44).

When compared with the typical habitat composition mix for the LCFR tributaries, the Bull River mainstem has similar amounts of pool and pocket water habitat; higher amounts of glide and run habitat; and lower amounts of low gradient riffle, high gradient riffle, and cascade habitat types (Appendix B, Figure B-45).

Fish habitat in the Bull River mainstem is fairly homogenous and lacks complexity. Much of the homogeneity is due to a combination of the low gradient nature of the tributary and the adjacent land use practices. Low gradient tributary reaches do not usually contain much fast water habitat, but tend

instead to consist primarily of slow water habitat types. Land use activities have also contributed to habitat homogeneity on the Bull River mainstem through channel clearing, stream channelization, dredging, road construction, and riparian zone deforestation.

Substrate Composition - Overall, substrate composition in the Bull River mainstem is dominated by gravel and sand/silt (Tukey test, $P < 0.05$). In reach one, substrate is a mix of gravel, rubble, cobble, and boulder (Tukey test, $P < 0.05$). Reach two is predominately gravel and cobble (Tukey test, $P < 0.05$). Reach three contains high amounts of sand/silt (Tukey test, $P < 0.05$), introduced into the stream from the East Fork. Reach four is predominately gravel (Tukey test, $P < 0.05$), and reach five contains a high percentage of rubble (Tukey test, $P < 0.05$) (Appendix B, Figure B-46). When compared with the tributary average, substrate in the Bull River mainstem consists of relatively high amounts of sand/silt; similar amounts of bedrock, peagravel, and gravel; and low amounts of cobble and boulder (Appendix B, Figure B-47).

Surface Fines - The occurrence of surface fines in the Bull River mainstem average 30 percent, and is greatest in reach three (Tukey test, $P < 0.05$) (Appendix B, Figure B-48), largely due to input from the East Fork. Relative to the tributary average, occurrence of surface fines in the Bull River mainstem is high. The percent surface fines is also significantly different (t-Test, $P < 0.001$) between slow (39%) and fast water habitat types (25%).

Riparian Vegetation - Along the Bull River mainstem, the riparian vegetation zone has been altered in reaches one, two, three, and four through a variety of land use activities. These activities have produced a homogeneous riparian zone dominated largely by grass/forbs. Reach five is relatively undeveloped and contains a fairly intact and functional riparian zone containing a well established and more natural vegetation mix.

The riparian vegetation along the Bull River mainstem consists primarily of grass/forbs (Tukey test, $P < 0.05$), with riparian shrub also common. Riparian vegetation in reach one and two is predominately grass/forbs (Tukey test, $P < 0.05$). Reach three and four are dominated by grass/forbs and riparian shrub (Tukey test, $P < 0.05$). Reach five contains a high amount of riparian shrub (Tukey test, $P < 0.05$) (Appendix B, Figure B-49).

When compared with the average riparian vegetation mix for the LCFR tributaries, the Bull River mainstem contains similar amounts of sedge/rush and upland shrub; higher amounts of grass/forbs and riparian shrub; and lower amounts of riparian tree and upland tree (Appendix B, Figure B-50).

The presence of vegetative bank cover (floodplain/riparian vegetation) along the Bull River mainstem averages 82 percent, ranging from 65 percent in reach five to 99 percent in reach two (ANOVA, P <0.10) (Appendix B, Figure B-51). The amount of vegetative bank cover for the Bull River mainstem is fairly moderate when compared with the tributary average.

Large Woody Debris - Within the Bull River mainstem, amounts of large woody debris <3.0 m in length and >3.0 m in length, and root-wads, are lower than the average for the LCFR tributaries and materials are largely restricted to the upper tributary reaches (Appendix B, Figure B-52). Numbers of LWD aggregates are moderate when compared with the average for the LCFR tributaries, and are also found predominately in the upper tributary reaches. LWD is uncommon in the lower tributary reaches due to a lack of LWD input from adjoining stream banks and the inability of the lower reaches to retain LWD during high run-off flows.

Single pieces of LWD <3.0 m in length average 1.45 pieces/100 m of stream and range from 0.65/100 m to 3.24/100 m. Among reaches in the Bull River mainstem, occurrence of LWD <3.0 m in length is relatively high in reach five and relatively low in reaches one, two, and three (Appendix B, Figure B-53). Size distribution of LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 64 percent, 30 percent, and 6 percent respectively.

Single pieces of LWD >3.0 m in length average 2.03 pieces/100 m and range from 0.22/100 m to 6.49/100 m. Occurrence is highest in reach four and much lower in reaches one, two, and three (Appendix B, Figure B-54). Size distribution of LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 69 percent, 16 percent, and 15 percent respectively.

Aggregations of LWD average 0.32 aggregates/100 m and range from 0.02/100 m to 0.96/100 m. The number of aggregates/100 m is highest in reaches four and five, and much lower in reaches one, two, and three (Appendix B, Figure B-55).

The distribution of root-wads average 0.26 root-wads/100 m and range from 0.04/100 m to 0.70/100 m. The number of root-wads/100 m is highest in reaches four and five, and lowest in reaches one, two, and three (Appendix B, Figure B-56).

Hydrology and Water Temperature The hydrology of the Bull River mainstem is characteristic of larger streams in the LCFR drainage that are subject to periodic high flow events and are not subject to intermittent flow patterns. The water temperature regime in the Bull River mainstem is relatively high compared to the other tributaries, but generally does not exceed levels suitable for salmonids.

A large spring area in Bull River mainstem lies upstream from Beray Creek and influences both mainstem discharge and water temperatures most of the year. Estimates indicate that these springs provide between 25 to 50 percent of the flow in the Bull River mainstem during average and low flow periods. Fairly constant water temperatures of 10°-11° C have been measured in these spring areas during spring, summer, and fall.

Hydrology - During 1994, discharge in the Bull River mainstem measured periodically at RM 8.3 averaged 2.8 m^3/sec, ranging from 0.6 m^3/sec during September to 4.7 m^3/sec during April (Appendix C, Table C-1).

Water Temperature - Water temperatures measured at RM 8.3 during 1994 averaged 7.2° C (Appendix C, Table C-2), ranging from a minimum of -0.37° C in November (Appendix C, Table C-3) to 17.4° C in May (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 10.2° C, ranging from 5.7° C to 17.4° C; in summer (June - August), temperatures averaged 11.1° C, ranging from 2.9° C to 13.1° C; during fall (September - November), they averaged 4.6° C, ranging from -0.37° C to 7.8° C; and in the winter months (December - February), water temperatures averaged 2.8° C, ranging from -0.7° C to 3.4° C.

Sediment Survey

Major Stream Features - Conducted in November 1994, the survey of major stream features in the Bull River mainstem extended from the stream mouth at Bull River Bay upstream to the confluence of the North and Middle Forks of the Bull River. Reach one is a B-3c channel type and extends from

the mouth to approximately the meander near section 35 (RM 1.4). Reach two is a C-3 channel type and extends upstream to near Copper Creek (RM 5.7). Reach three is an E-6 channel type and extends upstream to approximately Hamilton Gulch (RM 15.9). Reach four is a C-3 channel type and is located between Hamilton Gulch and the confluence of Dry Creek (RM 16.4). Reach five is an E-6 channel type and extends from Dry Creek to the middle of section 16. Reach six has both C-3 and E-6 channel type characteristics, and extends to the confluence of the North and Middle Forks (RM 17.7). For the purpose of the habitat survey reach six is combined with reach five.

Reach one is characterized by an entrenched, stable channel with boulders scattered throughout. A few residential dwellings exist along the banks of this reach, located on a bench overlooking the stream. Little or no LWD or spawning gravel is present. This reach has no undercut banks, approximately 2 percent eroding banks, and a width to depth ratio of 19. The riparian area is fairly dry, with scattered, open-spaced conifers.

Reach two is characterized by a meandering stream in an unforested riparian zone consisting mostly of shrubs and grasses and experiencing some horse and cattle grazing. A few dwellings along with associated roads and a bridge for the Solid Rock Church lie within the riparian zone This reach has no undercut or eroding banks and a width to depth ratio of 35. Some spawning gravels and low amounts of LWD are present in the channel.

Reach three is characterized by a slow flowing, meandering stream channel with stable banks consisting of dirt and gravels. The riparian zone is non-forested containing primarily sedges and grasses. This reach is relatively deep compared to the other tributaries, and has low amounts of spawning gravels, no undercut bank, 3 percent eroding banks, and a width to depth ratio of nine. Large woody debris is virtually non-existent with no available streamside sources within the reach.

Reach four is a short reach characterized by a stable meandering river channel through an open flood plain. The riparian zone is mostly grazed fields and open forest with several dwellings near the banks. This reach has 7 percent undercut banks, 2 percent eroding banks, and a width to depth ratio of 26. Spawning gravels and LWD uncommon.

Reach five is characterized by a slow flowing, meandering stream channel with stable banks consisting of dirt and gravels. This reach has a non-forested riparian zone dominated by sedges and grasses and is also fairly deep with low amounts of spawning gravels, 5 percent undercut bank, 1 percent eroding bank, and a width to depth ratio of 10. Large woody debris in this section is non-existent with no available streamside sources.

Reach six has a channel configuration containing the characteristics of both E-6 and C-3 channel types. Because of this, reach six is combined with reach five for the purposes of the habitat survey. Reach six contains a forested riparian area characterized by a canopy of mature cedar trees with stumps from an old riparian area timber harvest and a cobble substrate with low amounts of spawning gravel and fairly stable banks. The width to depth ratio is 22. Noticeable cobble movement has occurred in this reach, with deposits being concentrated behind instream obstructions. Large woody debris is found primarily in debris jams, and provides most of the habitat complexity in this reach.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the Bull River mainstem is 40 percent, ranging from 30 percent to 46 percent (Appendix B, Figure B-57). The median percent fine sediment for spawning substrate in the Bull River mainstem is higher than the overall average for the LCFR tributaries. Fine sediment deposition is highest in areas immediately below the confluence of the East Fork, including at the old county bridge site (RM 9.2) and the Vetters property (RM 7.8), and much lower at the Solid Rock Church (RM 4.7) and Scott's Crossing (RM 14.4) sites.

Predicted Embryo Survival - Predicted embryo survival to emergence for cutthroat trout in the Bull River mainstem is 19 percent, ranging from 10 to 32 percent (Appendix B, Figure B-58). For bull trout, predicted embryo survival to emergence is 22 percent, ranging from 13 to 36 percent (Appendix B, Figure B-59). When compared to the LCFR tributary average, predicted embryo survival to emergence for cutthroat and bull trout in the Bull River mainstem is relatively low. Predicted survival for cutthroat and bull trout embryo is best at the Scott's Crossing site and the Solid Rock Church site and poor for the areas located at the old county bridge and Vetters property sites. At present, these latter two spawning areas are principally utilized by brown trout and a predictive equation for embryo emergence is not available for this species.

Riffle Stability Index (RSI) - The Bull River mainstem is a larger, 5th order system with five surveyed channel reaches, but only reaches two and four have channel and substrate characteristics consistent with RSI criteria. RSI values range from 23 to 77.

Reach two is stable and is influenced by gravel movement and deposition from the upper reaches. Reach two is a C-3 channel type and contains one surveyed RSI site. The Wolman particle distribution in the riffles is 5 percent sand, 19 percent gravel, 68 percent cobble, and 9 percent boulder, while the mean grain size of the mobile particles is 63 mm. The RSI value for reach two is 23.

Reach four is a short reach, and has mobile gravels and cobbles but the substrate of the riffles is fairly stable. Reach four is a C-3 channel type and contains one surveyed RSI site. The Wolman particle distribution in the riffles is 38 percent gravel, 59 percent cobble, and 3 percent boulder while the mean grain size of the mobile particles is 96 mm. The RSI value for reach four is 59.

Spawning Habitat Availability There are an estimated 1,037 m^2 of suitable spawning habitat in the Bull River mainstem for fall-spawning salmonids. This equates to 0.038 m^2/m of stream length and about 0.2 percent of the total stream area. When compared with the average for the LCFR tributaries, the amount of spawning habitat per meter of stream is relatively low, but this habitat can still accommodate an estimated 288 adfluvial, or 648 resident, trout redds.

Rearing Habitat Availability There are approximately 8,187 m^2 of salmonid rearing habitat in the Bull River mainstem. This equates to 0.300 m^2/m of stream length and about 1.4 percent of the total stream area. When compared with the average for the LCFR tributaries, the amount of available rearing habitat per meter of stream is relatively low but the total area relatively high.

Productivity

Primary Productivity - We monitored periphyton accumulation in the Bull River mainstem over a 35 day period. The average autotrophic index is 11.22, ranging from 0.26 to 52.82, average chlorophyll content is 2.40 mg/m^2, ranging from 0.11 mg/m^2 to 4.94 mg/m^2, and net productivity averages 0.61 $mg/m^2/day$, ranging from 0.22 $mg/m^2/day$ to 1.56 $mg/m^2/day$. When compared with

the average for the tributaries, the autotrophic index, chlorophyll content, and net productivity in the Bull River mainstem is relatively high.

Secondary Productivity - Benthic invertebrate populations in the Bull River mainstem consist primarily of members from the order Ephemeroptera (69%), followed by Diptera (13%), and Coleoptera (10%) (Appendix B, Figure B-60). Invertebrate densities average 821/m^2 and range from 77/m^2 in reach one to 1,698/m^2 in reach five (Appendix B, Figure B-61). Aquatic invertebrate samples were not available from reach three, and the differences in invertebrate densities among reaches were not statistically significant (ANOVA, $P < 0.20$). Invertebrate species richness averages 15 species per reach, ranging from a low of 10 in reach one to a high of 20 in reach four (Appendix B, Figure B-62). The invertebrate species diversity index (SDI) is 2.327, ranging from 1.548 in reach five to 2.159 in reach four (Appendix B, Figure B-63). Compared to the LCFR tributary averages, invertebrate densities and species richness in the Bull River mainstem are relatively high and SDI is similar.

5.2.2 Fish Populations

Compared to the LCFR tributary average, fish densities in the Bull River mainstem are similar for westslope cutthroat trout, and relatively low for bull trout, brown trout, and brook trout (Appendix B, Figure B-64). Species composition and abundance varies among reaches. In general, trout populations in the Bull River mainstem are limited by a combination of low amounts of LWD, somewhat limited availability of suitable spawning and rearing habitat, and low habitat complexity.

Abundance and Habitat Utilization Single-pass snorkel-count population estimates were conducted in all reaches and habitat types found in the Bull River mainstem. An estimated 11,901 westslope cutthroat, 5,092 brook, 446 brown, and 79 bull trout were present (Appendix C, Table C-12). Average fish densities are high for cutthroat trout (0.421 fish/m of stream) and brook trout (0.180 fish/m) (Tukey test, $P < 0.05$), followed by brown trout (0.016 fish/m), and bull trout (0.003 fish/m) (Appendix C, Table C-13).

Westslope Cutthroat Trout - Westslope cutthroat trout are found throughout the Bull River mainstem and are the most abundant trout species in all the surveyed reaches. Cutthroat trout

densities average 0.421 fish/m of stream, ranging from 0.147 fish/m in reach two to 0.597 fish/m in reach five (Appendix C, Table C-13). While statistically significant differences in cutthroat trout densities were found between tributary reaches (ANOVA, P <0.001), the data set is insufficient to characterize (ie. high or low) the differences (Tukey test, inconclusive).

Comparison of cutthroat trout densities among habitat types within the surveyed reaches show relatively high numbers in pocket water and pool habitat types and relatively low numbers in glide habitat, although the differences were not found to be statistically significant (ANOVA, P <0.50) (Appendix C, Table C-14 and C-15).

Bull Trout - Bull trout are the least abundant of the four trout species in the Bull River mainstem, and were found only in reaches one and two (Appendix C, Table C-12). Bull trout densities average 0.013 fish/m for the two reaches, ranging from 0.008 fish/m in reach one to 0.015 fish/m in reach two (Appendix C, Table C-13), although the difference between the two reaches were not found to be statistically significant (t-Test, P <0.57).

Compared among different habitat types, bull trout densities in the Bull River mainstem are relatively high in low gradient riffle and pocket water habitat and relatively low in run habitat. The differences were not found to be statistically significant (ANOVA, P <0.20) (Appendix C, Table C-14 and C-15).

Brown Trout - Brown trout are found in reaches one, two, three, and four, where they are the third most abundant salmonid (Appendix C, Table C-12). Brown trout densities average 0.016 fish/m of stream, ranging from 0.011 fish/m in reach one to 0.033 fish/m in reach four (Appendix C, Table C-13), although the differences among tributary reaches are not statistically significant (ANOVA, P <0.50).

Compared among habitat types within the stream, brown trout densities are relatively high in pool habitat types and relatively low in glide and run habitat types (Appendix C, Table C-14). Although the differences are statistically significant (ANOVA, P <0.001), the data set is insufficent to statistically characterize them (Tukey test is inconclusive) (Appendix C, Table C-15).

Brook Trout - Brook trout are found throughout the Bull River mainstem and are the second most abundant of the four trout species (Appendix C, Table C-12). Brook trout densities average 0.180 fish/m of stream, ranging from 0.072 fish/m in reach two to 0.306 fish/m in reach four (Appendix C, Table C-13). Brook trout densities are high in reach four and low in reaches one, two, and three (Tukey test, $P < 0.05$).

Compared among habitat types, brook trout densities are relatively high in pocket water habitat and low in glide habitat (Appendix C, Table C-14, C-15). Although statistically significant differences in the distribution of brook trout among habitat types were found (ANOVA, $P < 0.001$), the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive).

Age, Growth and Mortality Fish population estimates in the Bull River mainstem were obtained by snorkeling. As a result, fish scale samples and fish lengths were not available for age and growth or length frequency analyses.

Rare Fish Genetics Given sample sizes of at least 25 fish from Berray Creek, fish from the Bull River mainstem were not available for electrophoretic testing. However, samples of cutthroat trout were obtained in 1992 from the mainstem tributaries of Copper Creek, Berray Creek, Dry Creek, Napoleon Gulch, Hamilton Gulch, and Star Gulch. Electrophoretic analysis showed alleles at the diagnostic loci characteristic of only westslope cutthroat trout (no evidence of hybridization) for the Berray Creek, Dry Creek, Napoleon Gulch, Hamilton Gulch, and Star Gulch samples (Sage 1993). The Copper Creek sample showed evidence of hybridization.

Hamilton Gulch, and Star Gulch, there is a 95 percent probability of detecting as little as one percent rainbow trout genes and better than 99 percent probability of detecting one percent Yellowstone cutthroat trout genes. Because no such variations were found, these populations have been classified as genetically pure, aboriginal westslope cutthroat trout (Sage 1993).

Due to the smaller sample sizes from the cutthroat trout populations in Dry Creek and Napoleon Gulch, it isn't possible to exclude the possibility that the populations may contain as much as 4.1 percent and 2.2 percent rainbow trout, or 2.0 percent and 1.2 percent Yellowstone cutthroat trout genes, respectively, that went undetected. Consequently, these populations could be "slightly"

hybridized with other taxa, but for management purposes they are currently being considered as pure strain, aboriginal westslope cutthroat trout (Sage 1993).

In the Copper Creek cutthroat trout sample, the IDDH*100 and mMEP-1*null variants were found and are characteristic of both Yellowstone cutthroat and rainbow trout. As a result, although the Copper Creek population shows evidence of hybridization, it could not be determined which taxa have contributed to it. Although slightly hybridized, this population is still considered to be pure westslope cutthroat for management purposes (Sage 1993).

Adfluvial Fish Spawning Annual redd counts for fall-spawning trout have been attempted on the Bull River mainstem for brown trout since 1980 and for bull trout since 1993. Redd counts were not conducted on the Bull River mainstem during 1989, 1990, and 1995 due to high flow conditions. Although conducted, weather conditions also prevented completion of the 1992 and 1994 counts. The surveyed river section begins near the confluence of the East Fork and proceeds downstream to the McDowell Bridge area. When possible, redd counts are conducted by floating the stream section in a small boat. Where stream conditions prevent floating the river, the redd counts are obtained by walking through the major spawning areas. Areas typically walked include from the East Fork confluence downstream approximately 0.8 km through the spawning area located on the Vetters property and from the mouth of Copper Creek downstream to the McDowell Bridge. These sections typically contain approximately 70 percent of the total number of redds counted in a given year (Huston 1992).

Brown Trout - The Bull River drainage is the major spawning area for brown trout in Cabinet Gorge Reservoir. Concern over mining activities in the drainage prompted redd surveys in the major brown trout spawning areas starting in 1980. Since then, the average number of brown trout redds counted in the Bull River mainstem has increased substantially. For the years between 1980 and 1985 the number of redds counted averaged 36 per year, ranging from a low of 10 in 1980 to a high of 53 in 1984. For the time period between 1986 and 1993, redd counts in the mainstem averaged 84 per year, ranging from a low of 64 in 1986 to a high of 95 during 1988 (Appendix C, Table C-10).

Brown trout redds have been found in both mid-channel areas with no readily available fish cover and along shorelines with cover readily available. Water depths over redds varies from a few inches

to as much as 5 feet while water velocities vary from 0.1 feet per second to 2.8 feet per second. No redds have been found in areas where water velocities are sufficient to cause surface disturbances (i.e. riffles with wave action) (Huston 1985).

Bull Trout - Although the 1994 bull trout redd counts were incomplete, the partial count in 1994 was higher than the total 1993 count (Appendix C, Table C-11). As noted earlier however, attempts in 1993 and 1994 to confirm that bull trout were present during the redd count period redds found only brown trout in the spawning areas.

5.3 East Fork of Bull River

The East Fork of Bull River flows approximately 10.0 km (6.3 miles) from Saint Paul Lake in the Cabinet Mountains Wilderness Area to its confluence with the Bull River mainstem (Figure 5-2). The East Fork drainage covers approximately 7,122 ha. Minor tributaries include Snake Creek, Lost Girl Creek, North Fork of the East Fork, Isabella Creek, and Placer Creek. Average elevation drop in the East Fork is about 35 m/km. In reach one, from the confluence with the Bull River mainstem to RM 1.3, average stream gradient in the East Fork is 20 m/km; for reach two (RM 1.3 to RM 2.5) the change in elevation is about 25 m/km; and in reach three (RM 2.5 to RM 5.0) the average elevation change is 49 m/km.

5.3.1 Fish Habitat

Fish habitat in the East Fork of Bull River consists of primarily high gradient riffle and pool habitat types; a substrate mix dominated by cobble and rubble in high gradient sections and sand/silt in low gradient sections; low amounts of fine sediment; functional although altered riparian zones; a riparian vegetation mix consisting primarily of low-cover vegetation types; and moderately high amounts of LWD.

Habitat Survey The habitat survey for the East Fork of Bull River extended from the confluence with the Bull River mainstem to a natural fish barrier located approximately 1.6 km (0.9 mi) above the Cabinet Mountains Wilderness Area boundary.

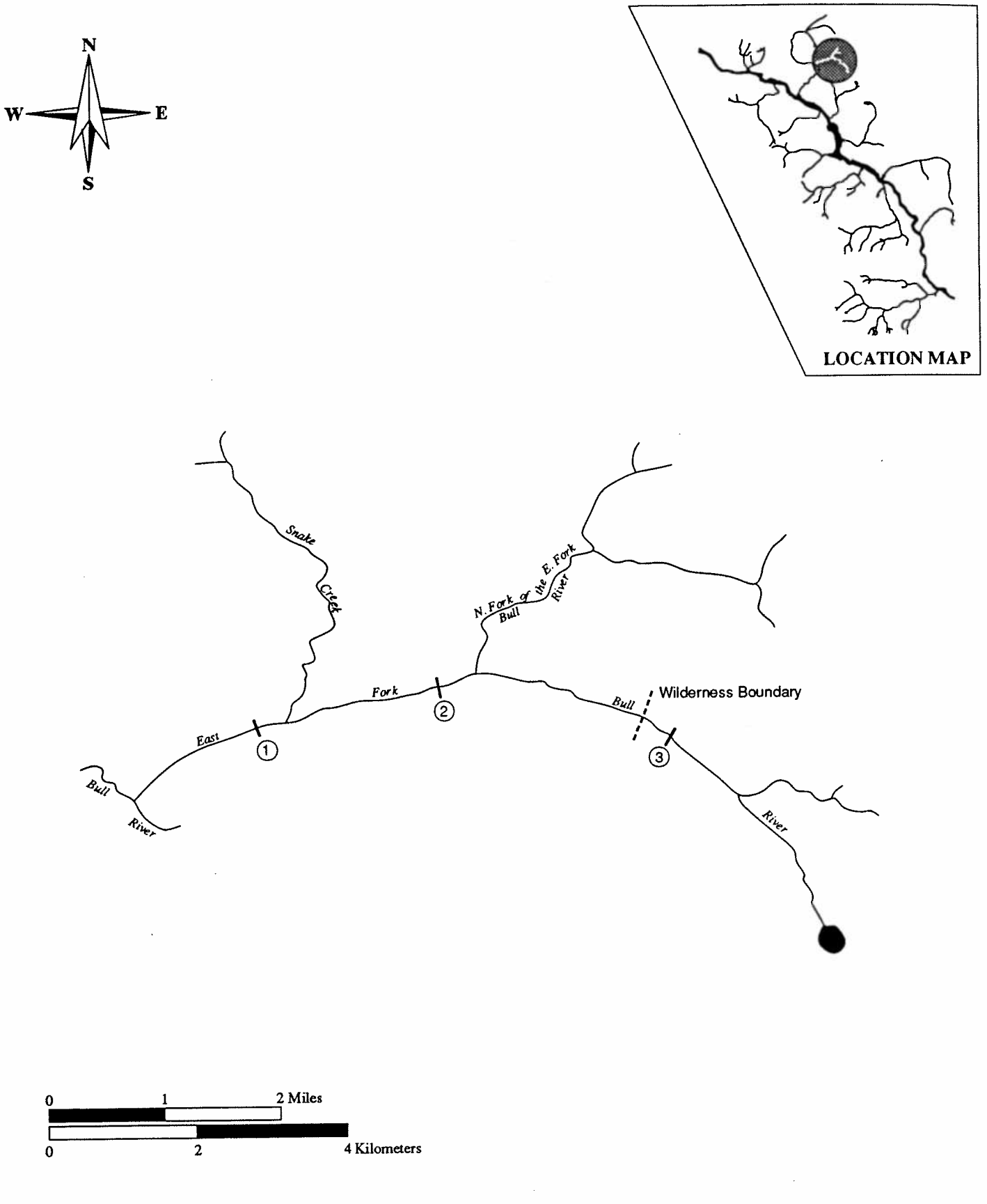

Figure 5-2. Map of the East Fork Bull River drainage showing major tributaries and reach breaks.

Habitat Composition - Fish habitat in the East Fork of Bull River consists primarily of high gradient riffle and pool habitat types. Reach one is predominately low gradient riffle, run, and pool habitat; reach two is mainly pool and high gradient riffle habitat; and reach three is dominated by high gradient riffle and pool habitat (Appendix B, Figure B-65).

When compared with the overall habitat composition mix for the LCFR tributaries, the East Fork of the Bull River has similar amounts of run and pocket water; higher amounts of pool and high gradient riffle; and lower amounts of glide, cascade, and low gradient riffle (Appendix B, Figure B-66).

Substrate Composition - Average substrate composition in the East Fork of Bull River is primarily gravel and rubble (Tukey test, $P < 0.05$), with all three reaches containing high amounts of these materials (Tukey test, $P < 0.05$) (Appendix B, Figure B-67). Substrate composition does vary slightly among and within the tributary reaches, being dominated by cobble and rubble in high gradient areas and sand/silt in low gradient areas. When compared with the average substrate composition for the LCFR tributaries, the East Fork of the Bull River contains similar amounts of peagravel, rubble, cobble, boulder, and bedrock; relatively high amounts of gravel; and relatively low amounts of sand/silt (Appendix B, Figure B-68). Reach one contains the highest amounts of fine sediment in the East Fork as a result of input from Snake Creek.

Surface Fines - Surface fines in the East Fork of Bull River average 8 percent occurrence, ranging from 7 percent to 11 percent. Occurrence is high in reaches one and two (Tukey test, $P < 0.05$) (Appendix B, Figure B-69), and was significantly different (t-Test, $P < 0.001$) between slow (10%) and fast water (7%) habitat types. Occurrence of surface fines in the East Fork is lower than the average for the LCFR tributaries, and is most common in the section below the confluence of Snake Creek.

Riparian Vegetation - Riparian vegetation along the East Fork of Bull River consists of a high percentage of grass/forb and sedge/rush, low-cover vegetation. Statistically significant differences in the composition of riparian vegetation was found among tributary reaches (ANOVA, $P < 0.001$), the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive). Reach one has high amounts of grass/forbes and low amounts of riparian tree and upland shrub

(Tukey test, P <0.05); reach two is primarily grass/forbs, riparian shrub, and sedge/rush (Tukey test, P <0.05); and reach three contains a high amount of sedge/rush and grass/forbs (Tukey test, P <0.05) (Appendix B, Figure B-71).

When compared with the average riparian vegetation mix for the LCFR tributaries, the East Fork contains similar amounts of grass/forbs, riparian shrub, upland shrub, and upland tree; low amounts of riparian tree; and high amounts of sedge/rush (Appendix B, Figure B-71).

The presence of vegetative bank cover along the East Fork of Bull River averages 83 percent , which is similar to the average for the LCFR tributaries. Occurrence is high in reach two (86 percent) and low in reaches three (84%) and one (77%) (Tukey test, P <0.05).

Large Woody Debris - In the East Fork of Bull River, occurrence of single pieces of LWD <3.0 m in length averages 6.08 pieces/100 m and range from 4.76/100 m in reach two to 7.86/100 m in reach one (Appendix B, Figure B-72). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 16 percent, 31 percent, and 53 percent respectively.

Single pieces of LWD >3.0 m in length average 10.46 pieces/100 m and range from 8.47/100 m in reach two to 13.23/100 m in reach one (Appendix B, Figure B-73). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 3 percent, 14 percent, and 84 percent respectively.

Aggregations of LWD average 0.50 aggregates/100 m and range from 0.30/100 m in reach three to 0.78/100 m in reach one (Appendix B, Figure B-74). The number of single pieces of LWD found in aggregations average 4.6 for the combined tributary reaches and range from 3 to 6 pieces/aggregation.

The distribution of root-wads averages 3.58 root-wads/100 m of stream, ranging from 2.80/100 m in reach two to 4.96/100 m in reach one (Appendix B, Figure B-75).

In comparison to the averages for the LCFR tributaries, amounts of LWD in the East Fork are similar for LWD <3.0 m in length and for LWD aggregations; low for LWD >3.0 m in length; and relatively high for root-wads (Appendix B, Figure B-76).

Hydrology and Water Temperature The hydrology of the East Fork of Bull River is characteristic of intermediate order, mid-reach tributaries that experience periodic high flow events and are not subject to intermittent flow patterns. The water temperature regime is moderate, which is also typical for this type of LCFR tributary stream and rarely exceeds levels suitable for salmonid populations.

Hydrology - During all but the driest flow periods, flows in the East Fork of Bull River are sufficient to support fish in all reaches. In 1994, tributary discharge monitored periodically at RM 0.4 averaged 1.4 m^3/sec, ranging from 0.3 m^3/sec in October to 3.4 m^3/sec during May (Appendix C, Table C-1).

Water Temperature - Water temperatures measured during 1994 at RM 0.5 of the East Fork averaged 5.6° C (Appendix C, Table C-2), ranging from a minimum of 0.4° C in October (Appendix C, Table C-3) to a maximum of 16.9° C in July (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 6.0° C, ranging from 4.9 to 7.1° C; in summer (June - August), temperatures averaged 10.2° C, ranging from 6.1 to 16.9° C; during fall (September - November), they averaged 2.8° C, ranging from 0.4 to 4.5° C; in the winter months (December - February), water temperatures averaged 3.5° C, ranging from 0.9 to 4.9° C .

Sediment Survey

Major Stream Features - Conducted in October 1994, the survey of major stream features in the East Fork extended from the confluence with the Bull River mainstem upstream to just within the Cabinet Mountains Wilderness boundary. Reach one is a C-3 channel type and extends from the mouth to RM 1.3. Reach two is a B-3 channel type and extends to just below Lost Girl Creek (RM 2.5). Reach three is an A-2 channel type and extends from below Lost Girl Creek into the Cabinet Mountain Wilderness Area (RM 5.0). Forest road 407 follows the stream up to the wilderness boundary.

Reach one is characterized by a meandering stream channel in a broad flood plain with 3 percent undercut banks, 1 percent eroding banks, and a width to depth ratio of 14. The riparian zone in the lower section of the reach consists of grass and brush while the upper section is forested. Reach one is strongly influenced by historic and ongoing land use activities, primarily grazing in the riparian zone and timber harvest. The old Forest Service Bull River Guard Station is located in the lower portion of this reach, in an area where the stream has two channels. The north channel appears artificially channelized and there are also several riparian roads and skid trails adjacent to the stream.

Reach two is characterized by a more restricted channel and a more forested riparian zone, with 8 percent undercut banks, 2 percent eroding banks, and a width to depth ratio of 15. Most of the private land near the section 5 and 6 line has been deforested and is grazed. Snake Creek provides considerable flow and input of sediment into this reach. Large woody debris is present, most often incorporated in debris jams.

Reach three has 8 percent undercut banks, no eroding banks, and a width to depth ratio of 18. The characteristics of reach three differ slightly above and below the confluence of the North Fork of the East Fork of the Bull River. The North Fork adds considerable flow to the East Fork, and appears to cause some instability in the channel below the confluence. A recent timber harvest was recently conducted adjacent to this area and firewood and/or shake logs are present in the channel. Above the North Fork confluence the stream is more pristine, flowing under a mature canopy of conifer trees with a riparian forest consisting primarily of cedar trees. Large woody debris is present in the channel providing both stability and complexity. Much of this wood is still bridging the channel and incorporated into large debris jams. Pack trail 645 follows the riparian zone within the wilderness area.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the East Fork of Bull River is 25 percent, ranging from 15 percent in reach three to 33 percent in reach two (Appendix B, Figure B-77). The median for the East Fork is lower than the average for the LCFR tributaries. Our core sampling also indicates that fine sediment input from Snake Creek is a key influence on the spawning habitat in the lower reaches of the East Fork.

Predicted Embryo Survival - Based on the fine sediment levels in the spawning substrate, predicted embryo survival to emergence for cutthroat trout in the East Fork of Bull River averages 39 percent, ranging from 28 percent in reach two to 51 percent in reach three (Appendix B, Figure B-78). For bull trout, predicted embryo survival to emergence averages 43 percent, ranging from 32 percent in reach two to 57 percent in reach three (Appendix B, Figure B-79). When compared to the average for the LCFR tributaries, predicted embryo survival to emergence for cutthroat and bull trout in the East Fork is relatively high.

Riffle Stability Index - The East Fork of the Bull River is a fourth order stream with RSI values in reaches one and two ranging from 26 to 77. The RSI values were not calculated for reach three because the channel type is inconsistent with RSI methodology criteria.

Reach one is a C-3 channel type with an average Wolman particle distribution of 4 percent sand, 27 percent gravel, 64 percent cobble, and 4 percent boulder. Mobile particle mean grain size averages 100 mm, ranging from 70 to 122 mm. The RSI values are 70, 26, and 76. Artificial channelization and other stream alterations appear to force the stream away from the old Forest Service Guard Station and into the north channel. These alterations, along with adjacent roading and riparian clearing, result in RSI values slightly lower than would otherwise be expected.

Reach two is a B-3 channel type with an average Wolman particle distribution of 3 percent sand, 17 percent gravel, 53 percent cobble, and 27 percent boulder. Mobile particle mean grain size averages 90 mm, ranging from 77 to 113 mm. Riffle Stability Index values are 45, 26, and 29. Downcutting of the channel in reach two results in the low RSI values for this reach.

Spawning Habitat Availability There are an estimated 210 m^2 of suitable habitat for fall-spawning salmonids in the East Fork of Bull River. This equates to 0.030 m^2/m of stream length and 0.6 percent of the total stream area. This habitat can accommodate an estimated 58 adfluvial or 131 resident salmonid redds. When compared with the average for the LCFR tributaries, the amount of spawning habitat per meter of stream is relatively low.

Rearing Habitat Availability There are approximately 1,471m^2 of salmonid rearing habitat in the East Fork of Bull River. This equates to 0.210 m^2/m of stream length and 4.1 percent of the total

stream area. When compared with the average for the LCFR tributaries, the amount of available rearing habitat per meter of stream in the East Fork is relatively low.

Productivity

Primary Productivity - We monitored periphyton accumulation in the East Fork of Bull River for 35 days. The average autotrophic index is 22.55, ranging from 1.35 to 118.90; average chlorophyll content is 0.89 mg/m^2, ranging from 0.09 mg/m^2 to 2.69 mg/m^2; net productivity averages 0.55 mg/m^2/day, ranging from 0.07 mg/m^2/day to 3.33 mg/m^2/day. When compared with the average for the LCFR tributaries, the autotrophic index and net productivity is relatively high, while the chlorophyll content of the periphyton samples is relatively low.

Secondary Productivity - Benthic invertebrate populations in the East Fork of Bull River consist primarily of members from the order Ephemeroptera (58%) followed by Trichoptera (12%), Plecoptera (11%), and Coleoptera (11%) (Appendix B, Figure B-80). Invertebrate densities average 606/m^2 and range from 523/m^2 in reach two to 701/m^2 in reach one (Appendix B, Figure B-81). The differences in invertebrate densities among reaches are not statistically significant (ANOVA, $P < 0.50$). Invertebrate species richness shows little variability, with 17 species in reaches two and three and 18 in reach one (Appendix B, Figure B-82). The invertebrate species diversity index (SDI) is 2.347, ranging from 1.642 in reach two to 2.31 in reach one (Appendix B, Figure B-83). Invertebrate densities, species richness, and SDI are fairly similar to the average values for the LCFR tributaries.

5.3.2 Fish Populations

Compared with the average for the LCFR tributaries, fish densities in the East Fork of Bull River are relatively high for cutthroat and brown trout, similar for bull trout, and relatively low for brook trout (Appendix B, Figure B-84). Species composition and abundance varies among reaches. In general, the trout populations in the East Fork are limited by a combination of low amounts of suitable spawning and rearing habitat and low habitat complexity.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates in the East Fork of Bull River were conducted in all reaches and habitat types. There were an estimated 5,108 westslope cutthroat trout, 547 brook trout, 609 bull trout, and 1,677 brown trout in the surveyed section of the East Fork (Appendix C, Table C-16). Fish densities are high for cutthroat (0.641 fish/m of stream) and brown trout (0.211 fish/m) and low for bull (0.076 fish/m) and brook trout (0.069 fish/m) (Tukey test, $P < 0.05$) (Appendix C, Table C-17).

Westslope Cutthroat Trout - Westslope cutthroat trout are present throughout the East Fork of Bull River, and are the most abundant trout in reaches two and three but the least abundant in reach one (Appendix C, Table C-16). Cutthroat trout densities average 0.641 fish/m of stream and range from 0.020 fish/m to 1.223 fish/m (Appendix C, Table C-17). Fish densities are high in reach two and low in reach one (Tukey test, $P < 0.05$).

Cutthroat trout densities are generally high in run, pool, and low gradient riffle habitat types; low in high gradient riffle and glide habitat types (Appendix C, Table C-18), although the differences were not shown to be statistically significant (ANOVA, $P < 0.20$) (Appendix C, Table C-19).

Bull Trout - Bull trout are also found throughout the East Fork of Bull River. They are the next to least abundant trout in reach one, the least abundant of the two species in reach three, and the least abundant trout in reach two (Appendix C, Table C-16). Bull trout densities in the East Fork average 0.076 fish/m of stream and range from 0.015 fish/m to 0.161 fish/m (Appendix C, Table C-17). Densities are high in reach three and low in reach one (Tukey test, $P < 0.05$).

With respect to habitat selection, bull trout densities are generally highest in cascade, low gradient riffle, and pool habitat types, and lowest in low gradient riffle habitat (Appendix C, Table C-18), although the differences were not found to be statistically significant (ANOVA, $P < 0.20$) (Appendix C, Table C-19).

Brown Trout - Brown trout are the most abundant trout in reach one, the second most abundant in reach two, but were not found in reach three (Appendix C, Table C-16). Brown trout densities average 0.211 fish/m of stream and range from 0.179 fish/m to 0.491 fish/m (Appendix C, Table C-17). For the two tributary reaches in which they are found, brown trout densities are high in reach

one (t-Test, P <0.009). Densities also appear high in run habitat and low in glide habitat (Appendix C, Table C-18), but the differences were not found to be statistically significant (ANOVA, P <0.50) (Appendix C, Table C-19).

Brook Trout - Brook trout are the second most abundant species in reach one, the third most abundant in reach two, and, as with brown trout, were not found in reach three (Appendix C, Table C-16). Brook trout densities in the East Fork of Bull River average 0.069 fish/m of stream and range from 0.103 fish/m in reach two to 0.113 fish/m in reach one (Appendix C, Table C-17) and the slight differences between the reaches was not statistically significant (t-Test, P <0.867).

Comparing densities in different habitat types in the East Fork, brook trout densities are relatively high in glide habitat and relatively low in run habitat (Appendix C, Table C-18, C-19), and although the differences are statistically significant (ANOVA, P <0.02), the data set is insufficent to statistically characterize the differences (Tukey test is inconclusive).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in the East Fork of Bull River is similar to the overall average for the LCFR tributaries, with the oldest fish sampled being age III+. Growth rate of cutthroat trout in the East Fork is also similar to the average for the tributaries, with age I+ fish reaching an average length of 68 mm (2.7 in) and age III+ a length of 157 mm (6.3 in) (Appendix B, Figure B-85). The instantaneous survival rate of 26 percent is also similar to the average for the tributaries.

Bull Trout - The oldest bull trout in the East Fork sample was age III+. Bull trout growth in the East Fork is relatively low when compared to the tributary average, with age I+ fish reaching an average length of 65 mm (2.6 in) and age III+ fish a length of only 147 mm (5.9 in) (Appendix B, Figure B-86). The instantaneous survival rate of age III+ bull trout is 18 percent, which is lower than the overall average for the tributaries.

Brown Trout - Longevity of brown trout in the East Fork of Bull River is considerably lower than the average for the LCFR tributaries, with the oldest fish sampled being only age II+. Growth of

brown trout in the East Fork is also low when compared to the tributary average, with age I+ fish reaching a length of 60 mm (2.4 in) and age II+ a length of 114 mm (4.6 in) (Appendix B, Figure B-87). The instantaneous survival rate of 21 percent is also lower than the average for the LCFR tributaries.

Brook Trout - Longevity of brook trout in the East Fork of Bull River is similar to the average for the LCFR tributaries with the oldest fish sampled being age III+. Growth of brook trout in the East Fork is similar to the average for the LCFR tributaries with age I+ fish reaching an average length of 59 mm (2.4 in) and age III+ averaging 153 mm (6.1 in) (Appendix B, Figure B-88). The instantaneous survival rate of 25 percent is also similar to the average for the tributaries.

Rare Fish Genetics

Westslope Cutthroat Trout - Cutthroat trout samples for genetic analysis were previously collected in 1985 from two locations in the East Fork of Bull River, near the Forest Service Bull River Guard Station (RM 0.2) and the Cabinet Mountains Wilderness boundary (RM 4.0). These samples have been classified as pure strain, aboriginal westslope cutthroat that may have been influenced by hatchery reared fish (MDFWP 1995). No physical barriers currently exist in the Bull River mainstem or East Fork of Bull River that would prevent upstream movement of cutthroat or rainbow trout stocks that could hybridize this population.

Bull Trout - Samples of bull trout were collected from the East Fork of Bull River during 1993, near the confluence of the North Fork of the East Fork. Based on fish size and sexual maturity, these samples included both resident and adfluvial life history types. Starch gel electrophoretic analysis of both types shows no genetic differences between resident and migratory fish (Leary 1994). The bull trout population in the East Fork of Bull River is considered to consist of pure strain bull trout. However, the presence of brook trout in this tributary places the bull trout population at potential risk of hybridization. The genetic composition of the East Fork bull trout population was also compared with that of the bull trout population in the West Fork of Fishtrap Creek (a tributary of the Clark Fork River located upstream of Thompson Falls, MT). The results of this comparison indicated that there are no genetic differences between bull trout in the East Fork of Bull River and those in the West Fork of Fishtrap Creek (Leary 1994).

Adfluvial Fish Spawning

Brown Trout - Brown trout spawning occurs in the East Fork of Bull River from Snake Creek downstream to the confluence with the Bull River mainstem. Brown trout spawning has also been documented in Snake Creek from below the East Fork Bull River Road crossing downstream to the East Fork confluence. From 1980 through 1982 the number of brown trout redds counted in the East Fork of Bull River, including Snake Creek, averaged 33 per year, ranging from a low of 24 in 1980 to a high of 41 redds in 1981. These counts are not comparable to the 1983 and 1984 counts because shelf and anchor ice, absent in 1980-82, was widespread in 1983-84 obscuring an unknown number of redds (Huston 1985) (Appendix C, Table C-10).

Brown trout redd counts were not conducted in the East Fork of Bull River between 1985 and 1992. Redd counts were resumed in 1993 as part of this study, with only three probable brown trout redds found in the East Fork of Bull River and none in Snake Creek. High flow conditions prevented reliable counts in 1994 and 1995.

Bull Trout - Systematic bull trout redd counts were conducted in the East Fork of Bull River for the first time in 1992. During this count, 12 redds were found between the wilderness boundary and the tributary mouth. No redds were found during the 1993 counts and no counts were conducted in 1994 and 1995 due to high flow conditions (Appendix C, Table C-11).

5.4 North Fork of Bull River

The North Fork of the Bull River flows approximately 10 km (6.3 mi) from Snowshoe Lake in the Cabinet Mountains Wilderness Area to it's confluence with the Bull River mainstem (Figure 5-3). The North Fork drainage covers approximately 2,978 ha. Minor tributaries include Verdun Creek. Average elevation drop is approximately 79 m/km. In reach one, from the confluence at the Bull River mainstem to RM 1.7, the average drop is approximately 59 m/km; in reach two (RM 1.7 to RM 2.9) the change in elevation is about 46 m/km; for reach three (RM 2.9 to RM 3.2), the stream drops approximately 40 m/km.

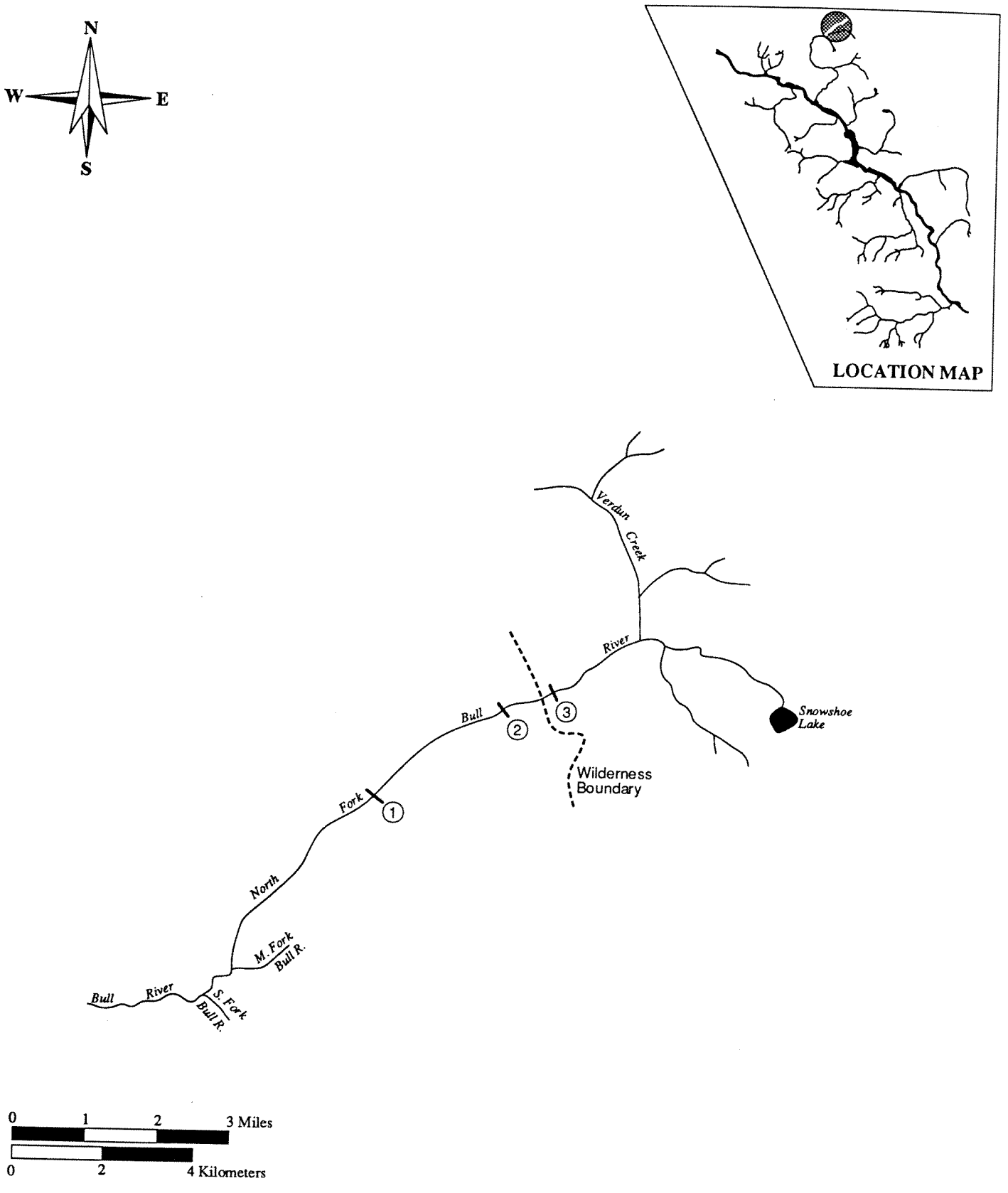

Figure 5-3. Map of the North Fork Bull River drainage showing major tributaries and reach breaks.

5.4.1 Fish Habitat

Fish habitat in the North Fork of Bull River consists of primarily cascade and high gradient riffle habitat types; a substrate mix dominated by rubble and cobble; low amounts of fine sediment; functional although altered riparian zone; a riparian vegetation mix consisting primarily of mid-cover and upper canopy vegetation types; and relatively high amounts of LWD.

Habitat Survey The habitat survey for the North Fork of the Bull River extended from the confluence with the Bull River mainstem to a natural fish barrier located at RM 3.2.

Habitat Composition - Fish habitat on the North Fork of Bull River is predominately high gradient riffle and cascade habitat types. Reach one is primarily high gradient riffle and low gradient riffle habitat; reach two is mainly cascade, high gradient riffle, and pool habitat; and reach three contains predominately cascade and pool habitat types (Appendix B, Figure B-89).

When compared with the overall habitat composition mix for the LCFR tributaries, the North Fork of the Bull River has similar amounts of pool and pocket water habitat; relatively high amounts of high gradient riffle and cascade habitats; and relatively low amounts of glide, run, and low gradient riffle habitat types (Appendix B, Figure B-90).

Substrate Composition - Substrate composition for the North Fork is predominately rubble and cobble (Tukey test, $P < 0.05$). Reach one contains high amounts of gravel (Tukey test, $P < 0.05$); and reach two and three is predominately cobble and rubble (Tukey test, $P < 0.05$) (Appendix B, Figure B-91).

When compared with the average substrate composition in the tributaries, the North Fork contains similar amounts of gravel, rubble, and bedrock; relatively high amounts of cobble and boulder; and relatively low amounts of sand/silt and peagravel (Appendix B, Figure B-92). Substrate composition varies with tributary reach, being dominated by rubble, cobble, and boulder in relatively high gradient reaches and sand/silt in low gradient reaches.

Surface Fines - Surface fines in the North Fork of Bull River average 3 percent and range from 2 percent to 6 percent (Appendix B, Figure B-93). Surface fines are highest in reach three (Tukey test, $P<0.05$). Surface fines are statistically different between slow (12%) and fast water (2%) habitat types (t-Test, $P< 0.001$). Surface fines in the North Fork are the lowest found in the tributaries.

Riparian Vegetation - Riparian vegetation on the North Fork of Bull River consists primarily of upland tree (Tukey test $P <0.05$). Reaches one and two have primarily of upland tree (Tukey test $P <0.05$); and reach three contains high amounts of riparian tree and riparian shrub (Tukey test $P <0.05$) (Appendix B, Figure B-94).

When compared with the average riparian vegetation mix for the tributaries, the North Fork contains similar amounts of upland shrub and riparian tree; high amounts of sedge/rush and upland tree; and relatively low amounts of grass/forbs and riparian shrub (Appendix B, Figure B-95).

The presence of vegetative bank cover for the North Fork of the Bull River is relatively moderate when compared with the tributary average. The presence of vegetative bank cover averages 74 percent and is highest in reach three (80%) with reduced but similar percentages in reaches two (70%) and one (68%) (Tukey test, $P <0.05$).

Large Woody Debris - In the North Fork of Bull River, single pieces of LWD <3.0 m in length average 17.62/100 m and range from 6.26/100 m in reach one to 27.99/100 m in reach three (Appendix B, Figure B-96). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 16 percent, 45 percent, and 39 percent respectively.

Single pieces of LWD >3.0 m in length average 37.81/100 m and range from 12.42/100 m in reach one to 67.47/100 m in reach three (Appendix B, Figure B-97). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 9 percent, 41 percent, and 50 percent respectively.

Aggregations of LWD average 3.07/100 m and range from 1.03/100 m in reach one to 5.93/100 m in reach three (Appendix B, Figure B-98). The number of single pieces of LWD found in aggregations average 3.4 for the combined tributary reaches and range from 3 to 4 pieces/aggregation. The

distribution of root-wads averages 9.77/100 m of stream, ranging from 3.69/100 m in reach one to 16.41/100 m in reach three (Appendix B, Figure B-99).

When compared with the average for the tributaries, LWD concentrations in the North Fork are relatively high for LWD <3.0 m in length, LWD >3.0 m in length, LWD aggregates and root-wads (Appendix B, Figure B-100).

Hydrology and Water Temperature The hydrology of the North Fork of Bull River is characteristic of low-order, headwater streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns. The water temperature regime is relatively low, which is also typical for this type of stream, and does not typically exceed levels suitable for salmonid populations.

Hydrology - During normal water years, flows are sufficient to support fish in the tributary sections above RM 0.4. Tributary sections between the mouth and RM 0.4 begin to go dry in mid-July. In 1994, tributary discharge monitored periodically at RM 0.7 averaged 0.7 m^3/sec, ranging from 0.04 m^3/sec in September to 2.9 m^3/sec during April (Appendix C, Table C-1).

Water Temperature - Water temperatures measured at RM 0.7 during 1994 averaged 5.9° C (Appendix C, Table C-2), ranging from a minimum of 2.3° C in April (Appendix C, Table C-3) to a maximum of 11.7° C in June (Appendix C, Table C-4). In the spring (March - May) water temperatures averaged 4.6° C, ranging from 2.3 to 9.0° C; in summer (June - August) temperatures averaged 8.9° C, ranging from 5.3 to 11.7° C; during fall (September - November) they averaged 6.7° C, ranging from 5.5 to 8.2° C; and in the winter months (December - February) averaged 3.4° C, ranging from 2.3 to 4.1° C.

Sediment Survey

Major Stream Features - Conducted in October 1994, the survey of major stream features in the North Fork of Bull River extended from the confluence with the Middle Fork of the Bull River to approximately the edge of section 11 (RM 0.7), then resumed at Trailhead 972 (RM 1.5) and proceeded to the upstream fish migration barrier (RM 3.2). Reach one is a C-3 channel type

extending from the confluence with the Middle Fork upstream to approximately RM 1.7. Reach two is a B-3 channel type and extends from RM 1.7 upstream to just below the Cabinet Mountain Wilderness Area boundary (RM 2.9). Reach three is an "A" channel type and extends from RM 2.9 to the fish migration barrier.

Reach one is characterized by a fairly entrenched channel with a loose cobble substrate, has relatively stable banks, a forested riparian zone, and low amounts of LWD in the channel. Old fire scarred trees, and stumps from an old timber harvest, are present in the riparian zone. This tributary has 1 percent undercut banks, 1 percent eroding banks, and a width/depth ratio of 11. Spawning gravels are generally uncommon but are more abundant below the crossing of Trail 972. The lower sections of this reach were dewatered at the time of the survey.

Reach two is characterized by a steeper, more entrenched channel that showed signs of an actively eroding channel. This reach is under a dense canopy of conifers with signs of fire and an old riparian harvest. The banks of the reach appears stable with no undercut bank, no eroding bank, and a width/depth ratio of 6. In areas of lesser gradient, bedload is deposited in piles and around the bowles of the trees. Amounts of large woody debris are low. Amounts of spawning gravels are also low and concentrated behind obstructions.

Reach three is characterized by a steep transport boulder channel under a canopy of conifers. This reach is almost entirely in the wilderness area with Trail 972 following the reach length. This reach has no undercut banks, no eroding banks, and a width/depth ratio of 7.

Spawning Area Substrate Composition - Sediment core samples were obtained only from reach one. In reaches two and three, it is not possible to obtain core samples per the sampling protocol as spawning gravels are limited to small depositional areas behind boulders and instream obstructions. The median percent fine sediment (<6.35 mm) for spawning substrate in the North Fork of Bull River is 32 percent. Fine sediment levels in spawning gravels on the North Fork are relatively moderate when compared with the median for the LCFR tributaries.

Predicted embryo survival to emergence for westslope cutthrout trout is 27 percent. If present, bull trout predicted embryo survival to emergence would be 33 percent. When compared with the tributary average, predicted embryo survival to emergence is relatively moderate for all species.

Riffle Stability Index - The North Fork of the Bull River is a third order stream with two surveyed reaches and RSI values ranging from 38 to 73. The North Fork experiences high water flows originating in the Cabinet Mountain Wilderness Area. These flashy flows downcut through reach two leaving the substrate loose and mobile with associated cobble deposition into lower tributary reaches. In reach two, gravels have aggraded and accumulated behind obstructions.

Reach one is a C-3 channel type with an average Wolman particle distribution of 2 percent sand, 19 percent gravels, 61 percent cobble, and 16 percent boulder. Mobile particle mean grain size averages 190 mm, ranging from 170 to 222 mm. The RSI values are 73, 73, and 64.

Reach two is a B-3 channel type that showed signs of downcutting through an alluvial soil. The average Wolman particle distribution is 3 percent sand, 19 percent gravels, 47 percent cobble, and 31 percent boulder. Mobile particle mean grain size averages 155 mm, ranging from 142 to 178 mm. The RSI values are 44, 38, and 65.

Spawning Habitat Availability There is an estimated 103 m^2 of suitable habitat for fall-spawning salmonids in the North Fork of Bull River. This equates to 0.024 m^2/m of stream length and 0.5 percent of the total stream area. This habitat can accommodate an estimated 29 adfluvial or 65 resident salmonid redds. When compared with the average for the LCFR tributaries, the amount of spawning habitat per meter of stream is relatively low.

Rearing Habitat Availability In the North Fork of Bull River, there is approximately 1,727 m^2 of salmonid rearing habitat. This equates to 0.400 m^2/m of stream length and 7.7 percent of the total stream area. When compared with the average for the LCFR tributaries, the amount of available rearing habitat per meter of stream is relatively similar.

Productivity

Primary Productivity - We monitored periphyton accumulation in the North Fork of Bull River for 35 days. The average autotrophic index is 1.94, ranging from 0.0 to 5.20; average chlorophyll content is 0.55 mg/m^2, ranging from 0.0 mg/m^2 to 1.57 mg/m^2; net productivity averages 0.08 mg/m^2/day, ranging from 0.0 mg/m^2/day to 0.38 mg/m^2/day. When compared with average values for the LCFR tributaries, the autotrophic index, chlorophyll content, and net productivity values are relatively low.

Secondary Productivity - Benthic invertebrate populations in the North Fork of the Bull River consist primarily of members from the order Ephemeroptera (78%) followed by Plecoptera (8%) and Trichoptera (7%) (Appendix B, Figure B-101). Invertebrate densities average 257/m^2 and range from 205/m^2 in reach three to 299/m^2 in reach one (Appendix B, Figure B-102). Invertebrate species richness for the stream was 14 species, ranging from a low of 12 in reach three to a high of 14 in reach two (Appendix B, Figure B-103). The invertebrate species diversity index (SDI) is 2.172, ranging from 1.575 in reach three to 1.855 in reach one (Appendix B, Figure B-104). Invertebrate densities and species richness are relatively low while species diversity is relatively similar to the average values for the LCFR tributaries.

5.4.2 Fish Populations

Compared with the averages for the LCFR tributaries, fish densities in the North Fork of Bull River are relatively high for cutthroat trout and low for brook trout (Appendix B, Figure B-105). In general, salmonid populations in the North Fork are limited by a combination of stream intermittency and low amounts of suitable spawning and rearing habitat. Species composition and abundance of salmonids varies among reaches. Tributary sections with relatively high amounts of unsedimented spawning gravels and unembedded cobble substrate have higher fish densities and a more diverse species mix than tributary sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all reaches and habitat types found in the North Fork of Bull River. There are an estimated 3,404 westslope cutthroat trout and 105 brook trout (Appendix C,

Table C-20) in the North Fork. Westslope cutthroat trout densities (0.667 fish/m) are significantly higher than those of brook trout (0.021 fish/m) (t-Test, P <0.001) (Appendix C, Table C-21). Although a few bull trout were found, numbers are too low to generate reliable population estimates. No brown trout were found.

Westslope Cutthroat Trout - Westslope cutthroat trout are present throughout the North Fork of Bull River and are the most abundant species in all three reaches (Appendix C, Table C-20). Cutthroat trout densities average 0.667 fish/m of stream, ranging from 0.277 fish/m in reach one to 1.239 fish/m in reach two (Appendix C, Table C-21). Although the differences in cutthroat trout densities among tributary reaches are significant (ANOVA, P<0.001), the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive).

Among habitat types, cutthroat trout densities are relatively high in pool habitats and relatively low in run and cascade habitat types (Appendix C, Table C-22). There was no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, P <0.10) (Appendix C, Table C-23).

Bull Trout - Bull trout are not present in the North Fork of the Bull River in numbers sufficient to develop a population estimate. Snorkelers found only two bull trout in the Noth Fork during three years of sampling, and it is likely that the bull trout seen here represent occassional migrants from the mainstem or South Fork of the Bull River.

Brook Trout - Brook trout are present throughout the North Fork of Bull River and are the second most abundant species in all three reaches (Appendix C, Table C-20). Brook trout densities average 0.021 fish/m of stream, ranging from 0.017 fish/m in reach two to 0.031 fish/m in reach three (Appendix C, Table C-21). There was no statistically significant difference in brook trout densities among reaches (ANOVA, P <0.50).

Among habitat types, brook trout densities are relatively high in pool habitat and relatively low in high gradient riffle habitat (Appendix C, Table C-22). There was no statistically significant difference in the distribution of brook trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-23).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in the North Fork of Bull River is similar to the average for the LCFR tributaries with the oldest fish sampled being age IV+. When compared to the average growth rate for the tributaries, growth of cutthroat trout in the North Fork is relatively moderate, with age I+ fish reaching a length of 65 mm (2.6 in) and age III+ a length of only 142 mm (5.7 in) (Appendix B, Figure B-106). The instantaneous survival rate of 22 percent is similar to the average for the tributaries.

Brook Trout - Longevity of brook trout in the North Fork is similar to the average for the LCFR tributaries with the oldest fish sampled being age III+. When compared with the average for the tributaries, growth of brook trout in the North Fork is relatively low, with age I+ fish reaching a length of 51 mm (2 in) and age III+ a length of 130 mm (5.2 in) (Appendix B, Figure B-107). The instantaneous survival rate of 29 percent is similar to the tributary average.

Rare Fish Genetics Cutthroat trout samples for genetic analysis were obtained from the North Fork of the Bull River in 1992. During electrophoretic testing, alleles characteristic of both westslope cutthroat and Yellowstone cutthroat trout were detected at three of the diagnostic loci. Because of this, the population was determined to be slightly hybridized with Yellowstone cutthroat trout but is still considered to be pure westslope cutthroat for management purposes. Yellowstone cutthroat trout were apparently introduced into the Bull River drainage and the North Fork during stocking efforts in the 1940's and 50's.

Adfluvial Fish Spawning Resident and rearing stocks of bull and brown trout are not present in the North Fork of the Bull River and fall-spawning adfluvial fish have not been observed using the tributary. Because of this, annual redd counts for adfluvial stocks of these species have not been conducted on this tributary.

5.5 South Fork of Bull River

The South Fork of the Bull River flows approximately 4.5 km (2.8 mi) from the western slopes of the Cabinet Mountains to its confluence with the Bull River mainstem (Figure 5-4). The South Fork

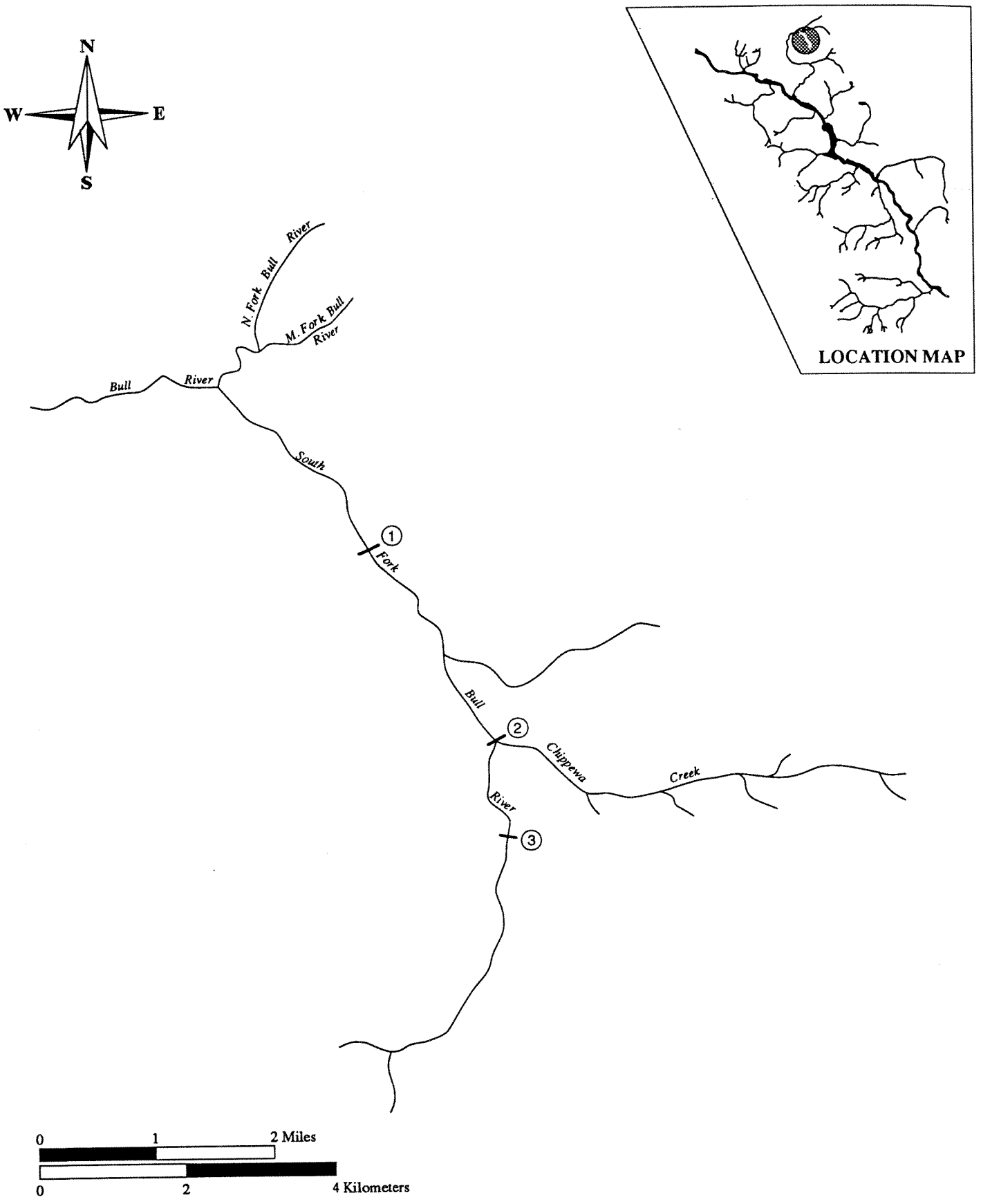

Figure 5-4. Map of the South Fork Bull River drainage showing major tributaries and reach breaks.

drainage covers approximately 3,108 ha. Minor tributaries include Chippewa Creek. Average elevation drop for the South Fork is about 36 m/km. In reach one, from the confluence with the Bull River mainstem to RM 1.2, the average drop is approximately 27 m/km; in reach two (RM 1.2 to RM 2.2) the change in elevation is about 46 m/km; and in reach three (RM 2.2 to RM 2.8) the stream drops approximately 40 m/km.

5.5.1 Fish Habitat

Fish habitat in the South Fork of Bull River consists primarily of pool, run, low gradient riffle, and high gradient riffle habitat types; a substrate mix dominated by gravel, peagravel, and rubble; low amounts of fine sediment; functional although altered riparian zones; a riparian vegetation mix consisting primarily of low- and mid-cover vegetation types; and relatively high amounts of large woody debris.

Habitat Survey The habitat survey for the South Fork of the Bull River extended from the confluence at the Bull River mainstem upstream to where normal summer flows are insufficient to support fish populations (RM 2.8).

Habitat Composition - Fish habitat in the South Fork of Bull River is predominately pool, run, low gradient riffle, and high gradient riffle habitat types. Reach one is primarily pool, low gradient riffle and run habitats; reach two is dominated by pool, cascade, and high gradient riffle habitat; and reach three is predominately pool and high gradient riffle habitat types (Appendix B, Figure B-108).

When compared with the overall habitat composition mix for the LCFR tributaries, the South Fork of the Bull River has similar amounts of run, low gradient riffle, and cascade habitats; relatively high amounts of pool habitat; and relatively low amounts of glide and high gradient riffle habitat (Appendix B, Figure B-109). Habitat composition varies with tributary reach, with the lower reaches consisting primarily of pool habitat while the upper reaches are predominately high gradient riffle.

Substrate Composition - Substrate composition in the South Fork of Bull River is predominately gravel, peagravel, rubble, and cobble (Tukey test, $P < 0.05$). Reach one contains high amounts of gravel, peagravel, rubble, and cobble (Tukey test $P < 0.05$); reaches two and three contain high

amounts of gravel (Tukey test P <0.05) (Appendix B, Figure B-110). Compared with the average substrate composition for the LCFR tributaries, percent composition in the South Fork is similar for rubble, boulder, and bedrock substrates; relatively high for peagravel and gravel; and relatively low for sand/silt and cobble (Appendix B, Figure B-111).

Surface Fines - Surface fines in the South Fork of Bull River average 9 percent and range from 8 percent in reach three to 10 percent in reach one (Appendix B, Figure B-112). Although statistically significant differences in the distribution of surface fines among reaches were found (ANOVA, P<0.05), the data set is insufficent to statistically characterize those differences (Tukey test, inconclusive). Occurrence of surface fines was not statistically different between slow (10%) and fast water (8%) habitat types (t-Test, P< 0.061). Occurrence of surface fines in the South Fork is lower than the tributary average.

Riparian Vegetation - Riparian vegetation along the South Fork of Bull River is predominately sedge/rush, grass/forbs, and riparian/shrub (Tukey test, P <0.05). Reach one contains predominately riparian shrub and grass/forbs (Tukey test P <0.05); reach two contains a high percentage of sedge/rush (Tukey test P <0.05); and reach three contains a low amount of riparian tree (Tukey test P <0.05) (Appendix B, Figure B-113).

When compared with the average riparian vegetation mix for the LCFR tributaries, the South Fork contains similar amounts of riparian shrub; relatively high amounts of upland shrub and sedge/rush; and relatively low amounts of grass/forbs, riparian tree, and upland tree (Appendix B, Figure B-114).

The presence of vegetative bank cover is fairly similar in all three reaches of the South Fork and averages 76 percent, ranging from 69 percent in reach three to 82 percent in reach one (ANOVA, P <0.20) (Appendix B, Figure B-115). The amount of vegetative bank cover for the South Fork is relatively moderate when compared with the LCFR tributary average.

Large Woody Debris - In the South Fork of Bull River, single pieces of LWD <3.0 m in length average 11.76/100 m and range from 4.69/100 m in reach one to 19.32/100 m in reach three (Appendix B, Figure B-116). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 21 percent, 36 percent, and 43 percent respectively.

Single pieces of LWD >3.0 m in length average 34.92/100 m and range from 10.57/100 m in reach one to 61.15/100 m in reach three (Appendix B, Figure B-117). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 11 percent, 18 percent, and 71 percent respectively.

Aggregations of LWD average 0.07/100 m and range from 0.03/100 m in reach one to 0.12/100 m in reach three (Appendix B, Figure B-118). Overall, the number of single pieces of LWD found in aggregations averages four pieces. The distribution of root-wads averages 4.61/100 m of stream, ranging from 1.60/100 m in reach one to 7.77/100 m in reach three (Appendix B, Figure B-119).

Amounts of LWD in the South Fork are relatively high for LWD <3.0 m in length, LWD >3.0 m in length, and root-wads; and relatively low for LWD aggregates when compared with the average for the LCFR tributaries (Appendix B, Figure B-120).

Hydrology and Water Temperature The hydrology of the South Fork of Bull River is characteristic of intermediate-order, mid-reach streams in the LCFR drainage that experience periodic high flow events and are not subject to intermittent flow patterns. The water temperature regime is relatively moderate, which is also typical for this type of stream, and generally does not exceed levels suitable for salmonid populations.

Hydrology - During normal water years, flows are sufficient to support fish throughout the tributary. In 1994, tributary discharge monitored periodically at the tributary mouth averaged 0.7 m^3/sec, ranging from 0.1 m^3/sec in September to 3.1 m^3/sec during April (Appendix C, Table C-1).

Water Temperature - Water temperatures measured at the tributary mouth during 1994 averaged 6.5° C (Appendix C, Table C-2), ranging from a minimum of 2.7° C in January (Appendix C, Table C-3) to a maximum of 13.8° C in July (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 5.0° C, ranging from 3.3 to 8.4° C; in summer (June - August) temperatures averaged 10.0° C, ranging from 6.0 to 13.8° C; during fall (September - November) they averaged 7.5° C, ranging from 2.9 to 11.4° C; and in the winter months (December - February) water temperatures averaged 3.6° C, ranging from 2.7 to 4.3° C.

Sediment Survey

Major Stream Features - Conducted in November of 1994, the survey of major stream features in the South Fork of Bull River extends from the confluence with the Bull River mainstem upstream to the forest road 2736 bridge (RM 2.8). Reach one is a C-4 channel type that extends from the confluence upstream to approximately the edge of section 13 (RM 1.2). Reach two is a B-3 channel type and extends upstream to the confluence of Chippewa Creek (RM 2.2). Reach three is a C-4 channel type and extends to the forest road 2736 bridge. Reach four is an "A" type channel and was not surveyed. Forest road 410 follows the entire length of the stream.

Reach one is characterized by a relatively complex, meandering stream channel under a canopy of large conifers with a riparian forest habitat type estimated to consist primarily of cedar. Stable LWD is available for channel stability. Suitable spawning gravels are common in a substrate of alternating armored gravels and small cobble to mobile gravels. This reach has 10 percent undercut banks, 1 percent eroding banks, and a width/depth ratio of 13.

Reach two is characterized by a more entrenched and downcut channel. The reach has 10 percent undercut banks, no eroding bank, and a width/depth ratio of 9. Moderate amounts of LWD are available in the reach. Spawning gravels are restricted to accumulations behind obstructions. Evidence of an old riparian harvest is present. Inflow from Chippewa Creek adds considerable flow to the tributary in this reach.

Reach three is characterized by a more meandering channel under a canopy of large cedar and hemlock conifers. Timber harvest activity has occurred in the upper reach with a 20 to 30 m buffer strip. This reach is fairly complex with most of the stable habitat being formed by LWD. Most of the LWD consists of slash located in debris accumulations. The reach has 7 percent undercut banks, no eroding banks, and a width/depth ratio of 11.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the South Fork of Bull River averages 34 percent, ranging from 31 percent in reach two to 35 percent in reaches one and three (Appendix B, Figure B-121). Fine sediment levels in

spawning gravels on the South Fork are relatively moderate when compared with the average for the LCFR tributaries.

Predicted embryo survival to emergence for cutthrout trout averages 27 percent, ranging from 26 percent in reaches one and three to 31 percent in reach two. For bull trout, predicted embryo survival to emergence averages 31 percent, ranging from 29 percent in reaches one and three to 35 percent in reach two. When compared to the LCFR tributary average, predicted embryo survival to emergence is relatively moderate for all species.

Riffle Stability Index (RSI) - The South Fork of the Bull River is a fourth order stream and had three surveyed reaches with RSI values ranging from 44 to 82. Reach one is a C-4 channel type with good complexity. The average Wolman particle distribution is 13 percent sand, 52 percent gravel, and 35 percent cobble. Mobile particle mean grain size averages 71 mm, ranging from 68 to 75 mm. The RSI values are 58, 82, and 68. The variation in the values for reach one could be explained by the high complexity of the stream. This tributary is transporting a fair amount of gravels yet the forested riparian area has kept the banks stable and has supplied LWD for channel stabilization. The higher value from RSI site two is probably from an area that has accumulated much of these transported gravels.

Reach two is a B-3 channel type and has an average Wolman particle distribution of 7 percent sand, 31 percent gravel, 45 percent cobble, and 18 percent boulder. Mobile particle mean grain size averages 94 mm, ranging from 84 to 106 mm. The RSI values are 44, 76, and 44. Reach two appears to be experiencing downcutting of the channel. The higher value at RSI site two could be the result of the increased flows and sediments originating from Chippewa Creek.

Reach three is a C-4 channel type and has an average Wollman particle distribution of 10 percent sand, 56 percent gravel, 35 percent cobble, and 2 percent boulder. Mobile particle mean grain size averages 56 mm, ranging from 61 to 51 mm. The RSI values are 65 and 53. Reach three is likely influenced by recent timber harvest activities. These harvests did have buffer strips along the stream shoreline, but the presence of slash piles and log jams indicate that LWD has entered the stream but not had a chance to incorporate into channel stability and thereby create stable fish habitat.

Spawning Habitat Availability There is an estimated 717 m^2 of suitable habitat for fall-spawning salmonids in the South Fork of Bull River. This equates to 0.118 m^2/m of stream length and 4.9 percent of the total stream area. This habitat can accommodate an estimated 199 adfluvial or 448 resident salmonid redds. When compared with the average for the LCFR tributaries, the amount of spawning habitat available in the South Fork for fall-spawning salmonids is relatively high.

Rearing Habitat Availability In the South Fork of Bull River, there is approximately 3,708 m^2 of salmonid rearing habitat. This equates to 0.610 m^2/m of stream length and 25.2 percent of the total stream area. The amount of available rearing habitat per meter of stream is relatively high when compared to the average for the LCFR tributaries.

Productivity

Primary Productivity - We monitored periphyton accumulation in the South Fork of Bull River for 35 days. The average autotrophic index is 13.52, ranging from 0.0 to 71.83; average chlorophyll content is 1.21 mg/m^2, ranging from 0.05 mg/m^2 to 5.25 mg/m^2; net productivity averages 0.28 $mg/m^2/day$, ranging from 0.0 $mg/m^2/day$ to 0.84 $mg/m^2/day$. When compared with average values for the LCFR tributaries, the autotrophic index in the South Fork is relatively high, net productivity is similar, and the chlorophyll content of the periphyton samples is low.

Secondary Productivity - Benthic invertebrate populations in the South Fork of the Bull River consist primarily of members from the order Ephemeroptera (57%) followed by Diptera (15%), Plecoptera (11%) and Trichoptera (11%) (Appendix B, Figure B-122). Invertebrate densities average 796/m^2 and range from 579/m^2 in reach three to 1107/m^2 in reach two (Appendix B, Figure B-123). There was no statistically significant difference in invertebrate densities among reaches (ANOVA, $P < 0.50$). Invertebrate species richness for the stream was 23 species, ranging from 15 in reach one to 23 in reach three (Appendix B, Figure B-124). The invertebrate species diversity index (SDI) is 2.714, ranging from a low of 2.013 in reach one to a high of 2.381 in reach two (Appendix B, Figure B-125). Invertebrate densities, species richness, and species diversity are relatively high when compared with the average values for the LCFR tributaries.

5.5.2 Fish Populations

Compared with the averages for the LCFR tributaries, fish densities in the South Fork of Bull River are relatively high for cutthroat trout and relatively low for brook and bull trout (Appendix B, Figure B-126). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in the South Fork are limited by a combination of low amounts of suitable spawning and rearing habitat, and low habitat complexity. Tributary sections with relatively high habitat complexity, unsedimented spawning gravels, and unembedded cobble substrate have higher fish densities and a more diverse species mix than tributary sections without those components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all reaches and habitat types found in the South Fork of the Bull River. In the South Fork there are an estimated 4,160 westslope cutthroat trout, 1,092 brook trout, and 121 bull trout (Appendix C, Table C-24). Fish densities are highest for westslope cutthroat trout (0.929 fish/m) followed by brook trout (0.244 fish/m) then bull trout (0.027 fish/m) (Tukey test, $P < 0.05$) (Appendix C, Table C-25).

Westslope Cutthroat Trout - Westslope cutthroat trout are present throughout the South Fork of Bull River and are the most abundant species in all three reaches (Appendix C, Table C-24). Cutthroat trout densities average 0.929 fish/m of stream, ranging from 0.789 fish/m to 0.970 fish/m (Appendix C, Table C-25). There was no statistically significant difference in cutthroat trout densities among reaches (ANOVA, $P < 0.50$).

Cutthroat trout densities are relatively high in pool habitat and lowest in cascade habitat (Appendix C, Table C-26, C-27). Although statistically significant differences in the distribution of cutthroat trout among habitat types were found (ANOVA, $<P$ 0.001), the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive).

Bull Trout - Bull trout are present in reaches one and two but are the least abundant trout species (Appendix C, Table C-24). Densities average 0.027 fish/m of stream, ranging from 0.021 fish/m to 0.079 fish/m (Appendix C, Table C-25). Bull trout densities are high in reach one and low in reach two (t-Test, $P < 0.013$).

Bull trout densities are relatively high in run and high gradient riffle habitat; and relatively low in pool habitat (Appendix C, Table C-26). There was no statistically significant difference in the distribution of bull trout among habitat types (ANOVA, P <0.10) (Appendix C, Table C-27).

Brook Trout - Brook trout are present throughout the South Fork of Bull River and are the second most abundant species in all three reaches (Appendix C, Table C-24). Brook trout densities average 0.244 fish/m of stream, ranging from 0.026 fish/m in reach three to 0.403 fish/m in reach two (Appendix C, Table C-25). Brook trout densities are statistically high in reaches one and two (Tukey test, P <0.05).

Brook trout densities are relatively high in pool habitat, relatively low in low gradient riffle, cascade, and high gradient riffle habitat types (Appendix C, Table C-26) although the differences in distribution are not statistically significant (ANOVA, P <0.10) (Appendix C, Table C-27).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in the South Fork of Bull River is similar to the average for the LCFR tributaries with the oldest fish sampled being age III+. When compared with the average growth rate for the tributaries, growth of cutthroat trout in the South Fork is relatively moderate, with age I+ fish reaching a length of 65 mm (2.6 in) and age III+ a length of 177 mm (7.1 in) (Appendix B, Figure B-127). The instantaneous survival rate of 21 percent is similar to the average for the tributaries.

Bull Trout - Data collected from bull trout populations in the South Fork of Bull River are not sufficient to complete age, growth, and mortality estimates for this stream.

Brook Trout - Brook trout scale samples are also not sufficient to complete the age and growth analysis for the South Fork. However, when calculated using the length frequency distribution (Appendix B, Figure B-128) the instantaneous survival rate for brook trout is 25 percent, which is lower than the average for the LCFR tributaries.

Rare Fish Genetics In the cutthroat trout sample from the South Fork of Bull River, IDDH*100 and sIDHP-1*71 alleles were found that have also been detected in other westslope cutthroat trout populations. As a result, it is not possible to rule out that the presence of these alleles may represent rare westslope cutthroat genetic variation. However, because of the close proximity of the location of this sample to the North Fork of Bull River sample, and because two of the three alleles found at the diagnostic loci were found in one fish, it's most likely that the variation is due to hybridization with Yellowstone cutthroat trout (Sage 1993). Although inconclusive, the potential low level of hybridization found has resulted in this population being considered pure westslope cutthroat for management purposes.

Adfluvial Fish Spawning Fall-spawning adfluvial fish (bull and brown trout) have not been observed using the South Fork of the Bull River for spawning. With the exception of periodic spot-checks, annual redd counts for adfluvial stocks of these species have not been conducted on this stream.

5.6 Middle Fork of Bull River

The Middle Fork of the Bull River flows approximately 8.0 km (5.0 mi) from the western slopes of the Cabinet Mountains Wilderness Area to its confluence with the North Fork of the Bull River (Figure 5-5). The Middle Fork drainage covers about 1,813 ha. Minor tributaries include Ibex Creek and Bighorn Creek. Average elevation drop is about 75 m/km. In reach one, from the confluence at the North Fork of Bull River to RM 2.3, the average drop is approximately 49 m/km; in reach two (RM 2.3 to RM 2.7) the change in elevation is about 120 m/km.

5.6.1 Fish Habitat

Fish habitat in the Middle Fork of Bull River consists of primarily high gradient riffle and pool habitat types; a substrate mix dominated by rubble and gravel; moderate amounts of fine sediment; functional although altered riparian zone; a riparian vegetation mix consisting primarily of low-cover and upper canopy vegetation types; and relatively moderate amounts of large woody debris.

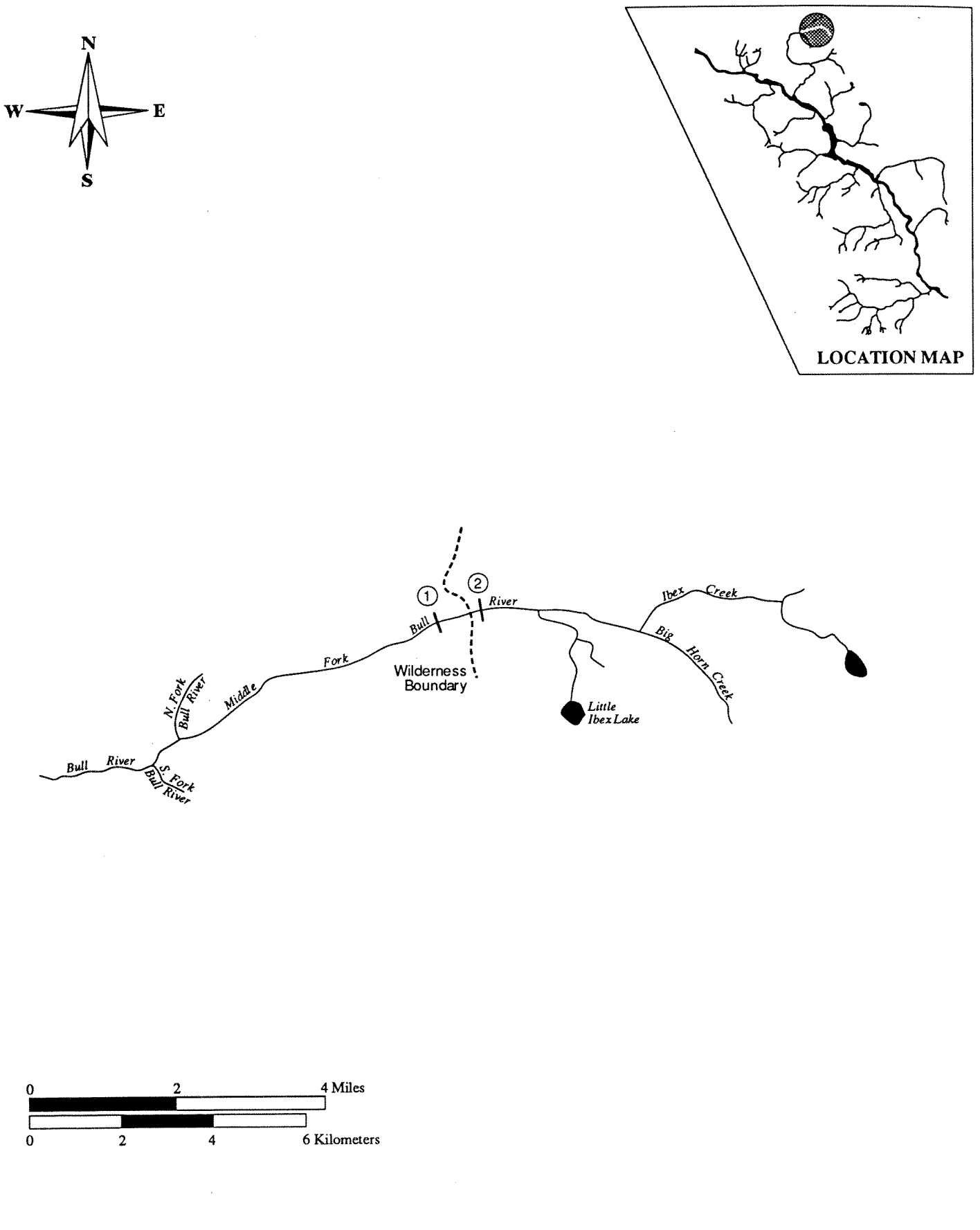

Figure 5-5. Map of the Middle Fork Bull River drainage showing major tributaries and reach breaks.

Habitat Survey The habitat survey for the Middle Fork included two tributary reaches and extended from the confluence with the North Fork of the Bull River to a permanent fish barrier located at RM 2.7.

Habitat Composition - Fish habitat in the Middle Fork of Bull River is predominantly high gradient riffle and pool habitat types. Reach one is primarily high gradient riffle and pool habitat; and reach two is dominated by pool and cascade habitat types. Habitat composition is similar between tributary reaches (Appendix B, Figure B-129).

When compared with the overall habitat composition mix for the surveyed LCFR tributaries, the Middle Fork of the Bull River has similar amounts of pocket water and cascade habitats; relatively high amounts of pool and high gradient riffle habitat; and relatively low amounts of glide, run, and low gradient riffle habitat types (Appendix B, Figure B-130).

Substrate Composition - Substrate composition in the Middle Fork is mainly rubble and gravel (Tukey test, $P < 0.05$). Reach one contains high percentages of rubble and gravel (Tukey test, $P < 0.05$); while reach two is predominately cobble, rubble, and boulder (Tukey test, $P < 0.05$) (Appendix B, Figure B-131).

When compared with the average substrate composition for the tributaries, the Middle Fork contains similar amounts of cobble, boulder, and bedrock; relatively high amounts of gravel and rubble; and relatively low amounts of sand/silt and peagravel (Appendix B, Figure B-132). Substrate composition varies with tributary reach, being dominated by rubble, cobble, and boulder in relatively high gradient reaches and sand/silt and gravel in low gradient reaches.

Surface Fines - Surface fines average 12 percent and range from 12 percent in reach one to 5 percent in reach two. Surface fines are high in reach one (14) and low in reach two (10) (T-test, $P < 0.005$). Surface fines are statistically different between slow (18%) and fast water (6%) habitat types (t-Test, $P < 0.001$). Surface fines in the Middle Fork are lower than the tributary average.

Riparian Vegetation - Riparian vegetation on the Middle Fork of Bull River is primarily upland tree (Tukey test, $P < 0.05$). Riparian vegetation in reach one is predominately upland tree (Tukey test P

<0.05). Reach two contains a low amount of upland shrub (Tukey test P <0.05) (Appendix B, Figure B-133).

When compared with the average riparian vegetation mix for the tributaries, the Middle Fork contains similar amounts of sedge/rush, upland shrub, and riparian tree; relatively high amounts of upland tree; and relatively low amounts of grass/forbs and riparian shrub (Appendix B, Figure B-134).

The presence of vegetative bank cover for the Middle Fork is similar in all reaches, averages 86 percent, and ranges from 92 percent in reach one to 78 percent in reach two (T-test, P <0.12). The amount of vegetative bank cover for the Middle Fork is similar to the tributary average.

Large Woody Debris - In the Middle Fork of Bull River, single pieces of LWD <3.0 m in length average 4.78/100 m and range from 3.52/100 m in reach one to 6.04/100 m in reach two. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 19 percent, 57 percent, and 25 percent respectively.

Single pieces of LWD >3.0 m in length average 8.85/100 m and range from 8.57/100 m in reach one to 9.13/100 m in reach two. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter is 2 percent, 45 percent, and 52 percent respectively.

Aggregations of LWD average 0.32/100 m and range from 0.31/100 m reach one to 0.34/100 m in reach two. The number of single pieces of LWD found in aggregations average 5.8 for the combined tributary reaches and range from 4 to 7 pieces/aggregation. The distribution of root-wads average 2.59/100 m of stream, ranging from 1.92/100 m in reach one to 3.25/100 m in reach three.
Amounts of LWD is relatively low for LWD >3.0 m in length, LWD <3.0 m in length, and LWD aggregates; and relatively low for root-wads when compared with the average for the LCFR tributaries (Appendix B, Figure B-135).

Hydrology and Water Temperature The hydrology of the Middle Fork of Bull River is characteristic of low order, headwater streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns. The water temperature regime is relatively

low and does not typically exceed levels suitable for salmonid populations, which is also typical for this type of stream in the LCFR drainage,.

Hydrology - During normal water years, flows in the Middle Fork of Bull River are sufficient to support fish in the stream sections between the stream mouth and RM 0.9. During drier years however, parts of this stream begin to go dry in late June. In 1994, tributary discharge monitored periodically at RM 0.1 averaged 0.4 m^3/sec, ranging from 0.0 m^3/sec during July - September to 1.2 m^3/sec during May (Appendix C, Table C-1).

Water Temperature - Water temperatures measured at RM 0.1 during 1994 averaged 4.7° C (Appendix C, Table C-2), ranging from a minimum of 0.8° C in January (Appendix C, Table C-3) to a maximum of 8.4° C in June (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 4.8° C, ranging from 3.9 to 5.8° C; in summer (June - August), temperatures were at 8.4° C; during fall (September - November), they averaged 6.0° C, ranging from 4.1 to 7.4° C; and in the winter months (December - February), water temperatures averaged 2.5° C, ranging from 0.8 to 5.4° C.

Sediment Survey

Major Stream Features - Conducted in October 1994, the survey of major stream features in the Middle Fork of Bull River extended from the confluence with the North Fork of the Bull River upstream to approximately the corner of section seven (RM 2.2). Reach one is a multiple thread, D-3 channel type while reach two is an A-2 channel type and was not surveyed. Pack trail 978 follows the length of the stream.

Reach one is characterized by a fairly wide flood plain with the channel meandering through a mature canopy of conifers with a forest habitat type consisting mainly of cedar. The riparian zone showed signs of an old timber harvest that has regenerated into the present closed canopy of conifers. It appears that excessive bed load has been deposited in this reach and has caused some channel braiding, although large woody debris in the channel is helping to stabilize the channel substrate. This reach has 2 percent undercut bank, 1 percent eroding bank, and a width/depth ratio of 17.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the Middle Fork of Bull River is 42 percent. Fine sediment levels in spawning gravels on the Middle Fork are relatively high when compared with the average for the tributaries. Sediment core samples were obtained only from reach one. In reach two, it was not possible to obtain core samples per the sampling protocol as spawning gravels were limited to depositional areas behind boulders and stream obstructions.

Predicted embryo survival to emergence for westslope cutthrout trout is 16 percent. Bull trout predicted embryo survival to emergence, if spawning were to occur, would be 19 percent. When compared with the tributary average, predicted embryo survival to emergence is relatively low.

Riffle Stability Index (RSI) - The Middle Fork of the Bull River is a fourth order stream. Reach one has RSI values ranging from 81 to 87. The RSI values were not calculated for reach two because the channel type is inconsistent with RSI methodology criteria.

Reach one has an average Wolman particle distribution of 1 percent sand, 49 percent gravels, 47 percent cobble, and 2 percent boulder. The mobile particle mean grain size averages 131 mm, ranging from 117 to 158 mm. The RSI values are 86, 87, and 81. It was noted at RSI site three that excessive water yield and riparian disruption are probably exaggerating the meandering morphology.

It appears that excessive water yield has deposited gravels and cobbles into reach one, aggrading the reach and forcing the stream into a braided condition. Concentrations of large gravels and cobbles have resulted in large mid-channel bars and deposits. The riparian zone does have a closed canopy of mature conifers with LWD available for input into the channel. This debris is helping to stabilize the channel and banks of this stream. We did observe some riparian disturbance from past fire and old harvest activity, but this stream appears to be trending toward recovery.

Spawning Habitat Availability There is an estimated 141 m^2 of suitable habitat for fall-spawning salmonids in the Middle Fork of Bull River. This equates to 0.032 m^2/m of stream length and 0.7 percent of the total stream area. This habitat can accommodate an estimated 39 adfluvial or 88 resident salmonid redds. When compared with the average for the tributaries, the amount of spawning habitat per meter of stream is relatively low.

Rearing Habitat Availability In the Middle Fork of Bull River, there are approximately 2,870 m^2 of salmonid rearing habitat. This equates to 0.650 m^2/m of stream length and 14.6 percent of the total stream area. When compared with the average for the tributaries, the amount of available rearing habitat per meter of stream is relatively high.

Productivity

Primary Productivity - In the Middle Fork of Bull River, we monitored periphyton accumulation for 35 days. The average autotrophic index is 18.64, ranging from 0.0 to 65.02; average chlorophyll content is 0.34 mg/ m^2, ranging from 0.0 mg/ m^2 to 0.84 mg/ m^2; net productivity averages 0.33 mg/ m^2/day, ranging from 0.02 mg/ m^2/day to 0.73 mg/ m^2/day. The autotrophic index is relatively high, chlorophyll content is low, and net productivity is similar to average values for the tributaries.

Secondary Productivity - Benthic invertebrate populations in the Middle Fork of Bull River consist primarily of members from the order Ephemeroptera (77%) followed by Trichoptera (14%) and Plecoptera (7%) (Appendix B, Figure B-136). Invertebrate densities average 696/ m^2 and range from 642/ m^2 in reach two to 750/m^2 in reach one. There was no statistically significant difference in invertebrate densities among tributary reaches (t-Test, $P < 0.20$). Invertebrate species richness for the stream was 13 species, ranging from 9 in the second reach to 13 in reach one. The invertebrate species diversity index (SDI) for the stream is 1.903, ranging from a low of 1.486 in reach two to a high of 1.504 in reach one. Invertebrate densities and diversity are relatively similar while species richness is relatively low when compared with average values for the LCFR tributaries.

5.6.2 Fish Populations

Compared with the averages for the LCFR tributaries, fish densities in the Middle Fork of Bull River are relatively moderate for brook and cutthroat trout (Appendix B, Figure B-137). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in the Middle Fork are limited by a combination of stream intermittency, high channel instability, low habitat complexity, and low amounts of LWD, suitable spawning and rearing habitat. Stream sections that are relatively stable with high habitat complexity, unsedimented spawning gravels,

suitable amounts of LWD, and unembedded cobble substrate have higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all reaches and habitat types found in the Middle Fork of the Bull River. In the Middle Fork, there are an estimated 2,310 westslope cutthroat trout and 1,302 brook trout (Appendix C, Table C-28). Average fish densities are high for brook trout and low for cutthroat trout (Appendix C, Table C-29). There is a statistically significant difference in fish densities among fish species (t-Test, $P < 0.019$).

Westslope Cutthroat Trout - Westslope cutthroat trout are present throughout the Middle Fork of Bull River and are the second most abundant species in reach one and the only species present in reach two (Appendix C, Table C-28). Cutthroat trout densities average 0.535 fish/m of stream, ranging from 0.229 fish/m in reach one to 0.920 fish/m in reach two (Appendix C, Table C-29), with the reach two densities significantly higher (t-Test, $P < 0.001$).

Fish densities are relatively high in pool and cascade habitats and low in run habitat types (Appendix C, Table C-30, C-31). Although statistically significant differences in the distribution of cutthroat trout among tributary reaches were found (ANOVA, $P < 0.010$), the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive).

Brook Trout - Brook trout are present in reach one where they are the most abundant salmonid species present (Appendix C, Table C-28). Brook trout densities average 0.301 fish/m for the stream and 0.540 in reach one (Appendix C, Table C-29). Brook trout densities are relatively high in pool habitat; and relatively low in high gradient riffle and low gradient riffle habitat types (Appendix C, Table C-30). However, there was no statistically significant difference in the distribution of brook trout among habitat types (ANOVA, $P < 0.50$) (Appendix C, Table C-31).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in the Middle Fork of Bull River is similar to the average for the tributaries with the oldest fish sampled being age IV+. Growth of cutthroat

trout in the Middle Fork is relatively low when compared with the average growth rate for the LCFR tributaries with age I+ fish reaching a length of 61 mm (2.4 in) and age III+ a length of 160 mm (6.4 in) (Appendix B, Figure B-138). The instantaneous survival rate of 55 percent is higher than the average for the tributaries.

Brook Trout - Longevity of brook trout in the Middle Fork of Bull River is higher than the average for the tributaries with the oldest fish sampled being age IV+. Growth of brook trout in the Middle Fork is relatively moderate when compared with the tributary average with age I+ fish reaching a length of 67 mm (2.6 in) and age III+ a length of 144 mm (5.7 in) (Appendix B, Figure B-139). The instantaneous survival rate of 24 percent is similar to the average for the tributaries.

Rare Fish Genetics In the cutthroat trout sample from the Middle Fork of Bull River, alleles characteristic of only westslope cutthroat trout were detected at the diagnostic loci. In addition, with the sample size of 25 fish, there is a 95 percent chance of detecting as little as one percent rainbow trout genes and better than a 99 percent chance of detecting as little as one percent Yellowstone cutthroat trout genes (Sage 1993). As a result, the population in this stream is considered to be pure aboriginal westslope cutthroat trout.

This stream has a barrier to upstream migration in the form of a permanent bedrock/boulder falls located approximately 2.8 km from the stream mouth. The mouth of the Middle Fork of Bull River also goes dry between mid-summer and late fall, further restricting movement of fish and potential sources of hybridization into this stream.

Adfluvial Fish Spawning Resident and/or rearing stocks of bull and brown trout are not present in the Middle Fork of the Bull River. With the exception of periodic spot-checks, annual redd counts for adfluvial stocks of these species have not been conducted on this stream.

5.7 East Fork of Blue Creek

The East Fork of Blue Creek flows approximately 7.5 km (4.7 mi) from the southwestern slopes of the Cabinet Mountains to its confluence with Cabinet Gorge Reservoir approximately 2.0 km (1.2 mi) east of the Cabinet Gorge Dam (Figure 5-6). The East Fork of Blue Creek drainage covers

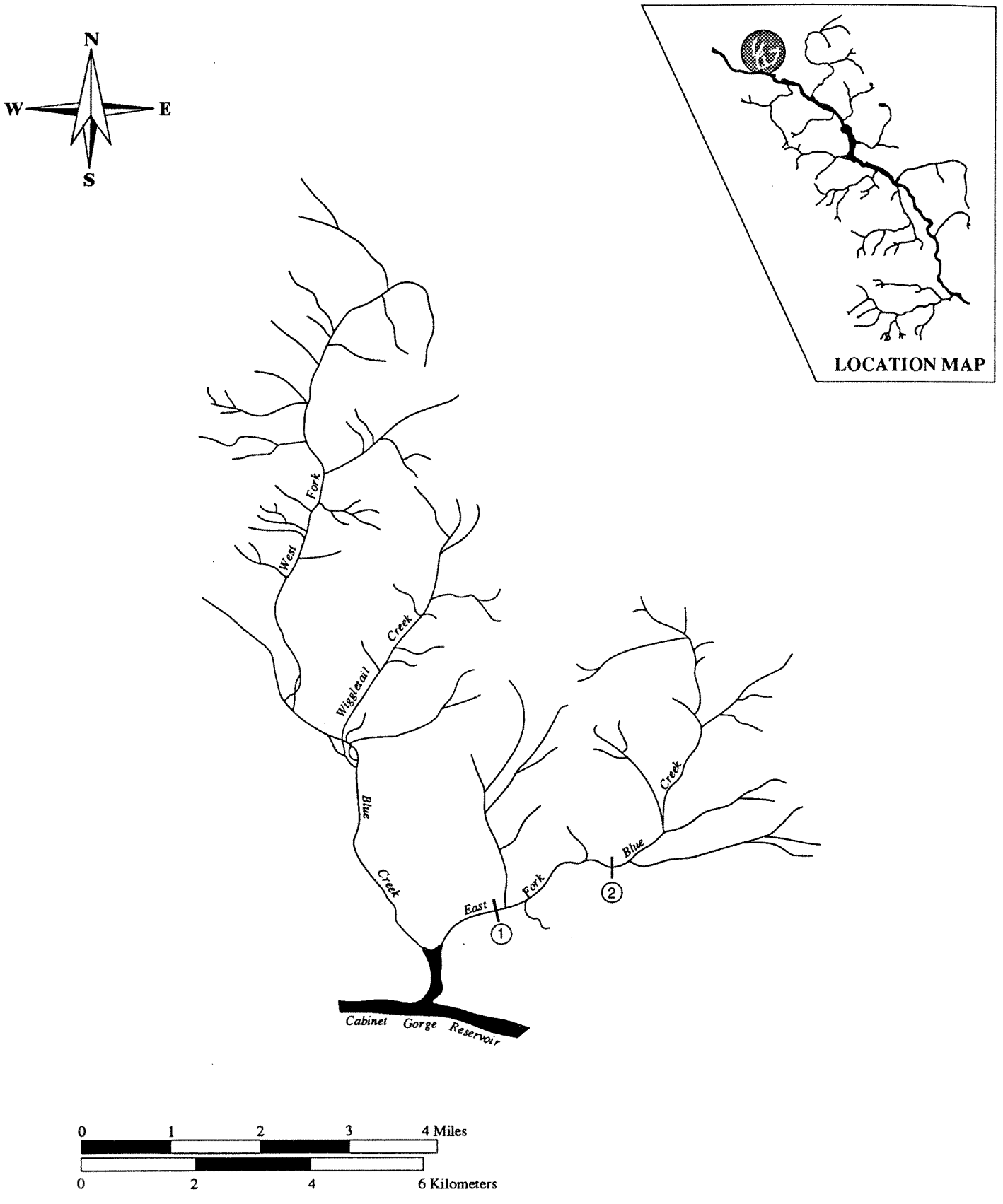

Figure 5-6. Map of the Blue Creek drainage showing major tributaries and reach breaks.

approximately 2,978 ha. Average elevation drop is about 33 m/km. In reach one, from the confluence at Cabinet Gorge Reservoir to RM 1.0, the average drop is approximately 58 m/km; in reach two (RM 1.0 to RM 2.2) the change in elevation is about 24 m/km.

5.7.1 Fish Habitat

Fish habitat in the East Fork of Blue Creek consists of primarily low gradient riffle, pool, and run habitat types; a substrate mix dominated by gravel; moderate amounts of fine sediment; a functional although altered riparian zone; a riparian vegetation mix consisting primarily of low- and mid-cover vegetation types; and relatively high amounts of LWD.

Habitat Survey The habitat survey for the East Fork of Blue Creek extended from the confluence at Cabinet Gorge Reservoir through two tributary reaches to a location where normal stream flow is insufficient to support fish populations (RM 2.2).

Habitat Composition - Fish habitat on the East Fork of Blue Creek is predominately low gradient riffle, pool, and run habitat types. Reach one is primarily low gradient riffle and pool habitat while reach two was mainly pool, low gradient riffle, and run habitat types (Appendix B, Figure B-140).

When compared with the overall habitat composition mix for the LCFR tributaries, the East Fork of Blue Creek had similar amounts of run habitat; relatively high amounts of pool and low gradient riffle habitat; and relatively low amounts of pocket water, glide, high gradient riffle, and cascade habitat types (Appendix B, Figure B-141).

Substrate Composition - Substrate composition in the East Fork was primarily gravel (Tukey test, $P < 0.05$). Reach one contains high amounts of gravel and peagravel (Tukey test, $P < 0.05$). Reach two had high concentrations of gravel (Tukey test, $P < 0.05$) (Appendix B, Figure B-142).

When compared with the average substrate composition for the LCFR drainage, the East Fork contains similar amounts of rubble and bedrock; relatively high amounts of peagravel and gravel; and relatively low amounts of sand/silt, cobble, and boulder (Appendix B, Figure B-143). Substrate

composition varies with tributary reach, being dominated by rubble, cobble, and boulder in relatively high gradient reaches and sand/silt in low gradient reaches.

Surface Fines - Surface fines in the East Fork average 15 percent and range from 13 percent in reach one to 16 percent in reach two. There was no statistically significant difference in the distribution of surface fines between the two reaches (T-test, P< 0.063). Average percent surface fines are statistically different between slow (18%) and fast water (11%) habitat types (t-Test, P< 0.001). Surface fines in the East Fork are similar to the drainage average.

Riparian Vegetation - Riparian vegetation on the East Fork was predominately grass/forbs and riparian shrub (Tukey test, P <0.05). Riparian vegetation in reach one was mainly grass/forbs (Tukey test, P <0.05); and reach two contains a high amount of grass/forbs and riparian shrub (Tukey test, P <0.05) (Appendix B, Figure B-144).

When compared with the average riparian vegetation mix for the drainage, the East Fork contains similar amounts of grass/forbs, riparian shrub, upland shrub, riparian tree, and upland tree; and relatively high amounts of sedge/rush (Appendix B, Figure B-145).

The presence of vegetative bank cover for the East Fork is relatively low when compared with the drainage average. Vegetative bank cover for the East Fork of Blue Creek is similar in all reaches, averages 58 percent, and ranges from 62 percent in reach one to 55 percent in reach two (T-test, P <0.13).

Large Woody Debris - Single pieces of LWD <3.0 m in length average 13.93/100 m and range from 13.35/100 m in reach one to 14.50/100 m in reach two. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 25 percent, 37 percent, and 39 percent respectively.

Single pieces of LWD >3.0 m in length average 16.12/100 m and range from 15.53/100 m in reach one to 16.70/100 m in reach two. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 7 percent, 41 percent, and 53 percent respectively.

Aggregations of LWD average 1.52/100 m and range from 1.37/100 m reach one to 1.66/100 m in reach two. The number of single pieces of LWD found in aggregations average 4.5 for the combined tributary reaches and range from 4 to 5 pieces per aggregation. The distribution of root-wads average 5.14/100 m of stream, ranging from 4.80/100 m in reach one to 5.48/100 m in reach two.

When compared with the drainage average, amounts of LWD in the East Fork were relatively high for LWD <3.0 m in length, >3.0 m in length, and root-wads; and relatively similar for LWD aggregations when compared with the drainage average (Appendix B, Figure B-146).

Hydrology and Water Temperature The hydrology of the East Fork is characteristic of intermediate order, mid-reach streams in the LCFR drainage that experience periodic high flow events and are not subject to intermittent flow patterns. The water temperature regime is relatively moderate, which is also typical for this type of stream in the LCFR drainage, and does not typically exceed levels suitable for salmonid populations.

Hydrology - During normal water years, flows are sufficient to support fish throughout the stream. Tributary discharge monitored at RM 0.5 during 1994 averaged 0.5 m^3/sec, ranging from 0.02 m^3/sec in October to 1.2 m^3/sec during April (Appendix C, Table C-1).

Water Temperature - Water temperatures measured at RM 0.5 during 1994 averaged 6.1° C (Appendix C, Table C-2), ranging from a minimum of 2.1° C in January (Appendix C, Table C-3) to a maximum of 11.5° C in September (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 5.7° C, ranging from 4.9 to 8.9° C; in summer (June - August), temperatures averaged 8.1° C, ranging from 6.0 to 10.5° C; during fall (September - November), they averaged 7.3° C, ranging from 4.7 to 11.5° C; and in the winter months (December - February), water temperatures averaged 3.2° C, ranging from 2.1 to 4.0° C .

Sediment Survey

Major Stream Features - Conducted in November of 1994, the survey of major stream features in the East Fork of Blue Creek extended from the stream mouth to approximately 0.6 km above the crossing of forest road 2745. Reach one is a B-4c channel type and extended from the mouth to the

road crossing (RM 1.0). Reach two was a C-4 channel type that extended upstream for the rest of the length of the surveyed stream to RM 2.2.

Reach one was characterized by LWD in aggregations and bridging the channel with deposited spawning gravels behind these obstructions. Old riparian roads and stumps indicated past timber harvest activity. Some fire scared trees were present in the riparian zone. The crossing of forest road 2745 influences the stream by crossing the flood plain and holding gravels in reach two. Most of the reach was under a canopy of conifer trees and contains relatively stable banks. This reach had no undercut or eroding banks and a width/depth ratio of 9.

Reach two was a relatively unstable, meandering reach of lower complexity in a forested riparian zone. Large woody debris including some sawed logs was in debris jams and were not fully incorporated into the channel. A section of private land upstream from this reach appears heavily harvested and may have resulted in the existing channel instability and localized braiding. This reach had 5 percent undercut banks, 2 percent eroding banks, and a width/depth ratio of 10.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the East Fork was 35 percent. Sediment core samples were obtained only from reach two. In reach one, it was not possible to obtain core samples per the sampling protocol as spawning gravels were restricted to depositional areas behind boulders and stream obstructions. Fine sediment levels in spawning gravels on the East Fork were relatively moderate when compared with the average for the drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 26 percent. If present, bull trout predicted embryo survival to emergence would have been 29 percent. When compared to the LCFR drainage average, predicted embryo survival to emergence was relatively moderate for all species.

Riffle Stability Index (RSI) - The East Fork of Blue Creek is a third order stream that had two surveyed reaches with RSI values ranging from 50 to 78. Extensive timber harvest activity was noted throughout the length of this stream.

Reach one was a B-4c channel type with an average Wolman particle distribution of 7 percent sand, 51 percent gravel, and 43 percent cobble. The mobile particle mean grain size averages 64 mm, ranging from 59 to 73 mm. The RSI values are 65, 50, and 57. In Reach one the stream flows below a mature conifer canopy with the trees stabilizing the stream banks. Large woody debris is concentrated in large jams, indicating that it is most likely logging debris. Gravels were accumulated behind these obstructions. Road 2745 seemed to be a dividing point in the channel morphology. The road crossing was functioning to store gravels above the road.

Reach two was a C-4 channel type of lower complexity and gravel transport. The average Wolman particle distribution was 6 percent sand, 49 percent gravel, and 45 percent cobble. Mobile particle mean grain size averages 94 mm, ranging from 82 to 104 mm. The RSI values are 78, 65, and 78. Reach two appears to have some lateral instability of the channel and mid-channel bars. The private section further up the reach was not intensively surveyed, but it appears that near shore forested areas have been harvested and some braiding of the channel is also evident.

Spawning Habitat Availability There are an estimated 130 m^2 of suitable habitat for fall-spawning salmonids in the East Fork. This equates to 0.074 m^2/m of stream length and 2.9 percent of the total stream area. This habitat can accommodate an estimated 36 adfluvial or 81 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively high.

Rearing Habitat Availability In the East Fork, there was approximately 1,089 m^2 of salmonid rearing habitat. This equates to 0.620 m^2/m of stream length and 24.3 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of available rearing habitat per meter of stream was relatively high.

Productivity

Primary Productivity - In the East Fork of Blue Creek, we monitored periphyton accumulation for 35 days. The average autotrophic index was 0.38, ranging from 0.0 to 1.32; average chlorophyll content was 4.75 mg/m^2, ranging from 0.0 mg/m^2 to 11.65 mg/m^2; net productivity averages 0.12 $mg/m^2/day$, ranging from 0.0 $mg/m^2/day$ to 0.53 $mg/m^2/day$. When compared with average values for the

drainage, the chlorophyll content of the periphyton samples was relatively high while the autotrophic index and net productivity values were low.

Secondary Productivity - In the East Fork of Blue Creek, invertebrate populations were not assessed in reach two because the invertebrate samples from this reach were not properly preserved in the field and as a result could not be processed in the lab. However, in reach one the benthic invertebrate populations consist primarily of members from the order Ephemeroptera (86%) followed by Plecoptera (6%) and Trichoptera (5%) (Appendix B, Figure B-147). Invertebrate densities average 955/m^2, species richness was 8 species, and species diversity (SDI) was 1.342. When compared with the average values for the drainage, invertebrate densities were relatively high, species richness and species diversity was low.

5.7.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in the East Fork were relatively high for cutthroat trout (Appendix B, Figure B-148). In general, salmonid populations in the East Fork are limited by a combination of high channel instability, low habitat complexity, and low amounts of suitable spawning and rearing habitat. Stream sections that were relatively stable and contains high habitat complexity, unsedimented spawning gravels and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all reaches and habitat types found in the East Fork of Blue Creek. Westslope cutthroat trout were the only salmonid species found. There are an estimated 2,601 westslope cutthroat trout in East Fork of Blue Creek (Appendix C, Table C-32).

Westslope Cutthroat Trout - Cutthroat trout densities average 0.741 fish/m of stream, ranging from 0.994 fish/m in reach two to 0.448 in reach one (Appendix C, Table C-33). There was no statistically significant difference in the distribution of cutthroat trout among tributary reaches (T-test, $P < 0.07$).

Cutthroat trout densities are high in pool habitat and low in low gradient riffle habitat (Appendix C, Table C-34, C-35). There was no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, P <0.10).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in the East Fork was lower than the average for the drainage with the oldest fish sampled being only age II+. Growth of cutthroat trout in the East Fork was relatively high when compared with the average growth rate for the drainage with age I+ fish reaching a length of 73 mm (2.9 in) and age II+ a length of 110 mm (4.4 in) (Appendix B, Figure B-149). The instantaneous survival rate of 13 percent was lower than the average for the drainage.

Rare Fish Genetics In 1993, cutthroat trout were obtained for electrophoretic testing from the East and West Forks of Blue Creek. Results from the analysis indicated that both these populations contains pure aboriginal westslope cutthroat trout. There are no barriers to upstream movement of fish and potential sources of hybridization in these streams.

Adfluvial Fish Spawning Resident and/or rearing stocks of bull and brown trout are not present in the East Fork of Blue Creek. With the exception of periodic spot-checks, annual redd counts for adfluvial stocks of these species have not been conducted on this stream.

5.8 Elk Creek

Elk Creek flows approximately 6.0 km from the northeastern slopes of the Bitterroot Range to its confluence with Cabinet Gorge Reservoir approximately 16 km west of Noxon, Montana (Figure 5-7). The Elk Creek drainage covers approximately 14,245 ha. Major streams in the drainage include West Fork Elk Creek and East Fork Elk Creek. Minor tributaries include Lone Cliff Gulch, Cascade Creek, Butte Creek, Lost Cabin Gulch, Jacks Gulch, Deer Creek, Pew Gulch, Beaver Gulch, and Rice Draw. Average elevation drop is about 9 m/km. In reach one, from the confluence at Cabinet Gorge Reservoir to RM 0.1, the average drop is approximately 30 m/km; in reach two (RM 0.1 to

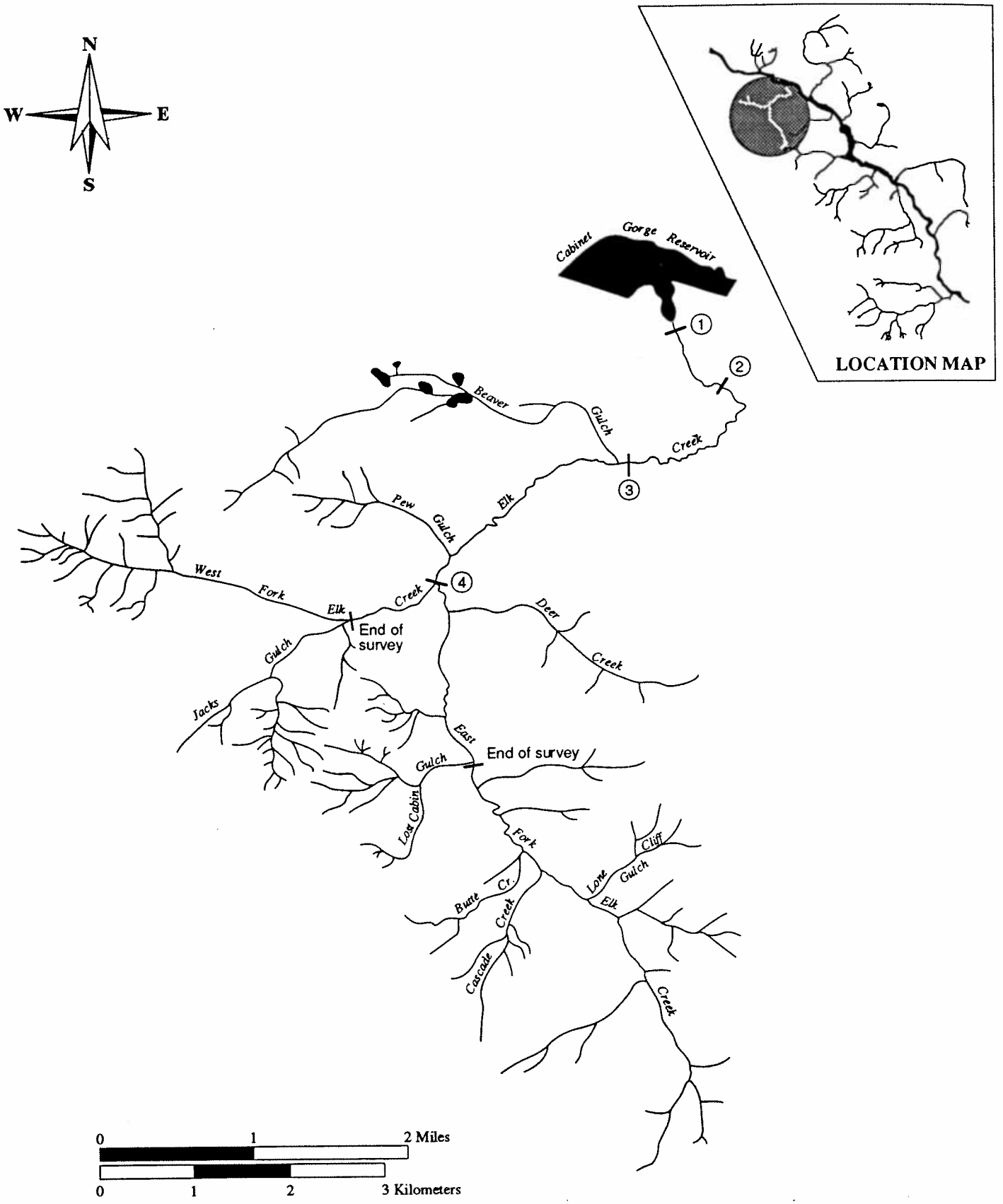

Figure 5-7. Map of the Elk Creek drainage showing major tributaries and reach breaks.

RM 1.5) the change in elevation is about 14 m/km; for reach three (RM 1.5 to RM 3.2) the stream drops approximately 5 m/km; and in reach four (RM 3.2 to RM 6.0) the average drop is 7 m/km.

5.8.1 Fish Habitat

Fish habitat in Elk Creek consists of primarily run, glide, pool, and low gradient riffle habitat types; a substrate mix dominated by gravel and peagravel; high amounts of fine sediment; a semi-functional and altered riparian zone; a riparian vegetation mix consisting primarily of low-cover and upper canopy vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for Elk Creek included four tributary reaches and extended from the confluence at Cabinet Gorge Reservoir to the confluence with the East and West Forks of Elk Creek (RM 6.0).

Habitat Composition - Fish habitat on Elk Creek consists primarily of run, glide, pool, and low gradient riffle habitat types. Reach one was predominately pool, cascade, and high gradient riffle habitat; reach two was primarily run, low gradient riffle, pool, and high gradient riffle; reach three was dominated by glide, pool, and run habitat; and reach four was predominately run, glide, and low gradient riffle habitat types (Appendix B, Figure B-150).

When compared with the overall habitat composition mix for streams in the lower Clark Fork River drainage, Elk Creek had similar amounts of pool, low gradient riffle, pocket water, and cascade habitats; relatively high amounts of glide and run habitat; and relatively low amounts of high gradient riffle habitat (Appendix B, Figure B-151). Habitat composition varies with tributary reach, with relatively high gradient tributary reaches containing high amounts of riffle habitat and relatively low gradient reaches containing high amounts of pool and glide habitat.

Substrate Composition - Substrate composition in Elk Creek was predominately gravel and peagravel (Tukey test, $P < 0.05$). Reach one contains high amounts of bedrock (Tukey test, $P < 0.05$); reach two contains a low amount of bedrock (Tukey test, $P < 0.05$); reach three contains a high percentage of peagravel, gravel, and sand/silt (Tukey test, $P < 0.05$); and reach four was predominately gravel (Tukey test, $P < 0.05$) (Appendix B, Figure B-152).

When compared with the average substrate composition for the LCFR drainage, Elk Creek contains similar amounts of gravel and bedrock; relatively high amounts of sand/silt and peagravel; and relatively low amounts of rubble, cobble, and boulder (Appendix B, Figure B-153).

Substrate composition varies with tributary reach, being dominated by rubble and cobble in relatively high gradient reaches and sand/silt in low gradient reaches.

Surface Fines - Surface fines in Elk Creek average 26 percent and range from 0 percent to 34 percent. Surface fines were highest in reach three, similar in reaches two and four, and lowest in reach one (<1%) (Tukey test, $P < 0.05$) (Appendix B, Figure B-154). Surface fines were statistically different between slow (33%) and fast water (20%) habitat types (t-Test, $P < 0.001$). Surface fines in Elk Creek were higher than the average for the drainage.

Riparian Vegetation - Riparian vegetation on Elk Creek was primarily grass/forbs (Tukey test, $P < 0.05$). Riparian vegetation in reach one was predominately sedge/rush (Tukey test, $P < 0.05$) while reaches two, three, and four were dominated by grass/forbs (Tukey test, $P < 0.05$) (Appendix B, Figure B-155).

When compared with the average riparian vegetation mix for the drainage, Elk Creek contains similar amounts of sedge/rush, riparian shrub, upland shrub, and riparian tree; relatively low amounts of upland tree; and high amounts of grass/forbs (Appendix B, Figure B-156).

The presence of vegetative bank cover for Elk Creek averages 73 percent and is relatively moderate when compared with the drainage average. Vegetative bank cover for Elk Creek is highest in reach three (89%) and lowest in reach one (24%) (Tukey test, $P < 0.05$) (Appendix B, Figure B-157).

Large Woody Debris - In Elk Creek, single pieces of LWD <3.0 m in length average 5.94/100 m and range from 2.32/100 m in reach two to 12.05/100 m in reach one (Appendix B, Figure B-158). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 54 percent, 42 percent, and 4 percent respectively.

Single pieces of LWD >3.0 m in length average 0.91/100 m and range from 0.0/100 m in reach one to 1.47/100 m in reaches three and four (Appendix B, Figure B-159). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 63 percent, 27 percent, and 11 percent respectively.

Aggregations of LWD average 0.22/100 m and range from 0.0/100 m in reach one to 0.35/100 m in reach three (Appendix B, Figure B-160). The number of single pieces of LWD found in aggregations average 4 for the combined tributary reaches and range from 2 to 7 pieces per aggregation. The distribution of root-wads average 0.15/100 m of stream, ranging from 0.0/100 m in reach one to 0.26/100 m in reach three (Appendix B, Figure B-161).

Amounts of LWD in Elk Creek were low for LWD <3.0 m in length, LWD >3.0 m in length, root-wads, and LWD aggregates when compared with the average for the LCFR drainage (Appendix B, Figure B-162).

Hydrology and Water Temperature The hydrology of Elk Creek is characteristic of large, high-order streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns. The water temperature regime is relatively high, which is also typical for this type of stream in the LCFR drainage, and can exceed levels suitable for salmonid populations.

Hydrology - During normal water years, flows are sufficient to support fish in the stream sections between RM 1.4 and 6.0. Stream sections between the stream mouth and RM 1.4 begin to go dry in mid-July. In 1994, tributary discharge monitored periodically at RM 4.6 averaged 1.5 m^3/sec, ranging from 0.2 m^3/sec in October to 3.4 m^3/sec during April (Appendix C, Table C-1).

Water Temperature - Water temperatures measured at RM 4.6 during 1994 averaged 8.7° C (Appendix C, Table C-2), ranging from a minimum of -0.04° C in December (Appendix C, Table C-3) to a maximum of 26.8° C in September (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 8.1° C, ranging from 6.0 to 15.8° C; in summer (June - August), temperatures averaged 15.5° C, ranging from 7.4 to 22.2° C; during fall (September - November) they averaged 6.9° C, ranging from -0.04 to 26.8° C; and in the winter months (December - February), water temperatures averaged 4.3° C, ranging from -0.04 to 5.7° C .

Sediment Survey

Major Stream Features - Conducted in June 1994, the survey of major stream features in Elk Creek extended from the mouth at Elk Creek bay upstream to the confluence of the East and West Forks of Elk Creek (RM 6.4). Reach one is an A-2 channel type extending a short distance above the reservoir (RM 0.1). Reach two was a C-4 channel type and extended to approximately the power line crossing (RM 1.5). Reach three is a B-2 channel type and extended from just above the power line crossing to RM 3.2. Reach four was a C-3 channel type and extended the rest of the length of the stream.

Reach one was a short, bedrock dominated reach with large pools that plunge into each other. The riparian zone was mostly cliff with LWD and spawning gravels non-existent. This reach had no undercut or eroding banks and a width/depth ratio of 6.

Reach two was a relatively short gravel reach that meandered through an unforested, grazed riparian area with grass and brush being the dominant vegetation. This reach had 2 percent undercut bank, 5 percent eroding bank, and a width/depth ratio of 21. Amounts of LWD were low but spawning gravels were present.

Reach three was a more entrenched reach dominated by scattered boulders. The riparian zone is largely unforested/deforested; riparian crossings and a power line crossing leaving an open canopy of conifers and brush. An old, collapsed log bridge is located at RSI site two. This reach had 3 percent undercut banks, 1 percent eroding banks, and a width/depth ratio of 14.

Reach four was a long, meandering reach that flows in and out of entrenched areas and a broad flood plain with some beaver activity and channel braiding. The riparian zone was mostly unforested and grazed with brush and grasses being the dominant vegetation type. Large woody debris was low but spawning gravels were available. Sediment sources were limited to isolated areas predominately channel meanders. This reach had 3 percent undercut banks, 2 percent eroding banks, and a width/depth ratio of 14.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Elk Creek was 28 percent, ranging from 25 percent in reach two to 46 percent in reach four (Appendix B, Figure B-163). There was no spawning substrate in reach one. Fine sediment levels in spawning gravels on Elk Creek were relatively moderate when compared with the average for the drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 35 percent, ranging from 11 percent in reach four to 39 percent in reach two (Appendix B, Figure B-164). If present, bull trout predicted embryo survival to emergence would average 39 percent and range from 14 percent in reach four to 43 percent in reach two (Appendix B, Figure B-165). When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in Elk Creek was relatively high.

Riffle Stability Index (RSI) - Elk Creek is a larger fourth order stream and had three surveyed reaches with RSI values ranging from 14 to 78. Good depositional areas were hard to locate in this stream. The RSI values were not calculated for reach one because the channel type was inconsistent with RSI methodology criteria. Reach one is a stable, bedrock dominated reach with large pools and it appears to have aggraded as a result of transported gravels.

Reach two was a C-4 channel type with a Wolman particle distribution of 8 percent sand, 26 percent gravel, 61 percent cobble, and 4 percent boulder. The mobile particle mean grain size for the single RSI site was 64mm. The RSI value was 35. Reach two meanders through a grazed riparian area.

Reach three was a B-2 channel type with an average Wolman particle distribution of 8 percent sand, 9 percent gravel, 31 percent cobble, and 51 percent boulder. Mobile particle mean grain size averages 59 mm, ranging from 55 to 64 mm. The RSI values are 17, 14, and 18. Reach three was more of a transport reach with boulders scattered throughout. The extremely low RSI values for this reach were surveyed from poor quality sites of lower confidence. Tree stumps and old structures indicate riparian disturbance within this reach.

Reach four was a C-4 channel type with an average Wolman particle distribution of 8 percent sand, 58 percent gravel, 32 percent cobble, and 1 percent boulder. Mobile particle mean grain size

averages 76 mm, ranging from 59 to 79 mm. The RSI values are 75, 64, and 78. Reach four was a long meandering reach through an unforested riparian area that could be considered for classification as a "B" or "F" channel type. This reach was laterally unstable with aggradation and braiding present and silt in the slack water.

Spawning Habitat Availability There are an estimated 345 m^2 of suitable habitat for fall-spawning salmonids in Elk Creek. This equates to 0.048 m^2/m of stream length and 0.5 percent of the total stream area. This habitat can accommodate an estimated 96 adfluvial or 216 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In Elk Creek, there was approximately 4,244 m^2 of salmonid rearing habitat. This equates to 0.590 m^2/m of stream length and 6.3 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of available rearing habitat per meter of stream was relatively high.

Productivity

Primary Productivity - In Elk Creek, we monitored periphyton accumulation for 35 days. The average autotrophic index was 11.60, ranging from 1.10 to 63.34; average chlorophyll content was 1.57 mg/m^2, ranging from 0.10 mg/m^2 to 3.92 mg/m^2; net productivity averages 0.46 $mg/m^2/day$, ranging from 0.10 $mg/m^2/day$ to 1.10 $mg/m^2/day$. When compared with the average values for the drainage, the autotrophic index and net productivity were relatively high while the chlorophyll content of the periphyton samples was low.

Secondary Productivity - In Elk Creek, benthic invertebrate populations consist primarily of members from the order Ephemeroptera (58%) followed by Plecoptera (15%) and Coleoptera (11%) (Appendix B, Figure B-166). Invertebrate densities average $993/m^2$ and range from $910/m^2$ in reach three to $1,111/m^2$ in reach four (Appendix B, Figure B-167). There was, however, no statistically significant difference in invertebrate densities among tributary reaches (t-Test, $P < 0.50$). Invertebrate species richness averages 23 species per reach, ranging from 21 in the second reach to 26 in reach three (Appendix B, Figure B-168). The invertebrate species diversity index (SDI) for the

stream was 2.862, ranging from a low of 2.163 in reach two to 2.443 in reach three (Appendix B, Figure B-169). Due to field crew safety considerations, invertebrate samples were not obtained from reach one. When compared with the average values for the drainage, invertebrate densities, species richness SDI were relatively high.

5.8.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in Elk Creek were relatively high for brown trout, moderate for brook trout, and relatively low for cutthroat trout (Appendix B, Figure B-170). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in Elk Creek are limited by a combination of stream intermittency, low amounts of LWD, and suitable spawning and rearing habitat. Stream sections with suitable amounts of LWD, unembedded cobble substrate, and clean spawning gravels had higher fish densities and a more diverse species mix than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all flowing reaches and habitat types found in Elk Creek. During 1994, reaches one and two were dry — as a result fish population estimates were not obtained for these tributary reaches. In Elk Creek, there are an estimated 2,205 brook trout, 1,903 brown trout, and 685 cutthroat trout (Appendix C, Table C-36). Fish densities in Elk Creek were statistically high for brook (0.304 fish/m) and brown (0.262 fish/m) trout and low for cutthroat trout (0.094 fish/m) (Tukey test, $P < 0.05$) (Appendix C, Table C-37).

Westslope Cutthroat Trout - Westslope cutthroat trout were present throughout Elk Creek although they were the least abundant species in reaches three and four (Appendix C, Table C-36). Cutthroat trout densities average 0.094 fish/m of stream, ranging from 0.007 fish/m in reach three to 0.146 fish/m in reach four (Appendix C, Table C-37), although the differences were not found to be statistically significant (t-Test, $P < 0.121$).

Cutthroat trout densities are relatively high in run and pool habitat, relatively low in glide and low gradient riffle habitat and in high gradient riffle habitat (Appendix C, Table C-38) although the

differences were not found to be statistically significant (ANOVA, P <0.50) (Appendix C, Table C-39).

Brown Trout - Brown trout were present in all Elk Creek tributary reaches and were the most abundant species in reach three and the second most abundant in reach four (Appendix C, Table C-36). Brown trout densities average 0.262 fish/m of stream, ranging from 0.189 fish/m in reach four to 0.387 fish/m in reach three (Appendix C, Table C-37) although once again the densities were not significantly different between reaches (t-Test, P <0.088).

Brown trout densities are relatively high in pool habitat; and relatively low in low gradient riffle habitat (Appendix C, Table C-38). The differences are not statistically significant (ANOVA, P <0.50) (Appendix C, Table C-39).

Brook Trout - Brook trout were present throughout the stream system and were the most abundant species in reach four and second most abundant in reach three (Appendix C, Table C-36). Brook trout densities average 0.304 fish/m of stream, ranging from 0.088 fish/m in reach three to 0.430 fish/m in reach four (Appendix C, Table C-37). Brook trout densities were highest in reach four (Tukey test, P <0.05) although overall differences among reaches were not found to be statistically significant (t-Test, P <0.106).

Brook trout densities are relatively high in run, low gradient riffle, and pool habitats; and low in glide habitat (Appendix C, Table C-38) although the differences were not statistically significant (ANOVA, P <0.50) (Appendix C, Table C-39).

Age, Growth and Mortality

Westslope Cutthroat Trout - Data collected from cutthroat trout populations in Elk Creek were not sufficient to complete age, growth, and mortality estimates for this stream.

Brown Trout - Longevity of brown trout in Elk Creek was higher than the average for the drainage with the oldest fish sampled being age V+. Growth of brown trout was high when compared with the LCFR drainage average with age I+ fish reaching a length of 80 mm (3.2 in) and age III+ a length

of 306 mm (12.2 in) (Appendix B, Figure B-171). The instantaneous survival rate of 27 percent was similar to the average for the drainage.

Brook Trout - The data set was not sufficient to develop reliable estimates of brook trout age and growth for this stream. However, when calculated from the length frequency distribution (Appendix B, Figure B-172), the instantaneous survival rate for brook trout was 18 percent which was lower than the average for the drainage.

Rare Fish Genetics Electrophoretic analysis of cutthroat trout was not conducted for populations in the Elk Creek Drainage.

Adfluvial Fish Spawning Elk Creek was checked for redds for the first time in 1993 and 22 redds thought to be from brown trout were located. It had been previously thought that the three falls/chutes located near the stream mouth were barriers to upstream movement of adfluvial fish from Cabinet Gorge Reservoir (Huston 1994). The presence of redds appearently from adfluvial fish above the falls complex indicates that this complex may not be a barrier to upstream fish movement. High flow conditions prevented completion of the redd counts for 1994 (Appendix C, Table C-10).

5.9 East Fork Elk Creek

The East Fork of Elk Creek flows approximately 11.0 km from the southeastern slopes of the Bitterroot Range to its confluence with Elk Creek (Figure 5-7). The East Fork drainage covers about 5,957 ha. Minor tributaries include Lone Cliff Gulch, Cascade Creek, Butte Creek, Lost Cabin Gulch, and Deer Creek. Average elevation change along the stream length is approximately 13 m/km.

5.9.1 Fish Habitat

Fish habitat in the East Fork consists of primarily low gradient riffle, run, and high gradient riffle habitat types; a substrate mix dominated by gravel, and rubble; high amounts of fine sediment; a functional although altered riparian zone; a riparian vegetation mix consisting primarily of mid-cover and upper canopy vegetation types; and relatively low amounts of large woody debris.

Habitat Survey The habitat survey for the East Fork of Elk Creek included one tributary reach and extended from the confluence with Elk Creek to a natural fish barrier in the form of an extensive cascade complex (RM 3.0).

Habitat Composition - Fish habitat was predominately low gradient riffle, run, and high gradient riffle habitat types. When compared with the overall habitat composition mix for streams in the LCFR drainage, the East Fork of Elk Creek had similar amounts of high gradient riffle; relatively high amounts of low gradient riffle and run; and relatively low amounts of pool habitat (Appendix B, Figure B-173).

Substrate Composition - Substrate composition in the East Fork consists primarily of gravel and rubble (Tukey test, $P < 0.05$). When compared with the LCFR drainage average, the East Fork has similar amounts of peagravel, cobble, and bedrock; relatively high amounts of gravel and rubble; and relatively low amounts of sand/silt and boulder (Appendix B, Figure B-174).

Surface Fines - Surface fines average 11 percent and were statistically different between slow (24%) and fast water (8%) habitat types (t-Test, $P < 0.001$). Surface fines in the East Fork were lower than the drainage average.

Riparian Vegetation - Riparian vegetation on the East Fork was predominately grass/forbs (Tukey test, $P < 0.05$). When compared with the average riparian vegetation mix for the drainage, the East Fork contains similar amounts of sedge/rush, riparian shrub, upland shrub, and riparian tree; relatively high amounts of grass/forbs; and low amounts of sedge/rush and upland tree (Appendix B, Figure B-175). The presence of vegetative bank cover for the East Fork averages 89 percent and is relatively moderate when compared with the drainage average.

Large Woody Debris - In the East Fork, single pieces of large woody debris (LWD) <3.0 m in length average 1.94/100 m. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 74 percent, 14 percent, and 12 percent respectively.

Single pieces of LWD >3.0 m in length average 0.83/100 m. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 20 percent, 38 percent, and 43 percent respectively.

Aggregations of LWD average 0.16/100 m. The number of single pieces of LWD found in aggregations average 2 and range from 2 to 5 pieces per aggregate. The distribution of root wads average 0.48/100 m.

Amounts of LWD in the East Fork were relatively low for all LWD classifications when compared with the average for the LCFR drainage (Appendix B, Figure B-176).

Hydrology and Water Temperature The hydrology of the East Fork is characteristic of low order, head water streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns. Water temperatures were not monitored in the East Fork. However, water temperatures periodically monitored by field crews indicate that the temperature regime most likely does not exceed levels suitable for salmonid populations.

Hydrology - During normal water years, flows are sufficient to support fish in the stream sections between RM 1.6 and the headwaters. Stream sections between RM 0.4 and 1.6 begin to go dry in late June. Tributary discharge monitored periodically at RM 0.1 during 1994 averaged 0.9 m^3/sec, ranging from 0.2 m^3/sec in October to 1.9 m^3/sec during May (Appendix C, Table C-1).

Water Temperature - Water temperature data is not available for the East Fork of Elk Creek.

Sediment Survey

Major Stream Features - Conducted in June of 1994, the survey of major stream features in the East Fork extended from the confluence with the West Fork upstream to the headwaters. Road 2273 follows the length of the stream. Reach one is a C-4 channel type, contains the end point of the habitat survey, and extended to just above Cascade Creek (RM 3.9). Reach two was a "C" type channel and extended to RM 4.2. Reach three consists of a B-3 channel type that extended from just

below Cliff Creek to RM 4.6. Reach four was an A-3 type channel that extended into the headwaters and was not surveyed.

Reach one was characterized by a meandering channel in an unforested, grassy flood plain with brush and grasses being the dominant vegetation type. The upper half of the reach had a band of alder brush bordering the stream with several dwellings and ranches along the banks. The channel was unstable and contains large amounts of mobile gravels. Spawning gravels were common throughout the reach but amounts of LWD was low. The lower portion of the reach had extensive stream enhancements including; brush staked along the banks and some pool creating structures. At RSI site three there was extensive bed load deposition and mid-channel bars with the stream flowing subsurface. Signs of an old riparian harvest were evident including the possibly of an old corduroy road in the stream channel. This reach had 16 percent undercut bank, 3 percent eroding bank, and a width/depth ratio of 17.

Reach two was a relatively short reach with a predominately cobble substrate. Reach two was a more forested reach with historical riparian harvest activity. Extensive bedload deposits of cobble were present. There were equestrian trails in the flood plain, while spawning gravels and LWD were not abundant in the reach. This reach is a transition reach between reaches one and three and had a width/depth ratio of 17.

Reach three was a steep transport reach that had relatively stable banks and a width/depth ratio of 7. Spawning gravels and LWD were scarce to non-existent. The riparian zone was in a state of regeneration and consists primarily of conifers approximately 15 years old.

Reach four was a steep forested reach with Road 2273 following closely along the channel. This road crosses the channel three times with 1.2 m culverts. The first road crossing in section 14 (RM 6.4) could be a fish migration barrier caused by an approximate 0.3 m drop from the culvert to the lower pool. Just below the second culvert crossing (RM 6.9) was a large log dam that is likely the remains of logging activities. The second and third (RM 7.5) culvert crossings were in fair condition. The width/depth ratio of this reach was 11.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the East Fork of Elk Creek was 27 percent. Fine sediment levels in spawning gravels on the East Fork were relatively low when compared with the average for the drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 36 percent. If present, bull trout predicted embryo survival to emergence would have been 40 percent. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in the East Fork was relatively high.

Riffle Stability Index (RSI) - The East Fork of Elk Creek is a third order stream that has two surveyed reaches with RSI values ranging from 18 to 89. Reach one is a C-4 channel type with an average Wolman particle distribution of 3 percent sand, 62 percent gravel, and 34 percent cobble. The mobile particle mean grain size averages 93 mm, ranging from 82 to 106 mm. The RSI values are 78, 75, and 89. Reach one was characterized by a grassy riparian zone with scattered brush and alders. Instability, gravel bars and particle transport were evident in this reach. Some fish habitat improvement and pool creation efforts have recently been undertaken in this stream; brush has been staked into the channel for stabilization and habitat enhancement purposes, and LWD has been added to encourage pool creation.

Reach two was a C-3 channel type but no RSI sites were surveyed. Considerable riparian disturbance was present in the upper end of reach two. In this reach there was what could have been an old corduroy road, stumps, and trails in the flood plain. Farther up the reach extensive bedload deposits have aggraded the entire area allowing the stream to flow subsurface through the porous substrate.

Reach three was a B-3 channel type with an average Wolman particle distribution of 1 percent sand, 17 percent gravel, 68 percent cobble, and 13 percent boulder. The mobile particle mean grain size averages 67 mm, ranging from 64 to 72 mm. The RSI values are 24, 23, and 18. The relatively low RSI values and loose cobble found in the high gradient section of reach three indicated downcutting of the channel with stable banks. The upper reaches are influenced by Road 2272 which has three crossings with 1.2 m diameter culverts and is supporting periodic timber harvest activity.

Spawning Habitat Availability There are an estimated 84 m^2 of suitable habitat for fall-spawning salmonids in the East Fork. This equates to 0.026 m^2/m of stream length and 0.6 percent of the total stream area. This habitat can accommodate an estimated 23 adfluvial or 53 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In the East Fork, there was approximately 2,585 m^2 of salmonid rearing habitat. This equates to 0.800 m^2/m of stream length and 18.1 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of available rearing habitat per meter of stream was relatively high.

Productivity

Primary Productivity - In the East Fork of Elk Creek, we monitored periphyton accumulation for 35 days. The average autotrophic index was 1.99, ranging from 0.13 to 5.14; average chlorophyll content was 5.94 mg/m^2, ranging from 1.71 mg/m^2 to 12.01 mg/m^2; net productivity averages 0.34 mg/m^2/day, ranging from 0.02 mg/m^2/day to 0.90 mg/m^2/day. When compared with the average for the LCFR drainage, the autotrophic index was relatively low, chlorophyll content was high, and net productivity was similar.

Secondary Productivity - Benthic invertebrate populations in the East Fork consist primarily of members from the order Ephemeroptera (63%) followed by Plecoptera (19%) and Diptera (13%) (Appendix B, Figure B-177). Invertebrate densities average 974/m^2, species richness was 19 and species diversity (SDI) was 2.149. When compared with average values for the LCFR drainage, invertebrate densities were high while species richness and SDI were relatively similar.

5.9.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in the East Fork were relatively high for brook trout and relatively low for cutthroat trout (Appendix B, Figure B-178). In general, salmonid populations in the East Fork are limited by a combination of stream intermittency, low amounts of LWD, and suitable spawning and rearing habitat. Stream sections with unsedimented

spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found in the East Fork of Elk Creek. Overall, there are an estimated 230 westslope cutthroat trout (0.048/m) and 2,296 brook trout (0.479/m) in the East Fork. Surprisingly, the densities were not found to be statistically significant (t-Test, P <0.062), a result of individual sample variation.

Westslope Cutthroat Trout - Westslope cutthroat trout were present throughout the East Fork of Elk Creek but were much less abundant than brook trout, the other trout species present. Cutthroat trout densities are relatively high in pool and high gradient riffle habitat types; and relatively low in low gradient riffle habitat (Appendix C, Table C-40), although the differences were not statistically significant (ANOVA, P <0.50) (Appendix C, Table C-41).

Brook Trout - Brook trout were present throughout the stream system where they were the most abundant salmonid species. Brook trout densities are relatively high in pool habitat; and relatively low in high gradient riffle habitat (Appendix C, Table C-40). There was no statistically significant difference in the distribution of brook trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-41).

Age, Growth and Mortality

Westslope Cutthroat Trout - The acquired data set was too small to reliably estimate age, growth, and survival of cutthroat trout in the East Fork of Elk Creek.

Brook Trout - Longevity of brook trout in the East Fork was similar to the average for the drainage with the oldest fish sampled being age III+. Growth of brook trout in the East Fork was relatively similar to the average for the LCFR drainage with age I+ fish reaching a length of 65 mm (2.6 in) and age III+ a length of 158 mm (6.3 in) (Appendix B, Figure B-179). The instantaneous survival rate calculated from age II was 15 percent and was lower than the average for the drainage.

Rare Fish Genetics Samples of cutthroat trout were not obtained for electrophoretic testing from the East Fork of Elk Creek.

Adfluvial Fish Spawning - Redd counts for adfluvial stocks of brown and bull trout were not conducted on the East Fork of Elk Creek.

5.10 West Fork Elk Creek

The West Fork of Elk Creek flows approximately 5.8 km from the southeastern slopes of the Bitterroot Range to its confluence with Elk Creek (Figure 5-7). The West Fork drainage covers about 3,108 ha. Minor tributaries include Jacks Gulch. Average elevation drop is about 19 m/km for the stream length.

5.10.1 Fish Habitat

Fish habitat in the West Fork consists of primarily low gradient riffle habitat; a substrate mix dominated by gravel; moderate amounts of fine sediment; a functional although altered riparian zone; a riparian vegetation mix consisting primarily of low-cover vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for the West Fork Elk Creek included one tributary reach and extended from the confluence with Elk Creek to a location were normal stream flows are insufficient to support fish populations (RM 2.0).

Habitat Composition - Fish habitat on the West Fork was predominately low gradient riffle habitat. When compared with the overall habitat composition mix for streams in the LCFR drainage, the West Fork of Elk Creek had similar amounts of pool, glide, and run habitats; relatively high amounts of low gradient riffle; and relatively low amounts of high gradient riffle habitat (Appendix B, Figure B-180).

Substrate Composition - Substrate composition in the West Fork contains high amounts of gravel (Tukey test, $P < 0.05$). When compared with the average substrate composition for the LCFR drainage, the West Fork contains similar amounts of rubble; relatively high amounts of peagravel

and gravel; and relatively low amounts of sand/silt, cobble, and boulder (Appendix B, Figure B-181).

Surface Fines - Surface fines for the West Fork average 17 percent and were statistically different between slow (19%) and fast water (13%) habitat types (t-Test, P< 0.001). Surface fines in the West Fork were higher than the drainage average.

Riparian Vegetation - Riparian vegetation on the West Fork was predominately grass/forbs (Tukey test, P <0.05). When compared with the average riparian vegetation mix for the drainage, the West Fork contains similar amounts of upland tree; relatively high amounts of grass/forbs and upland shrub; and relatively low amounts of sedge/rush, riparian shrub and riparian tree (Appendix B, Figure B-182). The presence of vegetative bank cover for the West Fork averages 66 percent and is relatively moderate when compared with the drainage average.

Large Woody Debris - In the West Fork, single pieces of large woody debris (LWD) <3.0 m in length average 4.49/100 m. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 95 percent, 6 percent, and 0 percent respectively.

Single pieces of LWD >3.0 m in length average 1.55/100 m. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 84 percent, 16 percent, and 0 percent respectively.

Aggregations of LWD average 0.58/100 m. The number of single pieces of LWD found in aggregations average 2.7, ranging from 2 to 7 pieces per aggregate. The distribution of root wads average 0.43/100 m.

In the West Fork, concentrations of LWD <3.0 m in length, LWD >3.0 m in length, root-wads, and LWD aggregations were lower than the average for the LCFR drainage (Appendix B, Figure B-183).

Hydrology and Water Temperature The hydrology of the West Fork is characteristic of low order, head water streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns. Water temperatures were not monitored in this stream.

However, periodic monitoring by field crews indicates that water temperatures most likely do not exceed levels suitable for salmonid populations.

Hydrology - During normal water years, flows are sufficient to support fish in the stream sections between RM 0.1 and Jacks Gulch. Stream sections between RM 0.1 nd the stream mouth begin to go dry in mid-July. Tributary discharge monitored periodically at RM 0.1 during 1994 averaged 0.5 m^3/sec, ranging from 0.0 m^3/sec in July through October to 1.8 m^3/sec during April (Appendix C, Table C-1).

Water Temperature - Water temperatures were not successfully monitored in this stream.

Sediment Survey

Major Stream Features - Conducted in June 1994, the survey of major stream features in the West Fork extended from the confluence with the East Fork of Elk Creek upstream to just below the Montana/Idaho border. Reach one was a C-4b channel type and is characterized by a meandering channel in a grazed, unforested riparian zone with dwellings, several unimproved vehicle crossings, dikes and active logging operations. Large woody debris in the lower reach was limited to brush that became more frequent further up the channel. Road 430 follows the stream up to Jacks Gulch. Sediment sources were concentrated around the dwellings, undeveloped vehicle crossings, and timber harvest areas. Further up the channel near RSI site three, the riparian zone became forested and sheltered under a canopy consisting primarily of cedar. During the survey, the stream channel above Jacks Gulch was dry. This reach had 11 percent undercut banks, 11 percent eroding banks, and a width/depth ratio of 19.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the West Fork of Elk Creek was 46 percent. Fine sediment levels in spawning gravels on the West Fork were relatively high when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 11 percent. If present, bull trout predicted embryo survival to emergence would have been 14 percent. When compared to the

LCFR drainage average, predicted embryo survival to emergence in the West Fork was relatively low.

Riffle Stability Index (RSI) - The West Fork of Elk Creek is a fourth order stream that had one surveyed reach with RSI values ranging from 66 to 79. Reach one was a C-4 channel type with an average Wolman particle distribution of 7 percent sand, 59 percent gravel, and 34 percent cobble. The mobile particle mean grain size averages 73 mm, ranging from 66 to 83 mm. The RSI values are 79, 76, and 61.

The West Fork of Elk Creek has been influenced by logging, road building, vehicle crossing, dwellings, and grazing. This stream was characterized by a broad flood plain with grass and brush the dominate vegetation. Stable LWD was limited in this channel. The RSI values in the West Fork indicate relatively high instability and a stream out of equilibrium. Further up the stream at site three the channel appeared more stable with a lower RSI value. In this section, the stream meandered through a mature stand of conifers then went dry just above Jacks Gulch.

Spawning Habitat Availability There are an estimated 163 m^2 of suitable habitat for fall-spawning salmonids in the West Fork. This equates to 0.034 m^2/m of stream length and 0.5 percent of the total stream area. This habitat can accommodate an estimated 45 adfluvial or 102 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In the West Fork, there was approximately 1,102 m^2 of salmonid rearing habitat. This equates to 0.230 m^2/m of stream length and 3.4 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of available rearing habitat per meter of stream was relatively low.

Productivity

Primary Productivity - We monitored periphyton accumulation in the West Fork for 35 days. The average autotrophic index was 2.41, ranging from 0.0 to 9.48; average chlorophyll content was 2.23 mg/m^2, ranging from 0.45 mg/m^2 to 5.00 mg/m^2; and net productivity averages 0.16 mg/m^2/day,

ranging from 0.03 mg/m^2/day to 0.33 mg/m^2/day. When compared with average values for the drainage, the autotrophic index and net productivity values were low while the chlorophyll content of the periphyton sample was similar.

Secondary Productivity - Benthic invertebrate populations in the West Fork consist primarily of members from the order Ephemeroptera (52%) followed by Trichoptera (21%) and Plecoptera (13%) (Appendix B, Figure B-184). Invertebrate densities average 1,138/m^2, species richness was 27 species and species diversity (SDI) was 2.660. When compared with average values for the drainage, invertebrate densities, species richness and SDI were all high in this stream.

5.10.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in the West Fork were relatively high for brook trout and relatively low for cutthroat trout (Appendix B, Figure B-185). In general, salmonid populations in the West Fork are limited by a combination of high channel instability, low amounts of LWD, and suitable spawning and rearing habitat. Stream sections that were relatively stable and contains unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found in the West Fork of Elk Creek. In the West Fork there are an estimated 47 westslope cutthroat trout and 4,274 brook trout. Fish densities were highest for brook trout (1.323 fish/m) followed by westslope cutthroat trout (0.014 fish/m) (T-test, P <0.004).

Westslope Cutthroat Trout - Westslope cutthroat trout were present in all surveyed tributary reaches, although they are the least abundant trout species. Cutthroat trout densities are relatively high in pool habitat and relatively low in glide habitat (Appendix C, Table C-42) although the difference was not statistically significant (ANOVA, P <0.50) (Appendix C, Table C-43).

Brook Trout - Brook trout are also present in all the tributary reaches and are the most abundant trout. Densities are relatively high in pool and run habitat types and relatively low in glide and high

gradient riffle habitat types (Appendix C, Table C-42) although the differences are not statistically significant (ANOVA, P <0.50)(Appendix C, Table C-43).

Age, Growth and Mortality

Westslope Cutthroat Trout - The data set is insufficient to estimate age, growth, and survival of cutthroat trout in the West Fork of Elk Creek.

Brook Trout - The brook trout data set is insufficient to estimate age and growth of the population in the West Fork. However, when calculated using the length frequency distribution (Appendix B, Figure B-186), the instantaneous survival rate for brook trout was 24% which was similar to the average for the drainage.

Rare Fish Genetics Electrophoretic analysis of cutthroat trout was not conducted for populations in the West Fork of Elk Creek.

Adfluvial Fish Spawning Redd counts for adfluvial stocks of brown and bull trout were not conducted on the West Fork of Elk Creek.

5.11 Pilgrim Creek

Pilgrim Creek flows approximately 9.5 km from the northeastern slopes of the Bitterroot Range to its confluence with Cabinet Gorge Reservoir at the town of Noxon, Montana (Figure 5-8). The drainage covers approximately 7,252 ha. Major streams in the drainage include the West and South Forks of Pilgrim Creek. Minor tributaries include Baxter Gulch and Four-mile Gulch. Average elevation drop is about 29 m/km. In reach one, from the confluence at Cabinet Gorge Reservoir to RM 1.8, the average drop is approximately 65 m/km; in reach two (RM 1.8 to RM 2.3) the change in elevation is about 60 m/km; and in reach three (RM 2.3 to RM 4.6) the stream drops approximately 11 m/km.

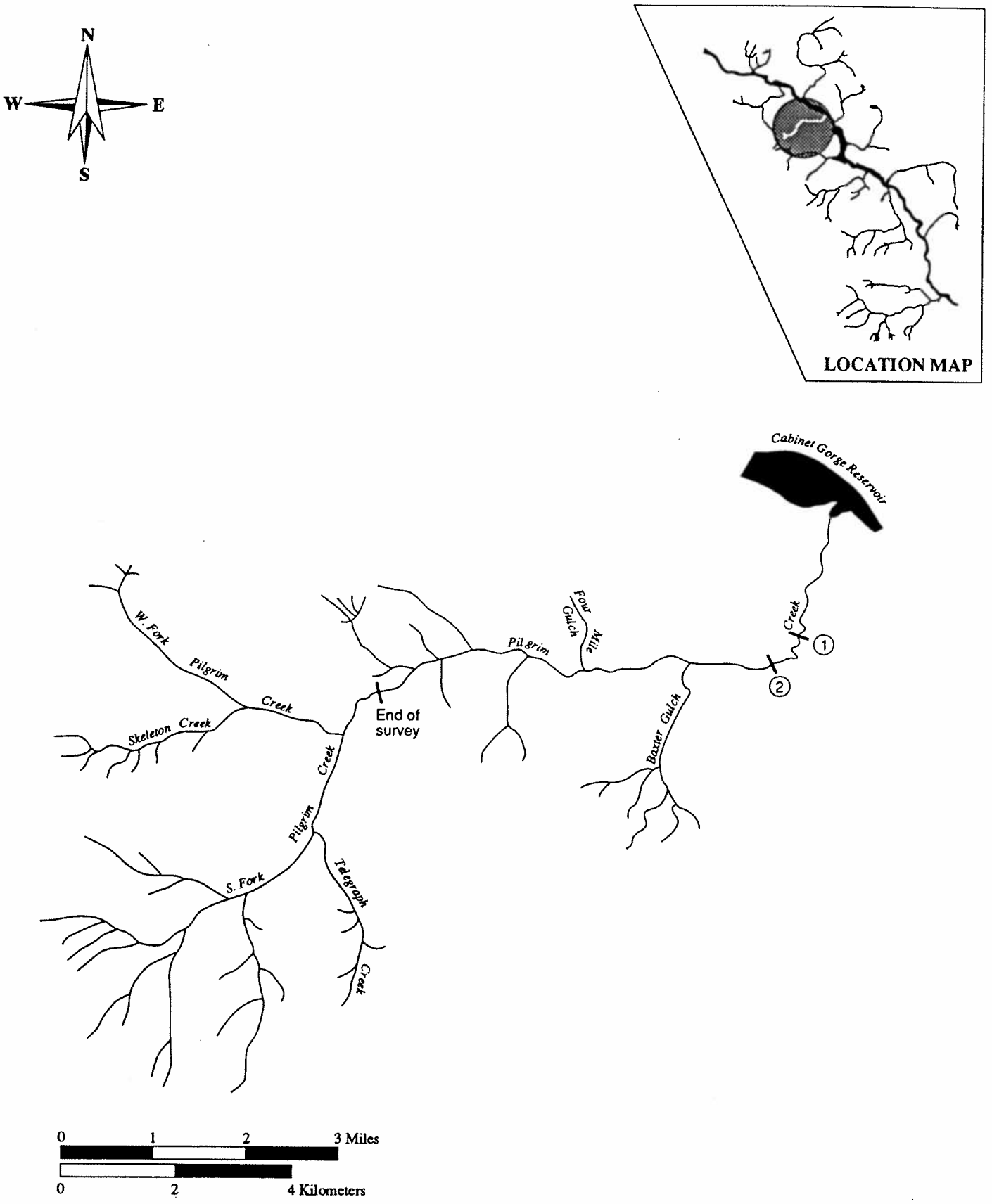

Figure 5-8. Map of the Pilgrim Creek drainage showing major tributaries and reach breaks.

5.11.1 Fish Habitat

Fish habitat in Pilgrim Creek consists of primarily run and low gradient riffle habitat types; a substrate mix dominated by gravel; high amounts of fine sediment; a semi-functional and altered riparian zone; a riparian vegetation mix consisting primarily of low- and canopy vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for Pilgrim Creek included three tributary reaches and extended from the confluence at Cabinet Gorge Reservoir to a location where normal summer flows are insufficient to support fish populations (RM 4.6).

Habitat Composition - Fish habitat on Pilgrim Creek was predominately run and low gradient riffle habitat types. Reach one was primarily cascade and run habitat; reach two was mainly run and low gradient riffle; and reach three was predominately low gradient riffle, run, and pool habitat types (Appendix B, Figure B-187).

When compared with the overall habitat composition mix for streams in the LCFR drainage, Pilgrim Creek had similar amounts of pool, glide, and low gradient riffle habitat; relatively high amounts of run and cascade habitat; and relatively low amounts of high gradient riffle habitat type (Appendix B, Figure B-188). Habitat composition varies with stream channel gradient. High gradient tributary reaches contains high amounts of cascade and high gradient riffle habitat while relatively low gradient reaches contains high amounts of run, pool, and glide habitat.

Substrate Composition - Substrate composition in Pilgrim Creek was dominated by gravel (Tukey test, $P < 0.05$). Reach one contains low amounts of bedrock (Tukey test, $P < 0.05$); and reaches two and three contains a high percentage of gravel (Tukey test, $P < 0.05$) (Appendix B, Figure B-189). Overall, substrate composition was relatively similar among tributary reaches.

When compared with the average substrate composition for the LCFR drainage, Pilgrim Creek contains similar amounts of sand/silt and bedrock; relatively high amounts of peagravel and gravel ; and relatively low amounts of rubble, cobble, and boulder (Appendix B, Figure B-190).

Surface Fines - Surface fines in Pilgrim Creek average 25 percent and range from 20 percent to 31 percent (Appendix B, Figure B-191). Surface fines were high in reach one (Tukey test, P <0.05). Surface fines were statistically different between slow (37%) and fast water (19%) habitat types (t-Test, P< 0.001). Surface fines in Pilgrim Creek were higher than the drainage average.

Riparian Vegetation - Riparian vegetation on Pilgrim Creek was predominately grass/forbs (Tukey test, P <0.05). Riparian vegetation in reach one was predominately grass/forbs, riparian tree, and riparian shrub (Tukey test, P <0.05); reach two contains a high amount of grass/forbs (Tukey test, P <0.05); and reach three consist primarily of grass/forbs (Tukey test, P <0.05) (Appendix B, Figure B-192).

When compared with the average riparian vegetation mix for the drainage, Pilgrim Creek contains similar amounts of upland shrub, riparian tree, and upland tree; relatively high amounts of grass/forbs; and relatively low amounts of sedge/rush and riparian shrub (Appendix B, Figure B-193).

The presence of vegetative bank cover for Pilgrim Creek is relatively moderate when compared with the drainage average. The presence of vegetative bank cover for Pilgrim Creek is similar in all reaches, averages 79 percent, ranging from 74 percent in reach one to 89 percent in reach two (ANOVA, P <0.20) (Appendix B, Figure B-194).

Large Woody Debris - In Pilgrim Creek, single pieces of LWD <3.0 m in length average 7.05/100 m and range from 1.92/100 m in reach three to 12.19/100 m in reach two (Appendix B, Figure B-195). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 78 percent, 20 percent, and 2 percent respectively.

Single pieces of LWD >3.0 m in length average 5.41/100 m and range from 1.64/100 m in reach one to 12.54/100 m in reach three (Appendix B, Figure B-196). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 65 percent, 27 percent, and 8 percent respectively.

Aggregations of LWD average 0.83/100 m and range from 0.45/100 m in reach three to 1.37/100 m in reach two (Appendix B, Figure B-197). The number of single pieces of LWD found in aggregations average 2 and range from 2 to 8 pieces per aggregate. The distribution of root-wads averages 0.66/100 m of stream, ranging from 0.10/100 m in reach one to 1.14/100 m in reach two (Appendix B, Figure B-198).

Amounts of LWD in Pilgrim Creek were low for LWD <3.0 m in length, LWD >3.0 m in length, LWD aggregates, and root-wads when compared with the average for the LCFR drainage (Appendix B, Figure B-199).

Hydrology and Water Temperature The hydrology of Pilgrim Creek is characteristic of intermediate order, mid-reach streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns in the upper reaches. The water temperature regime is relatively moderate, which is also typical for this type of stream in the LCFR drainage, and does not typically exceed levels suitable for salmonid populations.

Hydrology - Tributary discharge monitored at RM 0.1 in 1994 averaged 0.5 m^3/sec, ranging from 0.1 m^3/sec in September, October, December, and January to 1.4 m^3/sec during May (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish in the stream sections between RM 4.6 and the stream mouth. Stream sections between RM 4.6 and the confluence with the South and West Forks of Pilgrim Creek begin to go dry in late June.

Water Temperature - Water temperatures measured at RM 1.8 during 1994 averaged 6.7° C (Appendix C, Table C-2), ranging from a minimum of 3.4° C in October (Appendix C, Table C-3) to a maximum of 15.0° C in August (Appendix C, Table C-4). in the spring (March - May), water temperatures averaged 6.8° C, ranging from 6.1 to 8.9° C; in summer (June - August), temperatures averaged 8.7° C, ranging from 6.0 to 15.0° C; during fall (September - November), they averaged 6.0° C, ranging from 3.4 to 11.7° C; and in the winter months (December - February), water temperatures averaged 5.3° C, ranging from 3.6 to 5.5° C.

Sediment Survey

Major Stream Features - Conducted in June 1994, the survey of major stream features in Pilgrim Creek extended from the mouth at Pilgrim Creek Bay and continued for the length of the stream. Reach one was a C-4 channel type and extended from the mouth to the first confinement in the corner of section 31 (RM 1.8). Reach two was a B-3 channel type ending just into section 30 (RM 2.3). Reach three contains the end point of the habitat survey, was a C-4 channel type, and began at an old log dam and extended to the confluence of the West and South Forks of Pilgrim Creek.

Reach one was a meandering channel of slower velocity that flows through the town of Noxon, MT. The riparian zone was fairly well vegetated, although grazing, some beaver activity, channelization, and dwellings have influenced the stream. With 2 percent undercut bank, 1 percent eroding bank, and a width/depth ration of 15, the stream is recovering from man caused impacts. Large woody debris in the channel was concentrated in debris jams with reasonable recruitment of LWD.

Reach two had a short, relatively stable, more constricted channel with higher velocity flows through a transport type channel. This reach was a transition area between the two 'C' type channels of reaches one and three. An obstructive log dam (approximately 3.5 meters in height) was present at the upper end of this reach. The riparian zone was mostly vegetated under a canopy of conifers with no apparent disturbances. This reach had no undercut banks, 1 percent eroding banks, and a width/depth ratio of 12.

Reach three was an unstable, meandering, aggraded reach that began at an old log dam that at one time provided water for the town of Noxon. This dam retains a large amount of gravel within the reach. Large gravel bars and active gravel transport occurs throughout the reach. Spawning gravels were common but amounts of LWD were low in this reach. The riparian zone was open and grazed with brush and grass being the dominant vegetation. Dwellings were common along the stream banks. Road 149 follows the length of the reach. During the survey, the channel was dry for most of the length in section 33. This reach had 5 percent eroding banks, 5 percent undercut banks, and a width/depth ratio of 26.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Pilgrim Creek was 36 percent, ranging from 32 percent in reach three to 44 percent in reach two (Appendix B, Figure B-200). Fine sediment levels in spawning gravels on Pilgrim Creek were relatively moderate when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout averages 24 percent, ranging from 14 percent in reach two to 29 percent in reach three (Appendix B, Figure B-201). If present, bull trout predicted embryo survival to emergence would have been 28 percent rangeing from 17 percent in reach two to 33 percent in reach three (Appendix B, Figure B-202). When compared to the LCFR drainage average, predicted embryo survival to emergence in Pilgrim Creek was relatively moderate.

Riffle Stability Index - Pilgrim creek is a larger fourth order stream that had three surveyed reaches with RSI values ranging from 28 to 93. Reach one was a C-4 channel type with an average Wolman particle distribution of 10 percent sand, 55 percent gravels, 28 percent cobble, and 7 percent boulder. The mobile particle mean grain size averages 43 mm, ranging from 39 to 48 mm. The RSI values are 54, 40, and 61. Reach one appeared to have been diked and channelized in many areas to prevent flooding of the town of Noxon, Montana. This channelization could explain the seemingly lower RSI values found in this reach. Also, several beaver dams and impoundments were present in this area.

Reach two was a B-3 channel type and had an average Wolman particle distribution of 10 percent sand, 34 percent gravel, 39 percent cobble, and 13 percent boulder. Mobile particle mean grain size from the two RSI sites averages 44 mm, ranging from 43 to 44 mm. The RSI values are 28 and 45. Reach two was a transition channel between reaches one and two. The stream became constricted and flowed under a conifer canopy with stable banks.

Reach three was a C-4 channel type with an average Wolman particle distribution in the riffles of 17 percent sand, 75 percent gravels, and 9 percent small cobble. The mean grain size of the mobile particles averages 60 mm, ranging from 57 to 62 mm. The RSI values are 87, 93, and 80. Reach three was a very unstable, aggraded reach with a large amount of gravels stored behind the old water works dam. Special notice should be made of this dam since its collapse will result in a massive

transport of gravels into the lower reaches. Large gravel bars with a riparian zone of brush and grasses characterized this reach. Grazing and land clearing was evident throughout this reach.

Spawning Habitat Availability - There are an estimated 895 m^2 of suitable habitat for fall-spawning salmonids in Pilgrim Creek. This equates to 0.122 m^2/m of stream length and 2.1 percent of the total stream area. This habitat can accommodate an estimated 249 adfluvial or 559 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively high.

Rearing Habitat Availability - In Pilgrim Creek, there was approximately 4,696 m^2 of salmonid rearing habitat. This equates to 0.640 m^2/m of stream length and 11.0 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of available rearing habitat per meter of stream was high.

Productivity

Primary Productivity - We monitored periphyton accumulation in Pilgrim Creek for 35 days. The average autotrophic index was 3.37, ranging from 0.0 to 5.67; average chlorophyll content was 1.52 mg/m^2, ranging from 0.0 mg/m^2 to 4.37 mg/m^2; net productivity averages 0.23 mg/m^2/day, ranging from 0.07 mg/m^2/day to 0.69 mg/m^2/day. In this stream, the autotrophic index and chlorophyll content was relatively low while net productivity was relatively moderate when compared with the average values for the drainage.

Secondary Productivity - Benthic invertebrate populations in Pilgrim Creek consist primarily of members from the order Diptera (68%) followed by Ephemeroptera (20%) and Coleoptera (5%) (Appendix B, Figure B-203). Invertebrate densities average 844/m^2 and range from 265/m^2 in reach one to 1,776/m^2 in reach two (Appendix B, Figure B-204). There was, however, no statistically significant difference in invertebrate densities among reaches (ANOVA, $P < 0.20$). Invertebrate species richness for the stream was 17, ranging from 13 in the second reach to 17 in reach three (Appendix B, Figure B-205). The invertebrate species diversity index (SDI) for the stream was 1.530, ranging from a low of 0.492 in the second reach to a high of 2.146 in reach three (Appendix

B, Figure B-206). Invertebrate densities were high, species richness was similar, and species diversity was relatively low when compared with average values for the drainage.

5.11.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in Pilgrim Creek were relatively high for cutthroat trout and relatively moderate for brook trout (Appendix B, Figure B-207). Species composition and abundance of salmonids varies among tributary reaches. In general, salmonid populations in Pilgrim Creek are limited by a combination of low amounts of LWD, and suitable spawning and rearing habitat. Stream sections with unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all reaches and habitat types found in Pilgrim Creek. Self-sustaining populations of both westslope cutthroat and rainbow trout were present in this stream. Although in most cases, field personnel were able to discern differences between the two species based on phenotypic characteristics, it was not possible to determine the true genetic composition of species in the field. Because of this, westslope cutthroat trout, rainbow trout, and suspected hybrids (WCTxRBT) in Pilgrim Creek were combined into a single "cutthroat/rainbow trout" grouping.

In Pilgrim Creek there are an estimated 9,315 cutthroat/rainbow trout and 1,821 brook trout (Appendix C, Table C-44). Fish densities were high for cutthroat/rainbow trout (1.269 fish/m) and low for brook trout (0.248 fish/m) (t-Test, $P < 0.001$) (Appendix C, Table C-45).

Cutthroat/rainbow Trout - Cutthroat/rainbow trout are present throughout Pilgrim Creek and are the most abundant species in all three reaches (Appendix C, Table C-44). Densities average 1.269 fish/m of stream, ranging from 0.442/m in reach three to 1.700/m in reach one (Appendix C, Table C-45) and were statistically high in reach one and low in reach three (Tukey test, $P < 0.05$).

Cutthroat/rainbow trout densities are relatively high in pool and low gradient riffle and relatively low in cascade habitat (Appendix C, Table C-46, C-47), and although the differences are statistically

significant (ANOVA, P <0.02) the data set is insufficent to statistically characterize the differences (Tukey test inconclusive).

Bull Trout - No bull trout were found in Pilgrim Creek during 1993 or 1995 and only one bull trout (241 mm/10 in. in length) was found in 1994. Given its size, this was likely an adfluvial fish that moved into the stream from Noxon Reservoir.

Brown Trout - A single brown trout, 145 mm in length, was found in Pilgrim Creek during 1993 and none in 1994 or 1995.

Brook Trout - Brook trout are found throughout Pilgrim Creek but are less abundant than cutthroat/rainbow trout in all three reaches (Appendix C, Table C-44). Brook trout densities average 0.248 fish/m of stream, ranging from 0.055 fish/m in reach one to 0.576 fish/m in reach two (Appendix C, Table C-45) where densities are statistically high (Tukey test, P <0.05).

Brook trout densities are relatively high in pool habitat; and relatively low in high gradient riffle and run habitat types (Appendix C, Table C-46) but the differences are not statistically significant (ANOVA, P <0.50) (Appendix C, Table C-47).

Age, Growth and Mortality

Westslope Cutthroat /rainbow Trout - Longevity of cutthroat trout in Pilgrim Creek was similar to the average for the drainage with the oldest fish sampled being age III+. Growth of cutthroat/rainbow trout in Pilgrim Creek was relatively moderate when compared with the average growth rate for the LCFR drainage with age I+ fish reaching a length of 64 mm (2.5 in) and age III+ a length of 190 mm (7.6 in) (Appendix B, Figure B-208). The instantaneous survival rate of 20 percent was similar the average for the drainage.

Brook Trout - Longevity of brook trout in Pilgrim Creek was similar to the average for the drainage with the oldest fish sampled being age III+. Growth of brook trout in Pilgrim Creek is relatively moderate when compared with the average for the LCFR drainage with age I+ fish reaching a length

of 73 mm (2.9 in) and age III+ a length of 176 mm (7.0 in) (Appendix B, Figure B-209). The instantaneous survival rate of 19 percent was lower than the average for the drainage.

Rare Fish Genetics Samples of cutthroat trout were obtained near the mouth of Pilgrim Creek and from the West Fork of Pilgrim Creek in 1994. Electrophoretic analysis determined that the fish from the mouth of Pilgrim Creek were hybridized westslope cutthroat/rainbow trout. Samples obtained from the West Fork population were considered to be genetically pure aboriginal westslope cutthroat trout.

There are no barriers to upstream movement of fish in Pilgrim Creek. However, the lower reaches of the West Fork of Pilgrim Creek and the upper reaches of Pilgrim Creek near the confluence with the West Fork only flow during periods of run-off or during high flow events. These conditions restrict the upstream movement of fish and potential sources of hybridization into the West Fork of Pilgrim Creek.

Adfluvial Fish Spawning - Redd counts for brown and bull trout were conducted on Pilgrim Creek for the first time during 1993. No redds were found in the stream sections surveyed. High flow conditions prevented the successful completion of redd counts in 1994 and 1995.

5.12 Rock Creek

Rock Creek flows approximately 16.2 km (10.1 mi) from the southwestern slopes of the Cabinet Mountains Wilderness Area to its confluence with Cabinet Gorge Reservoir approximately 3.0 km (1.9 mi) east of Noxon, Montana (Figure 5-9). The Rock Creek drainage covers about 8,288 ha. Minor tributaries include West Fork Rock Creek, Orr Creek, Big Cedar Gulch, and Engle Creek. Average elevation drop is about 43 m/km. In reach one, from the confluence at Cabinet Gorge Reservoir to RM 1.9, the average drop is approximately 34 m/km; in reach two (RM 1.9 to RM 5.5) the change in elevation is about 62 m/km; for reach three (RM 5.5 to RM 6.2), the stream drops approximately 49 m/km ; and in reach four (RM 6.2 to RM 7.6), the average drop is 120 m/km.

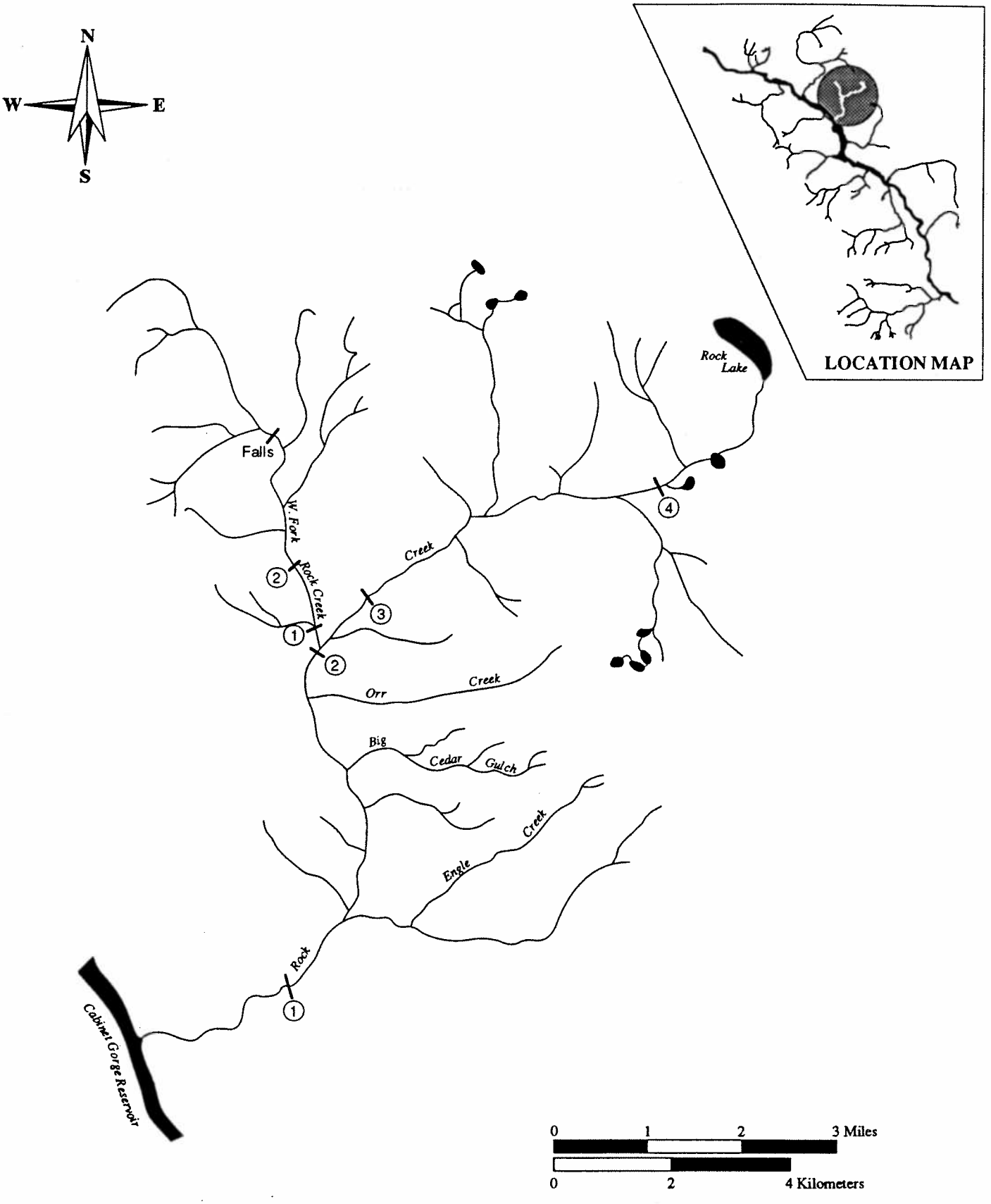

Figure 5-9. Map of the Rock Creek drainage showing major tributaries and reach breaks.

5.12.1 Fish Habitat

Fish habitat in Rock Creek consists of primarily run, low gradient riffle, and cascade habitat types; a substrate mix dominated by gravel, rubble, cobble, and boulder; low amounts of fine sediment; a largely non-functional and altered riparian zone; a riparian vegetation mix consisting primarily of a relatively even mix of vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for Rock Creek included four tributary reaches and extended from the confluence with Cabinet Gorge Reservoir to a natural fish barrier just below Rock Creek Meadows (RM 7.6).

Habitat Composition - Fish habitat on Rock Creek consists primarily of run, low gradient riffle, and cascade habitat types. Reach one was predominately run and low gradient riffle habitat; reach two was mainly run and glide habitat types; reach three was dominated by low gradient riffle and high gradient riffle habitat; and reach four was predominately cascade and low gradient riffle habitat types (Appendix B, Figure B-210).

When compared with the overall habitat composition mix for streams in the LCFR drainage, Rock Creek had similar amounts of pool, glide, low gradient riffle, and pocket water habitats; relatively high amounts of run and cascade habitats; and relatively low amounts of high gradient riffle habitat (Appendix B, Figure B-211). Habitat composition varies with stream channel gradient and confinement. Tributary reaches that were relatively high gradient and confined typically contains high amounts of cascade and riffle habitat; while relatively low gradient and unconfined tributary reaches contains high amounts of run, pool, and glide habitat types.

Substrate Composition - Substrate composition in Rock Creek was predominately rubble, cobble, gravel, and boulder (Tukey test, $P<0.05$). Reaches one and two contains high amounts of gravel (Tukey test, $P<0.05$); reach three was predominately cobble and boulder (Tukey test, $P<0.05$); and reach four had high amounts of boulder (Tukey test, $P<0.05$) (Appendix B, Figure B-212).

When compared with the average substrate composition for the LCFR drainage, Rock Creek contains similar amounts of gravel, rubble, and bedrock; relatively high amounts of cobble and boulder; and

relatively low amounts of sand/silt and peagravel (Appendix B, Figure B-213). Substrate composition varies with tributary reach, being dominated by cobble and boulder in relatively high gradient reaches and rubble and gravel in low gradient reaches.

Surface Fines - Surface fines in Rock Creek average 10 percent and range from <1 percent to 22 percent (Appendix B, Figure B-214). Surface fines were highest in reach one (Tukey test, $P<0.05$). Surface fines were also statistically differenct between slow (16%) and fast water (7%) habitat types (t-Test, $P< 0.001$). Surface fines in Rock Creek were lower than the drainage average.

Riparian Vegetation - Riparian vegetation on Rock Creek was predominately sedge/rush, upland tree, and riparian shrub (Tukey test, $P <0.05$). Reach one appeared to contain relatively high amounts of sedge/rush and grass forbs; reach two has relatively high amounts of riparian shrub; reach three contains a relatively high percentage of upland tree; and reach four was predominately sedge/rush, upland tree, and riparian shrub (Tukey test, $P <0.05$) (Appendix B, Figure B-215). Although statistically significant differences in vegetation composition were found in reaches one, two, and three (ANOVA, $P <0.001$), the data set was insufficent to statistically characterize the individual reaches (Tukey test, inconclusive).

When compared with the average riparian vegetation mix for the drainage, Rock Creek contains similar amounts of riparian shrub; relatively low amounts of grass/forbs and riparian tree; and high amounts of sedge/rush, upland shrub, and upland tree (Appendix B, Figure B-216).

The presence of vegetative bank cover for Rock Creek averages 33 percent, is greatest in reach four, and lower in reaches three, two, and one (Tukey test, $P <0.05$) (Appendix B, Figure B-217). The amount of vegetative bank cover along Rock Creek is the lowest occurrence found in the LCFR drainage. Low overall presence of vegetative bank cover for Rock Creek is due to conditions in reaches one and two where the stream channel is relatively broad and the banks unstable and poorly defined. These conditions have produced a relatively unstable, sparsely vegetated, and generally non-functional riparian zone.

Large Woody Debris - In Rock Creek, single pieces of LWD <3.0 m in length average 4.17/100 m and range from 2.14/100 m in reach one to 5.04/100 m in reach three (Appendix B, Figure B-218).

Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 15 percent, 33 percent, and 57 percent respectively.

Single pieces of LWD >3.0 m in length average 6.82/100 m and range from 3.77/100 m in reach one to 10.25/100 m in reach three (Appendix B, Figure B-219). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 8 percent, 17 percent, and 75 percent respectively.

Aggregations of LWD average 0.41/100 m and range from 0.21/100 m in reach one to 0.60/100 m in reach three (Appendix B, Figure B-220). The number of single pieces of LWD found in aggregations average 5.5 pieces per aggregate for the combined tributary reaches and range from 4 to 7 pieces per aggregate. The distribution of root-wads averages 3.22/100 m of stream, ranging from 1.66/100 m reach one to 4.27/100 m reach three (Appendix B, Figure B-221).

Amounts of LWD in Rock Creek were low for LWD <3.0 m in length, LWD >3.0 m in length, and LWD aggregates; and relatively high for root-wads when compared with the average for the LCFR drainage (Appendix B, Figure B-222).

Hydrology and Water Temperature The hydrology of Rock Creek is characteristic of intermediate order, mid-reach streams in the LCFR drainage that experience periodic high flow events and subject to extreme intermittent flow patterns. The water temperature regime is relatively moderate, which is also typical for this type of stream in the LCFR drainage, and typically does not exceed levels suitable for salmonid populations.

Hydrology - Tributary discharge monitored at RM 1.7 during 1994 averaged 0.7 m^3/sec, ranging from <0.1 m^3/sec in February to 2.3 m^3/sec during April (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish in the stream sections between RM 1.5 - 1.9 and between RM 3.4 - and the Rock Creek Meadows area. Stream sections between RM 1.5 and the stream mouth as well as between RM 1.9 - 3.4 begin to go dry in mid-July.

Water Temperature - Water temperatures measured at RM 1.7 in 1994 averaged 6.7° C (Appendix C, Table C-2), ranging from a minimum of 0.3° C in November (Appendix C, Table C-3) to a

maximum of 12.1° C in July (Appendix C, Table C-4). in the spring (March - May), water temperatures averaged 6.5° C, ranging from 5.2 to 8.3° C; in summer (June - August), temperatures averaged 10.8° C, ranging from 9.7 to 12.1° C; during fall (September - November), they averaged 6.0° C, ranging from 0.3 to 9.1° C; and in the winter months (December - February), water temperatures averaged 3.4° C, ranging from 2.7 to 4.4° C.

Sediment Survey

Major Stream Features - Conducted on 30 October 1993, this stream feature survey began at the falls located in Rock Creek Meadows approximately 1.0 km above the Rock Lake Trail bridge (Road 150-A) and proceeded downstream to the confluence with West Fork Rock Creek. The upper 2.2 km of the stream channel (reach four) was confined colluvial type A-2 and the lower 1.1 km (reach three) was mod-confined alluvial type B-1. Reaches three and four contains considerable amounts of stable LWD. Substrate consists primarily of large cobble and boulders with relatively little bedload movement. Stream banks were stable with some channel braiding. Spawning habitat was limited to isolated pockets of gravel behind stable debris or boulders. No development has occurred in this section of the drainage, suggesting the present characteristics of this stream approximate natural conditions.

Conducted on 30 and 31 October 1993, this stream feature survey began at the confluence with the West Fork of Rock Creek and proceeded downstream to the mouth at Cabinet Gorge Reservoir. The upper 3.9 km the stream channel (reach two) was mod-confined alluvial type B-1 and the lower 1.6 km (reach one) was unconfined alluvial type C-2. Reaches one and two contain relatively low amounts of stable LWD. Flows are flashy and seasonally intermittent. Substrate was relatively unstable and consists primarily of large cobble with considerable bedload movement. Channel braiding was relatively high with side channels being dry during late summer. Stream intermittency results in the dewatering of approximately 62 percent (2.4 km) of reach two and 92 percent (2.4 km) of reach one by late summer. Stream banks were washed-out but stable during moderate flows. A large corrugated metal pipe (CMP) located at Highway 200 is not a barrier to fish movement.

Spawning habitat in the lower reaches was restricted to isolated pockets of gravel behind stable debris or boulders above the confluence of Engle Creek. Below Engle Creek, spawning habitat was

found behind stable debris and boulders as well as some side and main-channel depositional areas. The source of these gravels and fine sediments is a large eroding bank located approximately 0.4 km up Engle Creek.

A significant portion of the riparian zone in reaches one and two was either logged or burned-off in wildfires during the late 1900s. Stream intermittency and logged/burned sections appear to be related. The presence and configuration of large rooted stumps in the present river channel suggests that the current channel configuration and seasonal flow patterns may not be the same as those that existed prior to logging and/or wildfire occurrence.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Rock Creek was 43 percent. Sediment core samples were obtained only from reach two. In reaches one, three, and four it was not possible to obtain core samples per the sampling protocol as spawning gravels were restricted to depositional areas behind boulders and stream obstructions. Fine sediment levels in spawning gravels on Rock Creek were relatively high when compared with the LCFR drainage average.

Predicted embryo survival to emergence for westslope cutthrout trout was 15 percent. For bull trout, predicted embryo survival to emergence was 18 percent. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in Rock Creek was relatively low.

Riffle Stability Index (RSI) - Rock Creek has two classified reaches with a total of 6 surveyed RSI sites. RSI values range from 34 to 61. The RSI values were not calculated for reaches one and four because the channel type was inconsistent with RSI methodology criteria.

Reach two is a C-3 channel type with an average Wolman particle distribution of 3 percent sand, 18 percent gravel, 69 percent cobble, and 10 percent boulder. The mean grain size of the transported particles averages 145 mm, ranging from 126 to 164 mm. The RSI values are 61, 59, and 51.

Reach three is a B-3 channel type with an average Wolman particle distribution of 9 percent gravel, 54 percent cobble, and 37 percent boulder. The mean grain size of transported particles averages 145

mm, ranging from 138 to 151 mm. The RSI values are 35, 34, and 42. Downcutting was noted throughout the reach.

Spawning Habitat Availability There are an estimated 227 m^2 of suitable habitat for fall-spawning salmonids in Rock Creek. This equates to 0.034 m^2/m of stream length and 1.1 percent of the total stream area. This habitat can accommodate an estimated 63 adfluvial or 142 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In Rock Creek, there was approximately 3,348 m^2 of salmonid rearing habitat. This equates to 0.500 m^2/m of stream length and 16.1 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of rearing habitat per meter of stream was relatively similar.

Productivity

Primary Productivity - We monitored periphyton accumulation in Rock Creek for 20 days. The average autotrophic index was 4.10, ranging from 0.66 to 7.25; average chlorophyll content was 2.31 mg/m^2, ranging from 0.85 mg/m^2 to 3.24 mg/m^2; and net productivity averages 0.50 $mg/m^2/day$, ranging from 0.11 $mg/m^2/day$ to 0.93 $mg/m^2/day$. Chlorophyll content and net productivity values were high while the autotrophic index was relatively low when compared with average values for the drainage.

Secondary Productivity - Benthic invertebrate populations in Rock Creek consist primarily of members from the order Ephemeroptera (69%) followed by Plecoptera (12%) and Trichoptera (10%) (Appendix B, Figure B-223). Invertebrate densities average $381/m^2$ and range from $352/m^2$ in reach four to $432/m^2$ in reach two (Appendix B, Figure B-224). There was no statistically significant difference in invertebrate densities among reaches (ANOVA, $P < 0.50$). Invertebrate species richness for the stream was 20, ranging from 13 in reach four to 20 in reach three (Appendix B, Figure B-225). The invertebrate species diversity index (SDI) for the stream was 2.555, ranging from 1.987 in the second reach to 2.397 in reach three (Appendix B, Figure B-226). Invertebrate samples were not obtained from reach one because it was dry during the sampling period. Invertebrate species richness

and SDI were similar while invertebrate densities were relatively low when compared with the average values for the LCFR drainage.

5.12.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in Rock Creek are relatively high for cutthroat trout and bull trout; and relatively low for brook trout (Appendix B, Figure B-227). Species composition and abundance of salmonids varies among reaches. In general, trout populations in Rock Creek are limited by stream intermittency and low amounts of suitable spawning and rearing habitat. Stream sections with unsedimented spawning gravels and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Fish population estimates were obtained during 1993 and 1994. The 1993 estimate was conducted during late fall and required electrofishing techniques slightly different than the basic methodology criteria. Consequently, the 1993 data for this stream are not directly comparable to other estimates obtained as part of this study although they were useful as an indication of species occurrence and distribution. The population, distribution, density, habitat utilization and other results for the Rock Creek mainstem presented below are based on the 1994 data.

Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types in reaches two, three, and four of Rock Creek. During the sample period reach one was dry. In addition, a significant portion of reach three was also dry. Because of this it was not possible to obtain sufficient fish population data from these reaches. As a result we combined the limited density estimates from reach three with those of reach four.

In the Rock Creek mainstem there are an estimated 6,445 westslope cutthroat trout, 634 brook trout, and 1,900 bull trout (Appendix C, Table C-48). Fish densities were high for westslope cutthroat trout (0.774 fish/m) and low for brook (0.076 fish/m) and bull (0.228 fish/m) trout (Tukey test, $P<0.05$) (Appendix C, Table C-49).

Westslope Cutthroat Trout - Westslope cutthroat trout were found in all three wetted reaches (two, three, and four) of the Rock Creek mainstem and were the most abundant trout species (Appendix C, Table C-48). Densities average 0.774 fish/m of stream, ranging from 0.675/m in reach two to 0.820/m in reaches three and four combined (Appendix C, Table C-49). The difference was not statistically significant (t-Test, P <0.603).

Cutthroat trout densities are relatively high in pool, pocket water, run, and high gradient riffle habitat; and relatively low in glide habitat (Appendix C, Table C-50) although the differences are not statistically significant (ANOVA, P <0.20) (Appendix C, Table C-51).

Bull Trout - Bull trout are found in all three generally wetted tributary reaches (two, three, and four) but are also the least abundant of the trout species in each reach (Appendix C, Table C-48). Densities average 0.228 fish/m of stream, ranging from 0.154 fish/m to 0.262 fish/m (Appendix C, Table C-49). Bull trout densities are highest in reaches three and four (t-Test, P <0.044).

Bull trout densities are relatively high in low gradient riffle and low in glide habitat (Appendix C, Table C-50, C-51), and although the differences are statistically significant (ANOVA, P <0.05) the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive).

Brook Trout - Brook trout were found only in reach two of the Rock Creek mainstem, where they were the second most abundant trout species (Appendix C, Table C-48). Brook trout densities average 0.076 fish/m for the stream overall and 0.241 fish/m for reach two (Appendix C, Table C-49). Densities are relatively high in low gradient riffle habitat and relatively low in high gradient riffle habitat (Appendix C, Table C-50) although the differences are not statistically significant (ANOVA, P <0.50) (Appendix C, Table C-51).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in Rock Creek was higher than the average for the drainage with the oldest fish sampled being age IV+. Growth of cutthroat trout in Rock Creek was relatively low when compared with the average growth rate for the LCFR drainage with age I+ fish reaching a length of 62 mm (2.5 in) and age III+ a length of 158 mm (6.3 in) (Appendix

B, Figure B-228). The instantaneous survival rate of 23 percent was similar to the average for the drainage.

Bull Trout - Bull trout growth in Rock Creek is relatively low when compared with the drainage average with age I+ fish reaching an average length of 66 mm (2.6 in) and age III+ fish a length of only 157 mm (6.3 in) (Appendix B, Figure B-229). The instantaneous survival rate of bull trout to age III+ was 23 percent and was lower than the average for the drainage.

Brook Trout - Longevity of brook trout in Rock Creek was similar to the average for the drainage with the oldest fish sampled being age III+. Growth of brook trout in Rock Creek was relatively moderate when compared with the average for the drainage with age I+ fish reaching a length of 68 mm (2.7 in) and age III+ a length of 168 mm (6.7 in) (Appendix B, Figure B-230). The instantaneous survival rate of 26 percent was similar to the average for the drainage.

Rare Fish Genetics In the Rock Creek drainage, samples of cutthroat trout were obtained from Rock Lake in 1987 and 1993; the upper reach of the East Fork of Rock Creek in the Rock Creek Meadows during 1987; and the East Fork of Rock Creek and mainstem Rock Creek in the vicinity of Engle Creek during 1986. Results indicate that the population in Rock Lake consists of hybridized westslope/Yellowstone cutthroat trout. The population in the Rock Creek Meadows area contains a mixture of pure westslope cutthroat trout, hybridized westslope/Yellowstone cutthroat trout, and hybridized westslope cutthroat/rainbow trout. Cutthroat trout populations in the East Fork and mainstem of Rock Creek consist of genetically pure aboriginal westslope cutthroat trout.

The hybridization in this drainage is most likely a result of past stocking activities in Rock Lake or the meadows, which are located at the drainage headwaters. While there are barriers to upstream fish movement in the Rock Creek Meadows and the outlet of Rock Lake further upstream, downstream movement of hybridized fish into areas currently occupied by pure strains of westslope cutthroat trout is possible.

Adfluvial Fish Spawning Redd counts for adfluvial fall-spawning salmonids were conducted on Rock Creek for the first time in 1993. During this count one bull trout redd was found below the

confluence with Engle Creek. High flows prevented the successful completion of redd counts during 1994 and 1995. Brown trout are not present in the drainage.

In recent years Rock Creek has not had sufficient flows at the stream mouth to allow upstream passage of fall-spawning fish from the reservoir. In 1993, the lower reach of Rock Creek was dry by late June. However, a bull trout redd was found in this stream during late December. The presence of this redd, despite the lack of flow at the stream mouth, indicates that bull trout may move into this stream during the spring or early summer.

5.13 West Fork Rock Creek

The West Fork of Rock Creek flows approximately 5.7 km (3.5 mi) from the southwestern slopes of the Cabinet Mountains to its confluence with mainstem Rock Creek (Figure 5-9). The West Fork drainage covers about 1,554 ha. Minor tributaries include Snort Creek. Average elevation drop is about 96 m/km. In reach one, from the confluence with Rock Creek to RM 0.4, the average drop is approximately 60 m/km; in reach two (RM 0.4 to RM 0.6) the change in elevation is about 120 m/km; for reach three (RM 0.6 to RM 1.6), the stream drops approximately 110 m/km.

5.13.1 Fish Habitat

Fish habitat in the West Fork consists of primarily high gradient riffle and pool habitat types; a substrate mix dominated by gravel, peagravel, and rubble; high amounts of fine sediment; a functional unaltered riparian zone; a riparian vegetation mix consisting primarily of mid-cover and upper canopy vegetation types; and relatively moderate amounts of LWD.

Habitat Survey The habitat survey for the West Fork of Rock Creek included three tributary reaches and extended from the confluence with Rock Creek to the West Fork Falls (RM 1.6).

Habitat Composition - Fish habitat on the West Fork consists primarily of high gradient riffle and pool habitat types. Reach one was predominately pool and low gradient riffle habitat; reach two was mainly pool and high gradient riffle habitat; and reach three was primarily high gradient riffle and cascade habitat types (Appendix B, Figure B-231).

When compared with the overall habitat composition mix for streams in the LCFR drainage, the West Fork had similar amounts of pool and pocket water habitats; relatively high amounts of high gradient riffle and cascade habitats; and relatively low amounts of glide, run, and low gradient riffle habitat types (Appendix B, Figure B-232). Habitat composition varies with stream channel gradient and confinement. Tributary reaches that were relatively high gradient and confined contain high amounts of cascade and riffle habitat while relatively low gradient and unconfined tributary reaches contain high amounts of run, pool, and glide habitat types.

Substrate Composition - Substrate composition in the West Fork was primarily rubble, gravel, and peagravel (Tukey test, $P < 0.05$). Reach one contains high amounts of peagravel (Tukey test, $P < 0.05$); reach two contains high amounts of gravel (Tukey test, $P < 0.05$); and reach three was predominately rubble and gravel (Tukey test, $P < 0.05$) (Appendix B, Figure B-233).

When compared with the average substrate composition for the LCFR drainage, the West Fork contains similar amounts of sand/silt, gravel, rubble, cobble and boulder; and relatively high amounts of peagravel (Appendix B, Figure B-234). Substrate composition was indicative of the relatively stable nature of the stream system and was relatively consistent among tributary reaches.

Surface Fines - Surface fines average 24 percent and range from 20 percent to 31 percent (Figure BB-235). Surface fines were high in reach one (Tukey test, $P<0.05$). Surface fines were statistically different between slow (32%) and fast water (15%) habitat types (t-Test, $P< 0.001$). Surface fines in the West Fork were higher than the drainage average.

Riparian Vegetation - Riparian vegetation on the West Fork consists of relatively high amounts of upland tree (Tukey test, $P < 0.05$). Riparian vegetation in reach one was predominately grass/forbs, upland tree, and riparian shrub (Tukey test, $P < 0.05$); reach two was primarily riparian shrub (Tukey test, $P < 0.05$); and reach three contains a high percentage of upland tree (Tukey test, $P < 0.05$) (Appendix B, Figure B-236).

When compared with the average riparian vegetation mix for the drainage, the West Fork contains similar amounts of upland shrub; relatively high amounts of riparian shrub and upland tree; and relatively low amounts of sedge/rush, grass/forbs, and riparian tree (Appendix B, Figure B-237).

The presence of vegetative bank cover for the West Fork is relatively high when compared with the drainage average. The presence of vegetative bank cover for the West Fork averages 93 percent, ranging from 87 percent in reach two to 99 percent in reach three. There was no statistically significant difference in the presence of vegetative bank cover among tributary reaches (ANOVA, P <0.50) (Appendix B, Figure B-238).

Large Woody Debris - In the West Fork of Rock Creek, single pieces of LWD <3.0 m in length average 6.97/100 m and range from 3.2/100 m in reach three to 12.9/100 m in reach two (Appendix B, Figure B-239). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 43 percent, 42 percent, and 15 percent respectively.

Single pieces of LWD >3.0 m in length average 4.61/100 m and range from 1.5/100 m in reach three to 10.0/100 m in reach two (Appendix B, Figure B-240). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 43 percent, 32 percent, and 24 percent respectively.

Aggregations of LWD average 0.9/100 m and range from 0.7/100 m in reach one to 1.2/100 m in reach two (Appendix B, Figure B-241). The number of single pieces of LWD found in aggregations average 4.5 pieces per aggregate for the combined tributary reaches and range from 4 to 5 pieces per aggregate. The distribution of root-wads averages 1.42/100 m of stream, ranging from 0.5/100 m in reach one to 2.9/100 m in reach two (Appendix B, Figure B-242).

Amounts of LWD in the West Fork were relatively low for all LWD classifications when compared with the average for the LCFR drainage (Appendix B, Figure B-243).

Hydrology and Water Temperature The hydrology of the West Fork is characteristic of intermediate order, mid-reach streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns. The water temperature regime is relatively low, which is also typical for this type of stream in the LCFR drainage, and does not typically exceed levels suitable for salmonid populations.

Hydrology - During 1994, tributary discharge monitored periodically at RM 0.1 averaged 0.2 m^3/sec, ranging from 0.03 m^3/sec in July to 0.7 m^3/sec during April (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish in the stream sections between RM 0.2 and the West Fork Falls. Stream sections between RM 0.2 and the stream mouth begin to go dry in early August.

Water Temperature - Water temperatures measured at RM 0.3 during 1994 averaged 6.6° C (Appendix C, Table C-2), ranging from a minimum of 3.3° C in January (Appendix C, Table C-3) to a maximum of 11.2° C in July (Appendix C, Table C-4). in the spring (March - May), water temperatures averaged 5.0° C, ranging from 4.0 to 6.3° C; in summer (June - August), temperatures averaged 10.3° C, ranging from 8.7 to 11.2° C; during fall (September - November), they averaged 7.4° C, ranging from 5.0 to 9.8° C; and in the winter months (December - February), water temperatures averaged 3.7° C, ranging from 3.3 to 4.1° C.

Sediment Survey

Major Stream Features - Conducted on 19 November 1993, this stream feature survey began at the falls located approximately 0.5 km below Road 150 (upper crossing) and proceeded downstream to the confluence with Rock Creek. The upper 1.7 km of the stream channel (reach three) was confined colluvial type A-2, the middle 0.3 km (reach two) was mod-confined alluvial type B-1, and the lower 0.6 km (reach one) was unconfined alluvial type C-1.

The stream contains low amounts of stable LWD. Substrate consist primarily of small cobble and gravel with relatively little bedload movement. Stream banks were stable with some channel braiding. Spawning habitat was present in the form of pockets of gravel behind and above stable debris or boulders and in main channel depositional areas. Stream intermittency results in the dewatering of 100 percent (0.6 km) of reach one and 20 percent (0.06 km) of reach two by late summer.

Some development (logging, roads) has occurred in this drainage, however, these activities did not appear to have had an impact on the characteristics of this stream. A CMP located at Road 150

(lower crossing) is not a barrier to fish movement. However, a temporary fish barrier consisting of sedimented LWD is located approximately 1.2 km above the confluence with Rock Creek.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the West Fork averages 27 percent, ranging from 24 percent in reach two to 28 percent in reach one. In reach three it was not possible to obtain core samples per the sampling protocol as spawning gravels were restricted to depositional areas behind boulders and stream obstructions. Fine sediment levels in spawning gravels on the West Fork were relatively low when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout averages 36 percent, ranging from 35 percent in reach one to 40 percent in reach two. For bull trout, predicted embryo survival to emergence averages 40 percent, ranging from 39 percent in reach one to 45 percent in reach two. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout was relatively high.

Riffle Stability Index (RSI) - Suitable locations for the establishment of RSI sample sites were not available in the West Fork of Rock Creek and RSI values were not calculated for this stream.

Spawning Habitat Availability There are an estimated 79 m^2 of suitable habitat for fall-spawning salmonids in the West Fork. This equates to 0.040 m^2/m of stream length and 2.9 percent of the total stream area. This habitat can accommodate an estimated 22 adfluvial or 50 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In the West Fork, there was approximately 899 m^2 of salmonid rearing habitat. This equates to 0.450 m^2/m of stream length and 32.1 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of rearing habitat per meter of stream was relatively similar.

Productivity

Primary Productivity - We monitored periphyton accumulation in the West Fork of Rock Creek for 39 days. The average autotrophic index was 9.84, ranging from 0.0 to 83.23; average chlorophyll content was 0.44 mg/m^2, ranging from 0.0 mg/m^2 to 1.74 mg/m^2; net productivity averages 0.07 mg/m^2/day, ranging from 0.0 mg/m^2/day to 0.27 mg/m^2/day. In this stream, the autotrophic index was high while the chlorophyll content and net productivity values were relatively low when compared with average values for the LCFR drainage.

Secondary Productivity - Invertebrate samples from reaches two and three of the West Fork were not preserved properly in the field and could not be processed in the lab. In reach one, benthic invertebrate populations consist primarily of members from the order Diptera (81%) and Ephemeroptera (17%) (Appendix B, Figure B-244). Aquatic benthic invertebrate densities were $283/m^2$, species richness was 9 species, and species diversity (SDI) was 1.060. Invertebrate densities, species richness and SDI were all low when compared with average values for the LCFR drainage.

5.13.3 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in the West Fork were relatively high for bull trout and relatively low for cutthroat trout (Appendix B, Figure B-245). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in the West Fork are limited by a combination of stream intermittency and low amounts of suitable spawning and rearing habitat. Stream sections that maintained year-around flows and contained unsedimented spawning gravels and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing fish population estimates were conducted in all reaches and habitat types found in the West Fork of Rock Creek. A significant portion of reach one was dewatered during the sample period and therefore it was not possible to obtain a suitable estimate of fish densities for this reach. Consequently, we combined the fish

density estimates from reach one and two and used this combined estimate to determine fish abundance in these reaches.

In the West Fork there are an estimated 553 westslope cutthroat trout and 743 bull trout (Appendix C, Table C-52). Fish densities are high for bull trout (0.281 fish/m) and relatively low for cutthroat trout (0.209 fish/m) (Appendix C, Table C-53). There was no statistically significant difference in densities between fish species (t-Test, P <0.667).

Westslope Cutthroat Trout - Westslope cutthroat trout are present throughout the stream system. Cutthroat trout are the second most abundant species in reaches three, one, and two (Appendix C, Table C-52). Cutthroat trout densities average 0.209 fish/m of stream, ranging from 0.209 fish/m in reaches two and three to 0.237 fish/m in reach one (Appendix C, Table C-53). There was no statistically significant difference in cutthroat trout densities among tributary reaches (t-Test, P <0.764).

Cutthroat trout densities are high in pool habitat types and relatively low in high gradient riffle habitat (Appendix C, Table C-54, C-55). There was no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, P <0.50).

Bull Trout - Bull trout were present throughout the stream system. Bull trout were the most abundant species in reach three, one, and two (Appendix C, Table C-52). Bull trout densities average 0.281 fish/m of stream, ranging from 0.281 fish/m in reaches two and three to 0.309 fish/m in reach one (Appendix C, Table C-53). There was no statistically significant difference in the distribution of bull trout among tributary reaches (t-Test, P <0.786).

Bull trout densities are relatively high in pool habitat and relatively low in run habitat (Appendix C, Table C-54). There was no statistically significant difference in the distribution of bull trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-55). Bull trout were not found in glide habitat types.

Age, Growth and Mortality

Westslope Cutthroat Trout - The number of readable cutthroat trout scale samples was not sufficient to complete the age and growth analysis for the West Fork of Rock Creek. However, when calculated using the length frequency distribution (Appendix B, Figure B-246), the instantaneous survival rate for cutthroat trout was 20 percent which was similar to the average for the drainage.

Bull Trout - As with the cutthroat trout data, the number of readable bull trout scale samples was not sufficient to complete the age and growth analysis for the West Fork. However, when calculated using the length frequency distribution (Appendix B, Figure B-247), the instantaneous survival rate of bull trout to age III+ was 35 percent which was relatively higher tha. ıe average for the drainage.

Rare Fish Genetics Samples of cutthroat and bull trout were not obtained from the West Fork of Rock Creek for electrophoretic testing.

Adfluvial Fish Spawning During the fall, stream flows in this stream are to low to allow passage of large adfluvial salmonids. Aside from periodic spot-checks, redd counts for adfluvial stocks of bull trout were not conducted on the West Fork of Rock Creek during late fall and early winter 1992-1994. Brown trout are not present in the drainage.

5.14 Swamp Creek

Swamp Creek flows approximately 31.5 km from Wanless Lake, located on the southwestern slopes of the Cabinet Mountains Wilderness Area, to its confluence with Noxon Reservoir approximately 5.3 km east of the Noxon Rapids Dam (Figure 5-10). The drainage covers about 8,933 ha. Minor tributaries include Galena Creek and Goat Creek. Average elevation drop is about 69 m/km. In reach one, from the confluence at Noxon Reservoir to RM 0.7, the average drop is approximately 60 m/km; in reach two (RM 0.7 to RM 9.5) the change in elevation is about 46 m/km; for reach three (RM 9.5 to RM 13.2), the stream drops approximately 104 m/km.

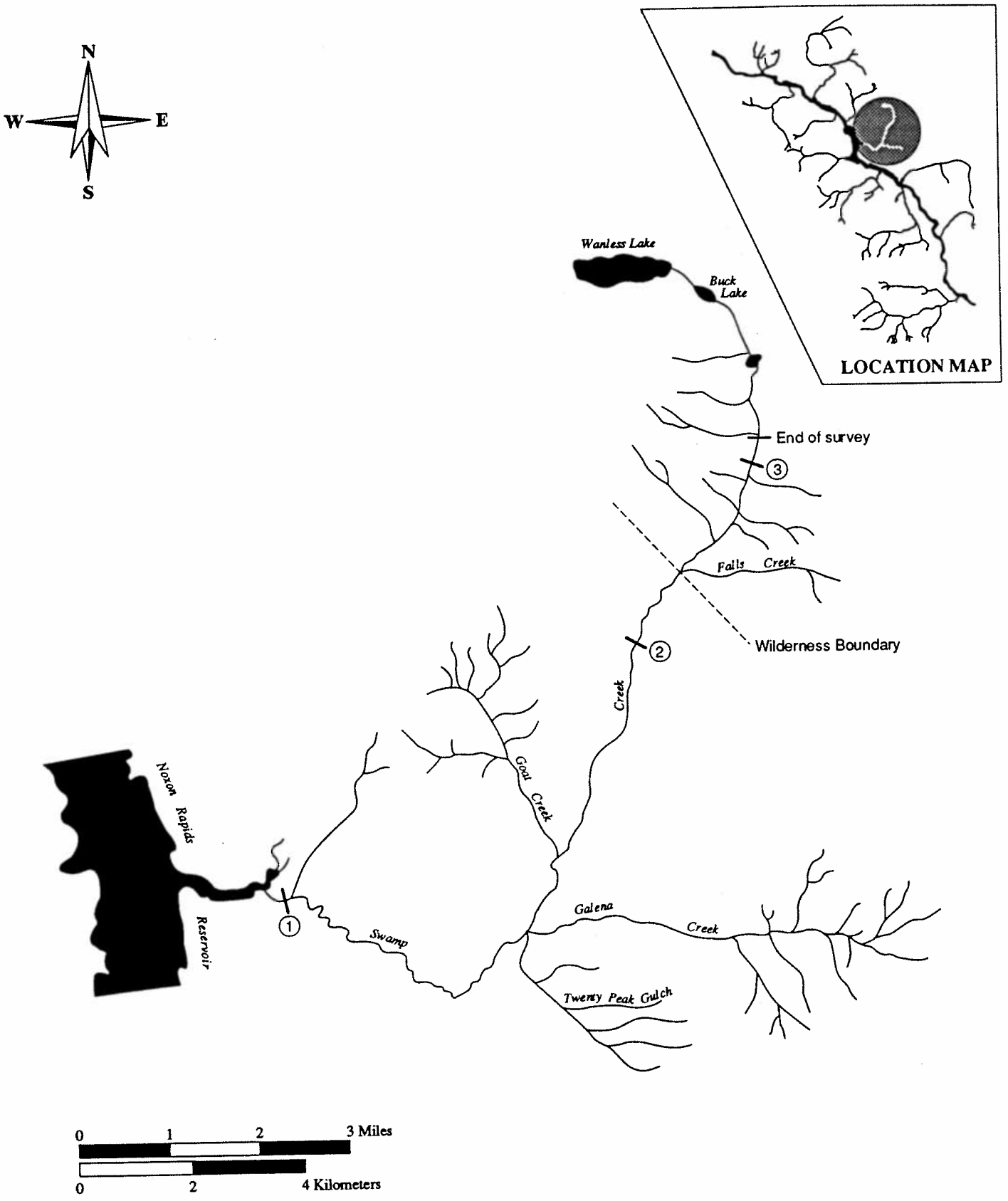

Figure 5-10. Map of the Swamp Creek drainage showing major tributaries and reach breaks.

5.14.1 Fish Habitat

Fish habitat in Swamp Creek consists of primarily run, cascade, low gradient riffle, and high gradient riffle habitat types; a substrate mix dominated by gravel and rubble; moderate amounts of fine sediment; a functional although altered riparian zone; a riparian vegetation mix consisting primarily of low- and upper canopy vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for Swamp Creek included three complete reaches and the lower end of a fourth reach which was combined with reach three. The survey extended from the confluence with Noxon Reservoir to a natural fish barrier (RM 13.2).

Habitat Composition - Fish habitat on Swamp Creek consists primarily of run, cascade, low gradient riffle, and high gradient riffle habitat types. Reach one was predominately low gradient riffle and cascade habitat; reach two was primarily low gradient riffle; and reach three was mainly cascade and high gradient riffle habitat types (Appendix B, Figure B-248).

When compared with the overall habitat composition mix for streams in the LCFR drainage, Swamp Creek had similar amounts of low gradient riffle and pocket water habitats; relatively high amounts of run and cascade habitat; and relatively low amounts of pool, glide, and high gradient riffle habitat types (Appendix B, Figure B-249). Habitat composition varies with stream channel gradient and confinement. Tributary reaches that were relatively high gradient and confined contain high amounts of cascade and riffle habitat; while relatively low gradient and unconfined tributary reaches contain high amounts of run, pool, and glide habitat types.

Substrate Composition - Substrate in Swamp Creek contains high amounts of gravel and rubble (Tukey test, $P < 0.05$). Reach one contains low amounts of bedrock and sand/silt (Tukey test, $P < 0.05$); reach two contains high amounts of gravel (Tukey test, $P < 0.05$); and reach three was primarily cobble (Tukey test, $P < 0.05$) (Appendix B, Figure B-250).

When compared with the average substrate composition for the LCFR drainage, Swamp Creek contains similar amounts of peagravel, gravel, rubble, cobble, boulder, and bedrock; and relatively low amounts of sand/silt (Appendix B, Figure B-251). Substrate composition varies with stream

channel gradient. Tributary reaches that were relatively high gradient contain high amounts of cobble and boulder; while relatively low gradient tributary reaches contain high amounts of gravel and sand/silt.

Surface Fines - Surface fines in Swamp Creek average 13 percent and range from 4 percent to 18 percent (Appendix B, Figure B-252). Surface fines were high in reach two and relatively low in reaches three and one (Tukey test, $P < 0.05$). Surface fines were statistically different between slow (34%) and fast water (6%) habitat types (t-Test, $P < 0.001$). Surface fines in Swamp Creek were similar to the drainage average.

Riparian Vegetation - Riparian vegetation on Swamp Creek consist primarily of grass/forbs and riparian tree (Tukey test, $P < 0.05$). Riparian vegetation in reach one was predominately upland tree (Tukey test, $P < 0.05$); reach two was primarily grass/forbs (Tukey test, $P < 0.05$); and reach three contains a high percentage of riparian tree and grass/forbs (Tukey test, $P < 0.05$) (Appendix B, Figure B-253).

When compared with the average riparian vegetation mix for the drainage, Swamp Creek contains similar amounts of grass/forbs and riparian shrub; relatively high amounts of upland shrub and riparian tree; and relatively low amounts of sedge/rush and upland tree (Appendix B, Figure B-254).

The presence of vegetative bank cover for Swamp Creek is relatively moderate when compared with the drainage average. The presence of vegetative bank cover for Swamp Creek averages 81 percent, ranging from 73 percent to 96 percent (Appendix B, Figure B-255). The presence of vegetative bank cover is highest in reach one (Tukey test, $P < 0.05$)

Large Woody Debris - In Swamp Creek, single pieces of LWD <3.0 m in length average 2.23/100 m and range from 1.35/100 m in reach two to 3.79/100 m in reach one (Appendix B, Figure B-256). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 83 percent, 17 percent, and 1 percent respectively.

Single pieces of LWD >3.0 m in length average 0.75/100 m and range from 0.55/100 m in reaches two and one to 1.15/100 m in reach three (Appendix B, Figure B-257). Size distribution for LWD

>3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 69 percent, 22 percent, and 9 percent respectively.

Aggregations of LWD average 0.36/100 m and range from 0.22/100 m in reach two to 0.55/100 m in reach one (Appendix B, Figure B-258). The number of single pieces of LWD found in aggregations average 2.4 pieces per aggregate for the combined tributary reaches and range from 2 to 13 pieces per aggregate. The distribution of root-wads averages 0.22/100 m of stream, ranging from 0.0/100 m in reach one to 0.48/100 m in reach three (Appendix B, Figure B-259).

Amounts of LWD in Swamp Creek were relatively low for LWD <3.0 m in length, LWD >3.0 m in length, LWD aggregates, and root-wads when compared with the average for the LCFR drainage (Appendix B, Figure B-260).

Hydrology and Water Temperature The hydrology of Swamp Creek is characteristic of intermediate order, mid-reach streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns in the lower tributary reaches. The water temperature regime is relatively moderate, which is also typical for this type of stream in the LCFR drainage, and does not typically exceed levels suitable for salmonid populations.

Hydrology - Tributary discharge monitored at RM 1.6 during 1994 averaged 0.9 m^3/sec, ranging from 0.1 m^3/sec in September and January. to 2.3 m^3/sec during April (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish in the stream sections between RM 1.4 and the headwaters. Stream sections between RM 1.4 and the stream mouth begin to go dry in late June.

Water Temperature - Water temperatures measured at RM 1.6 during 1994 averaged 7.2° C (Appendix C, Table C-2), ranging from a minimum of 2.8° C in November (Appendix C, Table C-3) to a maximum of 11.9° C in July (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 6.1° C, ranging from 5.0 to 7.3° C; in summer (June - August), temperatures averaged 10.4° C, ranging from 8.9 to 11.9° C; during fall (September - November), they averaged 8.3° C, ranging from 2.8 to 10.9° C; and in the winter months (December - February), water temperatures averaged 4.2° C, ranging from 3.6 to 4.7° C.

Sediment Survey

Major Stream Features - Conducted in September 1994, the survey of major stream features in Swamp Creek extended from the mouth at Swamp Creek Bay to the headwaters in the Cabinet Mountain Wilderness Area. Reach one is a B-2c channel type and extended from the stream mouth to RM 0.7. Reach two was a C-3 channel type and extended upstream through section 9 to RM 9.5. Reach three was a B-3 channel type that extended into the wilderness area to RM 13.2. Reach four is a C-2b channel and contains the endpoint of the habitat survey at RM 13.5. Reach five is an A-2 channel type and was not surveyed. Road 1119 follows the lower reaches and Trail 912 follows the length of the upper reaches. The lower end of reach four was combined with reach three for the habitat survey.

Reach one was a short, entrenched reach dominated by a boulder substrate. The riparian zone was an open spaced canopy of conifers and brush with a forest habitat of douglas fir. Large woody debris was limited in this reach and spawning gravels were rare. At RSI site one there was an undeveloped riparian road crossing and a power line crosses the stream approximately 850 m above of the stream mouth. This reach had no undercut or eroding bank and a width/depth ratio of 13.

Reach two was a long, meandering reach characterized by an open, grazed riparian zone. Several dwellings were present along the stream with bridges for the Swamp Creek Road crossing in two locations. Several undeveloped road crossings were present in the reach. The riparian zone is dominated by brush and grass with few trees. During the survey, the channel was dry approximately 220 m below the first bridge (RM 1.6) and flowed again just below the second bridge (RM 2.7). The entire reach was grazed with small amounts of LWD in the channel and little recruitment of LWD occurring. Spawning gravels and mid-channel bars were common throughout the reach. At RSI site four a canal headgate diverted approximately 65 percent of the stream flow. Several undeveloped road crossings, fences and a log bridge are located approximately 2,200 and 4,200 m upstream. Several side channels were present in this aggraded area. This reach had 7 percent undercut banks, 4 percent eroding banks, and a width/depth ratio of 13.

Reach three was characterized by a relatively straight channel containing boulders and large cobbles. The riparian zone was split between a canopy of conifers on the west slope and open area trees and

talus on the east facing slope. Riparian forest habitat type was hemlock on the south slope. This reach had 2 percent undercut banks, 3 percent eroding banks, and a width/depth ratio of 7. Excessive cobble deposits were present and LWD was virtually non-existent in the channel. Spawning gravels appeared to have been washed out of this reach.

Reach four was a boulder dominated reach that meandered slightly through a boulder flood plain with some side channels. The riparian zone was predominately brush with some fire scar on what appear to be old cedar trees. The substrate in this reach is loose and poorly mixed. This reach has a width to depth ratio of 11.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Swamp Creek was 32 percent, ranging from 27 percent in reach two to 35 percent in reach one (Appendix B, Figure B-261). Fine sediment levels in spawning gravels on Swamp Creek were relatively moderate when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 29 percent, ranging from 26 percent in reach one to 36 percent in reach two. For bull trout, predicted embryo survival to emergence was 33 percent, ranging from 29 percent in reach one to 40 percent in reach two (Appendix B, Figure B-262). When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in Swamp Creek was relatively moderate.

Riffle Stability Index (RSI) - Swamp Creek is a larger fourth order stream that had four surveyed reaches with RSI values ranging from 19 to 78. The stream was characterized by a long length that leaves the Cabinet Mountain Wilderness Area with high water flows and deposits bedload in aggraded lower reaches. Loose cobbles and the LWD accumulated into large debris jams indicates periodic high water flow events. In addition to wildfire, land use activities such as roads, timber harvesting and land clearing, and grazing appear to be the major influences on this stream. Very little LWD was available to provide for channel stability.

Reach one is a B-2 channel type with an average Wolman particle distribution in the riffles of 5 percent sand, 15 percent gravel, 36 percent cobble, and 43 percent boulder. The mean grain size of the mobile particles averages 119 mm, ranging from 116 to 122 mm. The RSI values are 28 and 31.

This reach was dry during the survey so particles were selected from likely riffle areas and other deposits.

Reach two was a C-3 channel type and had an average Wolman particle distribution of 11 percent sand, 41 percent gravel, 46 percent cobble, and 2 percent boulder. The mean grain size of the mobile particles averages 99 mm, ranging from 70 to 130 mm. The RSI values are 74, 78, 61, and 75. The first two sites were taken from a dry channel bed. Reach two appeared unstable with areas of dry channel that could be the result of deposited bedload that has aggraded the channel and/or stream diversion which allows the stream to flow subsurface through the porous substrate.

Reach three was a B-3 channel type and had an average Wolman particle distribution of 2 percent sand, 13 percent gravel, 48 percent cobble, and 37 percent boulder. The mean grain size of mobile particles averages 129 mm, ranging from 126 to 131 mm. The RSI values are 52, 21, and 19.

Reach four was a C-2 channel type and had an average Wolman particle distribution of 4 percent sand, 12 percent gravel, 42 percent cobble, and 26 percent boulder. The mobile particle mean grain size averages 129 mm ranged from 113 to 155 mm. The RSI values are 39, 35, and 22.

Spawning Habitat Availability There are an estimated 426 m^2 of suitable habitat for fall-spawning salmonids in Swamp Creek. This equates to 0.026 m^2/m of stream length and 0.3 percent of the total stream area. This habitat can accommodate an estimated 118 adfluvial or 266 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In Swamp Creek, there was approximately 5,151 m^2 of salmonid rearing habitat. This equates to 0.310 m^2/m of stream length and 3.4 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of rearing habitat per meter of stream was relatively low.

Productivity

Primary Productivity - We monitored periphyton accumulation in Swamp Creek for 40 days. The average autotrophic index was 6.10, ranging from 0.0 to 29.89; average chlorophyll content was 1.85 mg/m^2, ranging from 0.05 mg/m^2 to 4.79 mg/m^2; net productivity averages 0.26 mg/m^2/day, ranging from 0.0 mg/m^2/day to 0.76 mg/m^2/day. The autotrophic index was relatively low while the chlorophyll content and net productivity values were similar when compared with the average values for the LCFR drainage.

Secondary Productivity - Benthic invertebrate populations in Swamp Creek consist primarily of members from the order Ephemeroptera (59%) and Diptera (24%) (Appendix B, Figure B-263). Aquatic benthic invertebrate densities average 1,102/m^2 and range from 724/m^2 in reach two to 1,786/m^2 in reach one (Appendix B, Figure B-264). There was no statistically significant difference in invertebrate densities among reaches (ANOVA, $P < 0.50$). Invertebrate species richness for the stream was 20, ranging from 16 in reach three to 20 in reach one (Appendix B, Figure B-265). The invertebrate species diversity index (SDI) for the stream was 2.351, ranging from a low of 1.895 in reach one to a high of 2.374 in reach three (Appendix B, Figure B-266). Invertebrate densities were relatively high while species richness and SDI values in Swamp Creek were similar to the average values for the LCFR drainage.

5.14.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in Swamp Creek were relatively high for brook trout; and relatively low for brown and cutthroat trout (Appendix B, Figure B-267). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in Swamp Creek are limited by a combination of stream intermittency, low amounts of LWD and suitable spawning and rearing habitat. Stream sections with year-around flows, unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found in reaches two and three of

Swamp Creek. Reach one was dry during fish population estimates. In Swamp Creek there are an estimated 15,661 brook trout, 6,199 westslope cutthroat trout, and 1,418 brown trout (Appendix C, Table C-56). Fish densities were high for brook trout and relatively low for cutthroat trout and brown trout (Tukey test, P <0.05) (Appendix C, Table C-57).

Westslope Cutthroat Trout - Westslope cutthroat trout were present throughout Swamp Creek. They were the least abundant of the trout species in reaches two and three (Appendix C, Table C-56). Cutthroat trout densities average 0.287 fish/m of stream, ranging from 0.104 fish/m in reach two to 0.47/m in reach three (Appendix C, Table C-57); densities were highest in reach three (t-Test, P <0.003).

Cutthroat trout densities are relatively high in pool and high gradient riffle habitat types; and relatively low in run habitat (Appendix C, Table C-58). There was no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-59).

Bull Trout - Bull trout were not found in Swamp Creek during sampling in 1993, 1994, or 1995.

Brown Trout - Brown trout were found in reach two of Swamp Creek and were the second most abundant species in this reach (Appendix C, Table C-56). Brown trout were not found in reaches one or three. Brown trout densities were 0.132 fish/m for reach two and 0.066 fish/m for the stream overall (Appendix C, Table C-57).

Brown trout densities are relatively high in run habitat and relatively low in pool habitat (Appendix C, Table C-58, C-59). There was no statistically significant difference in the distribution of brown trout among habitat types (ANOVA, P <0.10).

Brook Trout - Brook trout were present throughout Swamp Creek and were the most abundant species in reaches two and three (Appendix C, Table C-56). Densities average 0.726 fish/m of stream, ranging from 0.603/m in reach two to 0.849/m in reach three (Appendix C, Table C-57). There was no statistically significant difference in brook trout densities between tributary reaches (t-Test, P <0.614).

Brook trout densities are relatively high in pool and low gradient riffle habitat types and relatively low in run habitat (Appendix C, Table C-58). There was no statistically significant difference in the distribution of brook trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-59).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in Swamp Creek was lower than the average for the drainage with the oldest fish sampled being age II+. Growth of cutthroat trout in Swamp Creek was relatively typical when compared with the average growth rate for the LCFR drainage with age I+ fish reaching a length of 69 mm (2.8 in) and age II+ a length of 115 mm (4.6 in) (Appendix B, Figure B-268). The data set is insufficient to estimate the instantaneous survival rate for cutthroat trout in this stream.

Brown Trout - Longevity of brown trout in Swamp Creek was higher than the average for the drainage with the oldest fish sampled being age V+. Growth of brown trout in Swamp Creek was relatively high when compared with the drainage average with age I+ fish reaching a length of 66 mm (2.6 in) and age III+ a length of 213 mm (8.5 in) (Appendix B, Figure B-269). The instantaneous survival rate of 39 percent was higher than the average for the drainage.

Brook Trout - Longevity of brook trout in Swamp Creek was higher than the average for the drainage with the oldest fish sampled being age IV+. Growth of brook trout in Swamp Creek was relatively moderate when compared with the average for the drainage with age I+ fish reaching a length of 63 mm (2.5 in) and age III+ a length of 149 mm (5.9 in) (Appendix B, Figure B-270). The instantaneous survival rate of 36 percent was higher than the average for the drainage.

Rare Fish Genetics In the Swamp Creek drainage, samples of cutthroat trout were obtained from Wanless Lake and three Cirque Lakes in 1987; from Swamp Creek near Fox Lane Road in 1986 and at the wilderness boundary during 1994. Results indicated that the populations in Cirque Lakes #1 and #2 consist of pure westslope cutthroat that may have been influenced by hatchery reared fish. Populations in Cirque Lake #3 were considered to be hybridized and contains pure westslope cutthroat and hybridized westslope/Yellowstone cutthroat trout. Wanless Lake contains hybridized westslope/Yellowstone cutthroat trout. Swamp Creek cutthroat trout populations at the wilderness

boundary consist of hybridized westslope/Yellowstone cutthroat, and at the Fox Lane Road site pure westslope cutthroat that could have been influenced by hatchery reared fish.

There is a barrier to upstream fish movement in the form of a permanent falls located approximately 21.5 km from the stream mouth. However, the source of hybridization in this drainage was from past stocking activities in Cirque Lakes and Wanless Lake located at the drainage headwaters. Because of this, downstream movement of hybridized fish into areas occupied by pure strains of westslope cutthroat trout most likely cannot be prevented.

Adfluvial Fish Spawning Redd counts were conducted in Swamp Creek for the first time in 1993. A bull trout redd count conducted in mid-October, located three fresh redds approximately 1.6 km upstream from the end of the Swamp Creek Road and above a 180-270 m section of dry streambed. During brown trout redd counts in mid-December, four very old redds were located between the end of the road and the lower 2.4 km of stream which had been dry since early August. It was believed that these redds were constructed by bull trout and were classified accordingly (Huston 1994) (Appendix C, Table C-10, C-11). High flow conditions prevented redd counts during 1994 and 1995.

5.15 Mainstem Marten Creek

Mainstem Marten Creek flows approximately 13.0 km from the southeastern slopes of the Bitterroot Range to its confluence with Noxon Reservoir approximately 11.0 km east of the Noxon Rapids Dam (Figure 5-11). The drainage covers about 4,662 ha. Minor tributaries include South Fork Marten Creek, Clinton Gulch, Devil Gap, Steep Creek, Fire Creek, Rabbit Run, North Branch Marten Creek, and South Branch Marten Creek. Average elevation drop is about 17 m/km. In reach one (below the beaver dam complex), from the confluence at Noxon Reservoir to RM 0.7, the average drop is approximately 12 m/km; in reach one (above the beaver dam complex), (RM 0.7 to RM 7.3) the change in elevation is about 16 m/km; for reach two (RM 7.3 to RM 8.1), the stream drops approximately 30 m/km.

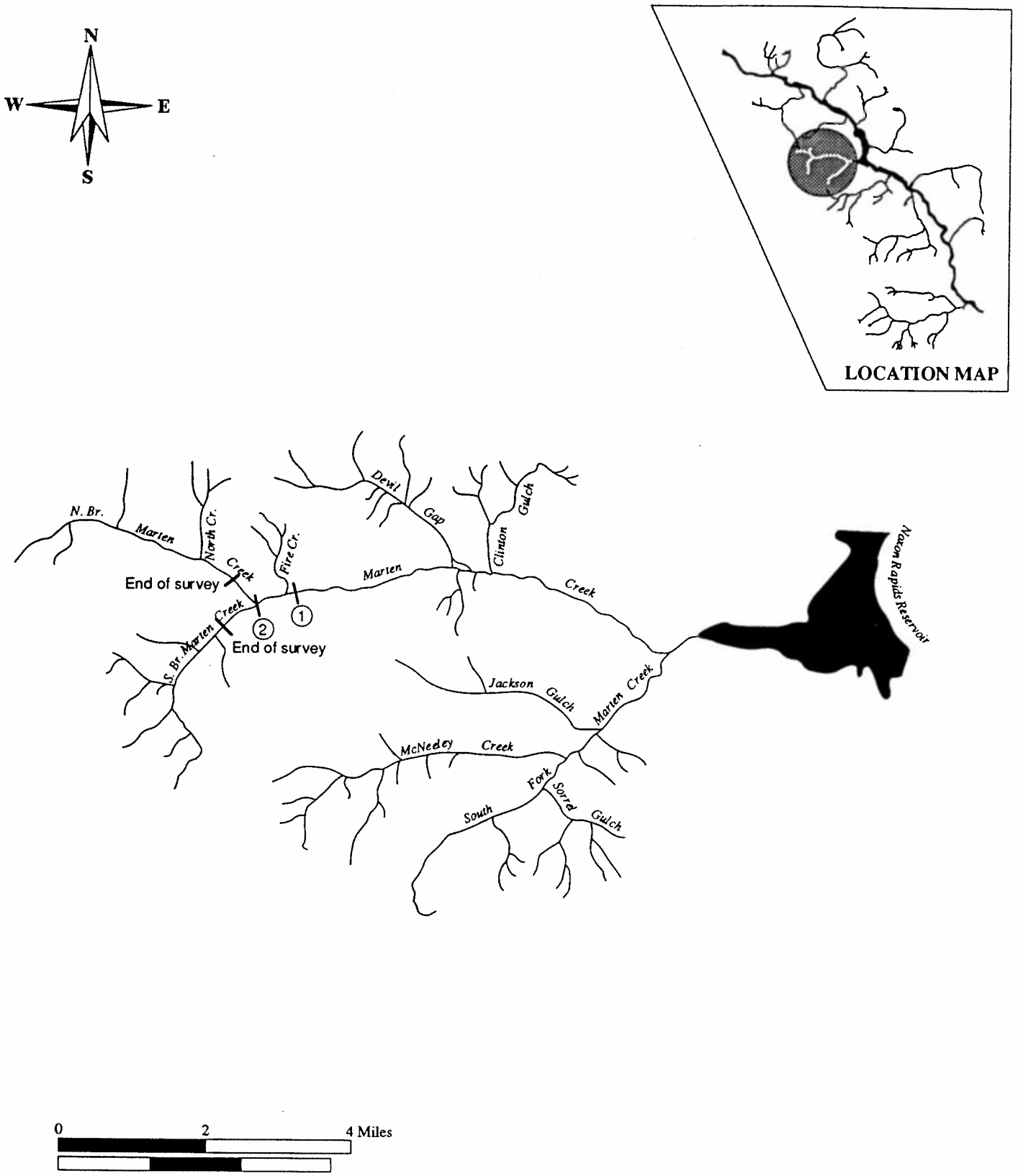

Figure 5-11. Map of the Marten Creek drainage showing major tributaries and reach breaks.

5.15.1 Fish Habitat

Fish habitat in mainstem Marten Creek consists of primarily low gradient riffle, high gradient riffle, and run habitat types; a substrate mix dominated by gravel and rubble; low amounts of fine sediment; a functional but altered riparian zone; a riparian vegetation mix consisting primarily of low- and mid-cover vegetation types; and relatively moderate amounts of LWD.

Habitat Survey The habitat survey for mainstem Marten Creek included two tributary reaches and extended from the confluence with Noxon Reservoir until the stream forks into the North and South Branches of Marten Creek (RM 8.1).

Habitat Composition - Fish habitat on mainstem Marten Creek consists primarily of low gradient riffle, high gradient riffle, and run habitat types. Reach one was predominately low gradient riffle, run, and pool habitat; and reach two mainly high gradient riffle and low gradient riffle habitat types (Appendix B, Figure B-271).

When compared with the overall habitat composition mix for streams in the LCFR drainage, mainstem Marten Creek had similar amounts of run habitat; relatively high amounts of low gradient riffle habitat; and relatively low amounts of pool, glide, high gradient riffle and cascade habitat types (Appendix B, Figure B-272).

Substrate Composition - The substrate composition in mainstem Marten Creek contains high amounts of gravel and rubble (Tukey test, $P < 0.05$). Reach one consists primarily of rubble and gravel (Tukey test, $P < 0.05$). Reach two appeared to contain relatively high amounts of gravel and rubble. Although statistically significant differences in substate composition were found in reach two (ANOVA, $P < 0.001$), the data set was insufficent to statistically characterize the differences (Tukey test, inconclusive). Substrate composition was similar among the tributary reaches (Appendix B, Figure B-273).

Substrate composition in Marten Creek contains relatively high amounts of cobble; similar amounts of peagravel, gravel, rubble, boulder, and bedrock; and low amounts of sand/silt when compared with the average substrate composition for the LCFR drainage (Appendix B, Figure B-274).

Surface Fines - Surface fines in mainstem Marten Creek average 11 percent and range from 11 percent in reach one to 10 percent in reach two. There was no statistically significant difference in surface fines between tributary reaches (t-Test, P <0.789). Surface fines were statistically different between slow (18%) and fast water (6%) habitat types (t-Test, P< 0.001). Surface fines in mainstem Marten Creek were lower than the drainage average.

Riparian Vegetation - Riparian vegetation on mainstem Marten Creek consists of high amounts of riparian shrub (Tukey test, P <0.05). Riparian vegetation in reach one was predominately riparian shrub (Tukey test, P <0.05); and reach two was primarily riparian shrub, riparian tree, and grass/forbs (Tukey test, P <0.05) (Appendix B, Figure B-275).

When compared with the average riparian vegetation mix for the drainage, mainstem Marten Creek contains similar amounts of grass/forbs, upland shrub, and riparian tree; relatively high amounts of riparian shrub; and relatively low amounts of sedge/rush and upland tree (Appendix B, Figure B-276).

The presence of vegetative bank cover for mainstem Marten Creek is relatively moderate when compared with the drainage average. The presence of vegetative bank cover for mainstem Marten Creek averages 81 percent, ranging from 79 percent in reach one to 84 percent in reach two. There was no statistically significant difference in the presence of vegetative bank cover between tributary reaches (t-Test, P<0.52).

Large Woody Debris - In mainstem Marten Creek, single pieces of LWD <3.0 m inlength average 6.52/100 m and range from 1.22/100 m in reach one to 11.83/100 m in reach two. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 74 percent, 16 percent, and 10 percent respectively.

Single pieces of LWD >3.0 m in length average 5.07/100 m and range from 1.18/100 m in reach one to 8.96/100 m in reach two. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 74 percent, 14 percent, and 11 percent respectively.

Aggregations of LWD average 1.20/100 m and range from 0.47/100 m in reach one to 1.94/100 m in reach two. The number of single pieces of LWD found in aggregations average 5 pieces per aggregate for the combined tributary reaches and range from 2 to 19 pieces per aggregate. The distribution of root-wads averages 2.13/100 m of stream, ranging from 0.46/100 m in reach one to 3.8/100 m in reach two.

Amounts of LWD in mainstem Marten Creek were similar for LWD aggregates; and relatively low for LWD <3.0 m in length, LWD >3.0 m in length, and root-wads when compared with the average for the LCFR drainage (Appendix B, Figure B-277).

Hydrology and Water Temperature The hydrology of mainstem Marten Creek is characteristic of large, high order streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns through the mid-reaches of the stream. The water temperature regime is relatively high, which is also typical for this type of stream in the LCFR drainage, and does not typically exceed levels suitable for salmonid populations but may have a propensity to do so.

Hydrology - In 1994, tributary discharge monitored periodically at RM 0.1 averaged 1.6 m^3/sec, ranging from an estimated 0.1 m^3/sec in February to 2.1 m^3/sec during April (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish in the stream sections between the stream mouth and RM 3.2, and between RM 5.4 and RM 8.1. Stream sections between RM 3.2 and RM 5.4 begin to go dry in mid-summer.

Water Temperature - Water temperatures measured at RM 0.1 during 1994 averaged 8.0° C (Appendix C, Table C-2), ranging from a minimum of 1.3° C in December (Appendix C, Table C-3) to a maximum of 14.0° C in June and September (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 7.0° C, ranging from 5.9 to 8.0° C; in summer (June - August), temperatures averaged 11.2° C, ranging from 7.8 to 14.0° C; during fall (September - November), they averaged 7.6° C, ranging from 3.0 to 14.0° C; and in the winter months (December - February), water temperatures averaged 5.1° C, ranging from 1.3 to 6.8° C.

Sediment Survey

Major Stream Features - Conducted in June 1994, the survey of major stream features in mainstem Marten Creek extended from the confluence at Marten Creek Bay and extended upstream to the confluence of the North and South Branches of Marten Creek. Reach one was a C-3 channel type and extended for approximately 9.4 km upstream (RM 5.9). Reach two was a B-3 channel type and extended the remaining 1.6 km of Marten Creek (RM 6.9). Road 151 follows the length of the stream.

Reach one of mainstem Marten Creek consists of a meandering stream channel through an open riparian zone of brush and grasses. Building foundations, roads, undeveloped campsites, and dwellings were present in the flood plain of this stream. Some beaver activity was present along with several large bedload deposits and spawning gravels were common. At RM 4.5 there was a large debris jam that had forced the stream out of the channel. Reach one has become a depositional reach for bedload materials transported from reach two and the North and South Branches of Marten Creek. This reach had no eroding banks, 10 percent undercut banks, and a width/depth ratio of 15.

Reach two was a relatively short reach ending at an unusual artificially created pool. The riparian area contains a tree canopy of conifers with signs of an old roadbed, dike, and rip-rap. This reach had 5 percent eroding banks, 1 percent undercut banks, and a width/depth ratio of 15.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in mainstem Marten Creek was 33 percent, ranging from 29 percent in reach two to 41 percent in reach one. Fine sediment levels in spawning gravels on Marten Creek were relatively moderate when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 28 percent, ranging from 18 percent in reach one to 33 percent in reach two. For bull trout, predicted embryo survival to emergence averages 32 percent, ranging from 21 percent in reach one to 38 percent in reach two. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in mainstem Marten Creek was relatively moderate.

Riffle Stability Index (RSI) - The mainstem of Marten Creek is a larger fourth order stream and had two surveyed reaches with RSI values ranging from 36 to 81. Marten Creek was characterized by a broad flood plain with brush being the dominant vegetation type. Considerable lateral instability, aggradation, and higher RSI values indicated an unstable stream out of equilibrium. Land use, roading, beaver impoundments, and the condition of the North and South Branches influence the stability of mainstem Marten Creek.

Reach one was a C-3 channel type with an average Wolman particle distribution of 4 percent sand, 29 percent gravel, and 67 percent cobble. The mean grain size of the mobile particles averages 126 mm, ranging from 122 to 131 mm. The RSI values are 81, 69, and 79. Large woody debris was not abundant and relatively unavailable for channel stabilization in this reach .

Reach two was a B-3 channel type with an average Wolman particle distribution of 7 percent sand, 28 percent gravel, 53 percent cobble, and 15 percent boulder. The mean grain size of mobile particles averages 80 mm, ranging from 70 to 89 mm. The RSI values are 48 and 36. This reach flowed through a conifer forest with large woody debris becoming available in the channel and the stream banks becoming more stable.

Spawning Habitat Availability There are an estimated 278 m^2 of suitable habitat for fall-spawning salmonids in mainstem Marten Creek. This equates to 0.022 m^2/m of stream length and 0.4 percent of the total stream area. This habitat can accommodate an estimated 77 adfluvial or 174 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In mainstem Marten Creek, there was approximately 8,234 m^2 of salmonid rearing habitat. This equates to 0.650 m^2/m of stream length and 10.4 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of rearing habitat per meter of stream was relatively high.

Productivity

Primary Productivity - Vandalism at our sampling site in mainstem Marten Creek prevented collection of sufficient data to evaluate primary productivity.

Secondary Productivity - Benthic invertebrate populations in mainstem Marten Creek consist primarily of members from the order Ephemeroptera (60%) followed by Plecoptera (20%) and Trichoptera (14%) (Appendix B, Figure B-278). Aquatic benthic invertebrate densities average 408/m^2 and range from 267/m^2 to 548/m^2. Invertebrate densities were highest in reach two (t-Test, P <0.006). Invertebrate species richness for the stream was 19, ranging from 15 in the second reach to 19 in reach one. The invertebrate species diversity index (SDI) for the stream was 2.353, ranging from 1.937 in reach one to 2.196 in reach two. Invertebrate densities were relatively low while species richness and SDI were similar when compared with the average values for the LCFR drainage.

5.15.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in mainstem Marten Creek were relatively high for brown trout; moderate for cutthroat trout; and relatively low for brook trout (Appendix B, Figure B-279). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in Marten Creek are limited by a combination of stream intermittency, migration barriers, low amounts of LWD, and suitable spawning and rearing habitat. Stream sections with year-around flows, unrestricted fish movement, unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities and a more diverse species mix than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all reaches and habitat types found in mainstem Marten Creek. An extensive beaver dam complex was found at RM 0.7. This complex is probably a barrier to upstream fish movement and brown trout were not found in stream sections above this area. In order to more accurately describe fish population abundance, composition, and distribution for reach

one, it has been divided it into two sections, below the beaver dam (BBD) and above the beaver dam (ABD).

In the surveyed mainstem of Marten Creek there are an estimated 6,521 westslope cutthroat trout, 2,889 brown trout, and 22 brook trout (Appendix C, Table C-60). Fish densities were highest for cutthroat trout (0.502 fish/m) followed by brown trout (0.222 fish/m) and lowest for brook trout (0.003 fish/m) (Tukey test, $P < 0.05$) (Appendix C, Table C-61).

Westslope Cutthroat Trout - Westslope cutthroat trout were present throughout and were the most abundant species in reaches one-ABD and two; and second most abundant species in reach one-BBD (Appendix C, Table C-60). Cutthroat trout densities average 0.520 fish/m of stream, ranging from 0.048 fish/m to 0.900 fish/m (Appendix C, Table C-61). Cutthroat densities were high in reach two (t-Test, $P < 0.001$).

Cutthroat trout densities are relatively high in pool and high gradient riffle habitat and relatively low in cascade habitat (Appendix C, Table C-62). Although statistically significant differences in the distribution of cutthroat trout among habitat types were found (ANOVA, $P < 0.05$), the data set was insufficent to statistically characterize the differences (Tukey test, inconclusive) (Appendix C, Table C-63).

Bull Trout - Bull trout were not found in Marten Creek during sampling in 1994 or 1995.

Brown Trout - Brown trout were present only in reach one-BBD of the Marten Creek mainstem, but were the most abundant trout species in this reach (Appendix C, Table C-60). Densities in the reach were high (Tukey test, $P < 0.05$) at 0.477 fish/m, equating to 0.222/m for the entire mainstem (Appendix C, Table C-61).

Brown trout densities are relatively high in low gradient riffle and glide habitat; and relatively low in run habitat (Appendix C, Table C-62, C-63). There was no statistically significant difference in the distribution of brown trout among habitat types (ANOVA, $P < 0.50$). Brown trout were not found in cascade or high gradient riffle habitat types.

Brook Trout - During 1993, brook trout were found only in reach one-BBD and were the least abundant species (Appendix C, Table C-60). Brook trout densities were 0.002 fish/m for the stream and 0.002 fish/m for reach one-BBD (Appendix C, Table C-61). Brook trout were only found in pool habitat types in reach one-BBD (Appendix C, Table C-62, C-63). However, during bull trout presence absence surveys conducted during 1995, brook trout were found throughout reach one in relative abundance equal to that of cutthroat trout. Because of this, it is most likely that the 1993 estimates of brook trout abundance and distribution in this stream were inaccurate.

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in the Marten Creek mainstem was similar to the average for the drainage, with the oldest fish sampled being age IV+. Growth of cutthroat trout in mainstem Marten Creek was relatively low when compared with the average growth rate for the drainage with age I+ fish reaching a length of 63 mm (2.5 in) and age III+ a length of 160 mm (6.4 in) (Appendix B, Figure B-280). The instantaneous survival rate of 30 percent was higher than the average for the drainage.

Brown Trout - Longevity of brown trout in mainstem Marten Creek was lower than the average for the drainage with the oldest fish sampled being age II+. Growth of brown trout in mainstem Marten Creek was high when compared with the drainage average with age I+ fish reaching a length of 81 mm (3.2 in) and age II+ a length of 152 mm (6.0 in) (Appendix B, Figure B-281). The instantaneous survival rate of 34 percent was similar to the average for the drainage.

Brook Trout - Longevity of brook trout in mainstem Marten Creek was higher than the average for the drainage with the oldest fish sampled being age V+. Growth of brook trout in mainstem Marten Creek was relatively high when compared with the average for the drainage with age I+ fish reaching a length of 80 mm (3.2 in) and age III+ a length of 179 mm (7.2 in) (Appendix B, Figure B-282). The instantaneous survival rate of 32 percent was higher than the average for the drainage.

Rare Fish Genetics Cutthroat trout populations were sampled in mainstem Marten Creek from the upper reach above Fir (Fire) Creek in 1983-84. Electrophoretic analysis showed these fish to be pure westslope cutthroat that may have originated from the State of Montana's brood stock. A fish barrier

exists in the form of an extensive beaver dam complex approximately 1.2 km from the stream mouth. In addition, the mid-reach of this stream goes dry for about 9-10 months a year. This seasonal intermittency, occurring since before the 1900's, is believed to be the major isolator of the upper tributary reaches (Huston 1986).

Cutthroat trout were obtained from the upper reaches of the South Fork of Marten Creek during 1993. Results of the electrophoretic testing indicated that this population was pure aboriginal westslope cutthroat trout. As with the mainstem of Marten Creek, the mid-reaches of the South Fork are seasonally intermittent. This, combined with extensive beaver dam complexes in the headwater reaches, could be a barrier to the upstream movement of fish and potential sources of hybridization.

Adfluvial Fish Spawning Annual redd count surveys have been conducted on Marten Creek since 1986 for brown trout and since 1993 for bull trout. Initially, redds were counted in the lower stream section beginning at the second cabin and proceeding downstream to the stream mouth. However, in 1988 the presence of an extensive beaver dam complex located approximately 1.1 km from the stream mouth prevented movement of adfluvial fish into the upper tributary reaches. As a result, beginning in 1988 redd counts were conducted between the beaver dam complex and the stream mouth.

Brown Trout - The brown trout redd count data indicate a declining trend in the number of brown trout spawning in this stream. Redd counts conducted in 1986, 1987, and 1991 through 1993 averaged 21 redds per year, ranging from a high of 36 in 1987 to a low of 12 in 1993. The redd counts in 1988 were conducted early and brown trout had not completed spawning. Counts for 1989 and 1990 were not conducted due to high flow conditions. Although attempted, redd counts in 1994 were not completed because of high flows (Appendix C, Table C-10).

Bull Trout - Intensive bull trout redd counts were conducted in Marten Creek for the first time in 1993. Three redds were found in the reach between the beaver dam complex and the stream mouth (Appendix C, Table C-11). Redd counts were not conducted or completed in 1994 or 1995 because of high flows.

5.16 North Branch Marten Creek

The North Branch of Marten Creek flows approximately 4.1 km from the southeastern slopes of the Bitterroot Range to its confluence with the mainstem of Marten Creek (Figure 5-11). The North Branch drainage covers about 1,295 ha. Minor tributaries include North Creek and Gem Creek. Average elevation drop along the stream length is about 60 m/km.

5.16.1 Fish Habitat

Fish habitat in the North Branch consists of primarily pocket water and high gradient riffle habitat types; a substrate mix dominated by rubble, cobble; low amounts of fine sediment; a functional although altered riparian zone; a riparian vegetation mix consisting primarily of mid-cover and upper canopy vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for the North Branch of Marten Creek included one tributary reach and extended from the confluence with mainstem Marten Creek to a location where normal stream flows are insufficient to support fish populations (RM 0.2).

Habitat Composition - Fish habitat on the North Branch consists primarily of pocket water and high gradient riffle habitat types. When compared with the overall habitat composition mix for the tributaries, the North Branch of Marten Creek had similar amounts of run, high gradient riffle, and cascade habitats; relatively high amounts of pocket water habitat; and relatively low amounts of pool habitat (Appendix B, Figure B-283).

Substrate Composition - Substrate composition in the North Branch was primarily rubble and cobble (Tukey test, $P < 0.05$). When compared with the average substrate composition for the LCFR drainage, the North Branch contains similar amounts of bedrock; relatively high amounts of rubble, cobble, and boulder; and relatively low amounts of sand/silt, peagravel, and gravel (Appendix B, Figure B-284).

Surface Fines - Surface fines in the North Branch average 7 percent and were statistically different between slow (12%) and fast water (6%) habitat types (t-Test, P< 0.001). Surface fines in the North Branch were lower than the drainage average.

Riparian Vegetation - Riparian vegetation on the North Branch contains low amounts of upland shrub and sedge/rush (Tukey test, P <0.05). When compared with the average riparian vegetation mix for the drainage, the North Branch contains similar amounts of upland shrub; relatively high amounts of riparian shrub, riparian tree, and upland tree; and relatively low amounts of sedge/rush and grass/forbs (Appendix B, Figure B-285). The presence of vegetative bank cover for the North Branch averages 94 percent and is relatively high when compared with the drainage average.

Large Woody Debris - In the North Branch, single pieces of large woody debris (LWD) <3.0 m in length average 3.08/100 m. The size distribution for LWD <3.0 m in length showed all materials to be <25 cm in diameter.

Single pieces of LWD >3.0 m in length average 8.12/100 m. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 76 percent, 24 percent, and 0 percent respectively.

Aggregations of LWD average 0.84/100 m. An average of 3.0 single pieces of LWD are found in aggregations. No root-wads were found in this stream section.

Amounts of LWD in the North Branch were low for LWD <3.0 m in length, LWD >3.0 m in length, LWD aggregates, and root-wads when compared with the average for the LCFR drainage (Appendix B, Figure B-286).

Hydrology and Water Temperature During normal water years, flows are sufficient to support fish in the stream section between the stream mouth and RM 0.2. Tributary discharge and water temperature was not monitored in this stream.

Sediment Survey

Major Stream Features - Conducted in June 1994, the survey of major stream features in the North Branch of Marten Creek extended from the confluence with the South Branch of Marten Creek upstream approximately 350 m. Reach one was a B-3 channel type and extended just a short way up the stream. Marten Creek Road crosses the stream with a bridge. Reach two was an A-3 type channel and was not included in the survey. Road 2213 follows most of the length of this stream.

Reach one was a short reach characterized by loose cobbles and downcutting of the channel. Spawning gravels were limited and concentrated behind obstructions and at water's edge. The stream was laterally stable and flows mostly under a canopy of hemlock conifer trees with 10 percent undercut banks, no eroding banks and a width/depth ratio of 11. Extensive hill-slope timber harvest was evident but was currently regenerating to a closed canopy.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the North Branch was 34 percent. Fine sediment levels in spawning gravels on the North Branch were relatively moderate when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 27 percent. If present, bull trout-predicted embryo survival to emergence would have been 31 percent. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout was moderate.

Riffle Stability Index (RSI) - The North Branch of Marten Creek is a third order stream and had one surveyed reach with a total of two RSI sites. This stream appeared well entrenched with stable banks and a well vegetated riparian area consisting primarily of hemlock trees. Extensive harvest in the headwaters and riparian disturbance was evident, but the stream is trending toward recovery. Excessive water flows seemed to have downcut the channel leaving loose cobbles with undercut banks.

The surveyed reach was a B-3 channel type and had an average Wolman particle distribution of 3 percent sand, 23 percent gravel, 41 percent cobble, and 29 percent boulder. The mean grain size of

the mobile particles for the two sites averages 61mm, ranging from 49 to 73 mm. The RSI values are 22 and 29.

Spawning Habitat Availability There are an estimated 45 m^2 of suitable habitat for fall-spawning salmonids in the North Branch. This equates to 0.134 m^2/m of stream length and 3.1 percent of the total stream area. This habitat can accommodate an estimated 13 adfluvial or 28 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively high.

Rearing Habitat Availability In the North Branch, there was approximately 235 m^2 of salmonid rearing habitat. This equates to 0.700 m^2/m of stream length and 15.9 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of available rearing habitat for juvenile salmonids in the North Branch was relatively high.

Productivity Primary and secondary productivity was not monitored in the North Branch of Marten Creek.

5.16.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in the North Branch were relatively high for cutthroat trout (Appendix B, Figure B-287). In general, salmonid populations are limited by a combination of stream intermittency, low amounts of LWD, and suitable spawning and rearing habitat. Stream sections with adequate year-around flows, unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization

Westslope Cutthroat Trout - Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found in the North Branch Marten Creek. In the North Branch there are an estimated 335 westslope cutthroat trout (Appendix C, Table C-64). Cutthroat trout densities were 0.940 fish/m (Appendix C, Table C-65).

Cutthroat trout densities are relatively high in high gradient riffle, pocket water, and run habitat types and relatively low in pool habitat. However, there was no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, P <0.50).

Age, Growth and Mortality

Westslope Cutthroat Trout - Scale samples were not obtained from fish in the North Branch of Marten Creek. As a result, age and growth estimates for this cutthroat trout population were not possible. However, when calculated from the length frequency distribution (Appendix B, Figure B-288), the instantaneous survival rate for cutthroat trout was 19 percent which was lower than the average for the drainage.

Rare Fish Genetics Fish populations in the North Branch of Marten Creek have not been sampled for electrophoretic testing.

Adfluvial Fish Spawning Redd counts for adfluvial stocks of brown and bull trout were not conducted on the North Branch of Marten Creek during late fall and early winter 1992-1994.

5.17 South Branch Marten Creek

The South Branch flows approximately 3.1 km from the southeastern slopes of the Bitterroot Range to its confluence with mainstem Marten Creek (Figure 5-11). The South Branch drainage covers about 1,300 ha. Average elevation change for the stream channel is about 54 m/km.

5.17.1 Fish Habitat

Fish habitat in South Branch consists of primarily high gradient riffle habitat; a substrate mix dominated by gravel; moderate amounts of fine sediment; a functional, although altered, riparian zone; a riparian vegetation mix consisting of a relatively even mix of vegetation types; and relatively high amounts of LWD.

Habitat Survey The habitat survey for the South Branch of Marten Creek included one tributary reach and extended from the confluence with Marten Creek to a location where normal stream flows are insufficient to support fish populations (RM 0.7).

Habitat Composition - Fish habitat on the South Branch consists primarily of high gradient riffle habitat. When compared with the overall habitat composition mix for streams in the LCFR drainage, the South Branch had similar amounts of cascade habitat; relatively high amounts of high gradient riffle; and relatively low amounts of pool, glide, run, and low gradient riffle habitat types (Appendix B, Figure B-289). The habitat composition of the South Branch is a direct result of high stream channel gradient and channel confinement.

Substrate Composition - Substrate composition in the South Branch was primarily gravel (Tukey test, $P < 0.05$). When compared with the average substrate composition for the drainage, the South Branch contains similar amounts of sand/silt, gravel, and boulder; relatively high amounts of peagravel; and relatively low amounts of rubble and cobble (Appendix B, Figure B-290).

Surface Fines - Surface fines in the South Branch average 14 percent and were statistically different between slow (21%) and fast water (10%) habitat types (t-Test, $P < 0.012$). Surface fines in the South Branch were similar to the drainage average.

Riparian Vegetation Composition - Riparian vegetation on the South Branch was predominately riparian shrub (Tukey test, $P < 0.05$). When compared with the average riparian vegetation mix for the drainage, the South Branch contains similar amounts of grass/forbs and upland shrub; relatively high amounts of riparian shrub and riparian tree; and relatively low amounts of sedge/rush and upland tree (Appendix B, Figure B-291). The presence of vegetative bank cover for the South Branch averages 95 percent and is the highest found in the LCFR drainage.

Large Woody Debris - In the South Branch, single pieces of large woody debris (LWD) <3.0 m in length average 37.17/100 m. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 51 percent, 44 percent, and 5 percent respectively.

Single pieces of LWD >3.0 m in length average 19.09/100 m. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 83 percent, 16 percent, and 1 percent respectively.

Aggregations of LWD average 6.24/100 m. The number of single pieces of LWD found in aggregations average 8.5 pieces per aggregation and range from 3 to 22 pieces per aggregation. The distribution of root-wads averages 2.7/100 m.

When compared with the average for the drainage, LWD concentrations in the South Branch are relatively high for LWD <3.0 m in length, LWD >3.0 m in length, and LWD aggregates; and relatively moderate for root-wads (Appendix B, Figure B-292).

Hydrology and Water Temperature During normal water years, flows are sufficient to support fish throughout the stream section surveyed. Tributary discharge and water temperature regime was not monitored in the South Branch of Marten Creek.

Sediment Survey

Major Stream Features - Conducted in June of 1994, the survey of major stream features in the South Branch of Marten Creek extended from the confluence with Marten Creek upstream for approximately 1.2 km. Reach one was a C-3 channel type that extended for approximately 0.4 km upstream; reach two was a B-3a channel type that extended for approximately 0.8 km further up the stream; and reach three was an A-2 channel type and was not surveyed. Road 187 follows for most of the length of the stream. The lower end of reach two was combined with reach one during the habitat survey.

Reach one was relatively complex with a fair amount of LWD. Insect larvae and detritus describe a higher productivity, cobble dominated stream. Salmonid spawning gravel was common but concentrated behind debris and in braided stream sections. Old riparian disturbance was noted in the form of logging debris, cables, landings, and road crossings. The riparian zone was dominated by brush, willows, and alder. The stream banks were stable with 1 percent of the banks eroding, 54 percent of the banks undercut, and a width/depth ratio of 16.

Reach two had old riparian roads, logging debris, and log jams indicating a previous riparian timber harvest. Approximately 0.4 and 1.3 km upstream, there were large debris jams associated with old bridge locations which were retaining a large amount of gravel. These structures created a considerable dam approximately 5.0 m high and constituted most of the LWD in this channel. Logs laying straight downstream similar to an old log flume seem evidence of past timber harvest and log drives in the watershed. Fish habitat was only evaluated in the lower end of this reach but the survey noted a width/depth ratio of 11 and relatively stable banks.

Reach three is an A-2 channel that flowed under a canopy of hemlock trees. No survey was conducted in this reach.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in the South Branch of Marten Creek was 23 percent. Fine sediment levels in spawning gravels on the South Branch were relatively low when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 41 percent. If present, bull trout predicted embryo survival to emergence would have been 46 percent. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in the South Branch was relatively high.

Riffle Stability Index (RSI) - The South Branch of Marten Creek is a third order stream with two surveyed reaches and RSI values ranging from 27 to 67. The confinement caused by what is likely an old landing or road rip-rap contributes to the lower RSI values in reach one. Old logging roads, bridges, and log flumes are also present in and adjacent to the stream. These features, though providing significant instream structure, have stored large amounts of gravels and their collapse will undoubtedly flush these gravels down the channel. The RSI values for both reaches indicated stability; however, the deterioration of the embedded debris could be a degrading influence on the entire stream.

Reach one was a C-3 channel type and had an average Wolman particle size distribution of 4 percent sand, 28 percent gravel, 57 percent cobble, and 10 percent boulder. The mean grain size of the mobile particles averages 72 mm, ranging from 64 to 80 mm. The RSI values are 43, 42, and 27.

Reach two was a B-3a channel type with an average Wolman particle distribution of 4 percent sand, 47 percent gravel, 41 percent cobble, and 8 percent boulder. The mean grain size of the mobile particles averages 71 mm, ranging from 69 to 71mm. The RSI values are 45, 51, and 67.

Spawning Habitat Availability There are an estimated 42 m^2 of suitable habitat for fall-spawning salmonids in the South Branch. This equates to 0.042 m^2/m of stream length and 1.1 percent of the total stream area. This habitat can accommodate an estimated 12 adfluvial or 26 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In the South Branch, there was approximately 714 m^2 of salmonid rearing habitat. This equates to 0.710 m^2/m of stream length and 19 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of available rearing habitat per meter of stream was relatively high.

Productivity Primary and secondary productivity was not monitored in the South Branch of Marten Creek.

5.17.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in the South Branch were relatively high for cutthroat trout (Appendix B, Figure B-293). In general, salmonid populations in the South Branch are relatively robust. However, if limited the relatively low amounts of suitable spawning habitat in the stream may restrict the population.

Abundance and Habitat Utilization

Westslope Cutthroat Trout - Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found in the South Branch of Marten Creek. In the South Branch there are an estimated 1,263 cutthroat trout (Appendix C, Table C-66). Cutthroat trout densities were 1,160 fish/m (Appendix C, Table C-67) and are high in pool habitat and low in high gradient riffle habitat. There was no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, $P < 0.10$).

Age, Growth and Mortality

Westslope Cutthroat Trout - Scale samples were not obtained from fish in the South Branch of Marten Creek. Consequently age and growth analysis for the cutthroat trout population in this stream was not possible. However, when calculated from the length frequency distribution (Appendix B, Figure B-294), the instantaneous survival rate of cutthroat trout was 15 percent which was relatively lower than the average for the drainage.

Rare Fish Genetics Fish populations in the South Branch of Marten Creek have not been sampled for electrophoretic testing.

Adfluvial Fish Spawning Redd counts for adfluvial stocks of brown and bull trout were not conducted on the South Branch of Marten Creek during late fall and early winter 1992-1994.

5.18 Graves Creek

Graves Creek flows approximately 21.0 km from the southwestern slopes of the Cabinet Mountains in Lolo National Forest to its confluence with Noxon Reservoir approximately 7.0 km east of Thompson Falls, Montana (Figure 5-12). The Graves Creek drainage covers approximately 7,381 ha. Minor tributaries include Thorne Creek, Winniemuck Creek, and Irvs Creek. Stream gradient within various reaches of Graves Creek determines stream morphology. For the stream section surveyed, between the confluence and Graves Creek Falls, average elevation drop is approximately 20 m/km. In reach one, from the confluence at Noxon Reservoir to RM 1.1, the average drop is

Figure 5-12. Map of the Graves Creek drainage showing major tributaries and reach breaks.

approximately 17 m/km; in reach two (RM 1.1 to RM 2.1) the change in elevation is about 25 m/km; and in reach three (RM 2.1 to RM 2.7), the stream drops approximately 100 m/km.

5.18.1 Fish Habitat

Fish habitat in Graves Creek consists of primarily high gradient riffle, cascade, and low gradient riffle habitat types; a substrate mix dominated by cobble, gravel, and rubble; low amounts of fine sediment; a functional although altered riparian zone; a riparian vegetation mix consisting primarily of low-cover and upper canopy vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for Graves Creek included three tributary reaches and extended from the confluence at Noxon Reservoir to a natural fish barrier at Graves Creek Falls (RM 2.7).

Habitat Composition - Fish habitat in Graves Creek consists primarily of high gradient riffle, cascade, and low gradient riffle habitat types. Reach one was predominately low gradient riffle, high gradient riffle, and run habitat; reach two was mainly high gradient riffle and cascade habitat; and reach three was primarily cascade, and high gradient riffle habitat types (Appendix B, Figure B-295).

When compared with the overall habitat composition mix for streams in the LCFR drainage, Graves Creek had similar amounts of low gradient riffle habitat; relatively high amounts of high gradient riffle and cascade habitats; and relatively low amounts of pool and run habitat types (Appendix B, Figure B-296). Habitat composition varies with stream channel gradient and confinement. Tributary reaches that were relatively high gradient and confined, contains high amounts of cascade and riffle habitat; while relatively low gradient and unconfined tributary reaches contains high amounts of run, pool, and glide habitat types.

Substrate Composition - Substrate composition in Graves Creek was predominately cobble, gravel, and rubble (Tukey test, $P<0.05$). Reach one contains high amounts of rubble, gravel (Tukey test, $P<0.05$); reach two was predominately cobble, rubble, gravel, and boulder (Tukey test, $P<0.05$); and reach three contains a relatively high percentage of boulder, cobble, rubble, and gravel (Appendix B, Figure B-297). Although statistically significant differences in substrate composition in reach three

were found (ANOVA, P <0.001), the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive).

When compared with the average substrate composition for the drainage, Graves Creek contains similar amounts of gravel, rubble, and bedrock; relatively high amounts of cobble and boulder; and relatively low amounts of sand/silt and peagravel (Appendix B, Figure B-298).

Surface Fines - Surface fines in Graves Creek average 7 percent and range from 1 percent to 11 percent. Surface fines were high in reach one and relatively low in reaches two and three (Tukey test, P< 0.05) (Appendix B, Figure B-299). Surface fines were statistically different between slow water (22%) and fast water (5%) habitat types (t-Test, P< 0.001). Surface fines in Graves Creek were lower than the drainage average.

Riparian Vegetation - Riparian vegetation in Graves Creek consist primarily of grass/forbs (Tukey test, P <0.05). Vegetation in reach one was predominately grass/forbs (Tukey test, P <0.05); reach two was dominated by grass/forbs and riparian tree (Tukey test, P <0.05); and reach three contains a high amount of riparian tree (Tukey test, P <0.05) (Appendix B, Figure B-300).

When compared with the average riparian vegetation mix for the drainage, Graves Creek contains similar amounts of upland shrub; relatively high amounts of grass/forbs and riparian tree; and relatively low amounts of sedge/rush, riparian shrub, and upland tree (Appendix B, Figure B-301).

The presence of vegetative bank cover for Graves Creek averages 78 percent, ranging from 73 percent in reach one to 81 percent in reach two (Appendix B, Figure B-302). There was no statistically significant difference in the presence of vegetative bank cover among tributary reaches (ANOVA, P <0.50). The amount of vegetative bank cover for Graves Creek is relatively moderate when compared with the drainage average.

Large Woody Debris - In Graves Creek, single pieces of LWD <3.0 m in length average 5.81/100 m and range from 1.54/100 m in reach three to 11.11/100 m in reach two (Appendix B, Figure B-303). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 67 percent, 23 percent, and 10 percent respectively.

Single pieces of LWD >3.0 m in length average 5.64/100 m and range from 3.25/100 m in reach one to 9.88/100 m in reach two (Appendix B, Figure B-304). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 49 percent, 32 percent, and 19 percent respectively.

Aggregations of LWD average 0.91/100 m and range from 0.22/100 m in reach one to 1.79/100 m in reach two (Appendix B, Figure B-305). The number of single pieces of LWD found in aggregations average 2.4 for the combined tributary reaches and range from 2 to 19 pieces per aggregation. The distribution of root-wads averages 1.26/100 m of stream, ranging from 0.78/100 m in reach one to 2.09/100 m in reach two (Appendix B, Figure B-306).

Amounts of LWD in Graves Creek were relatively low for LWD >3.0 m in length, root-wads, LWD <3.0 m in length, and LWD aggregates when compared with the average for the LCFR drainage (Appendix B, Figure B-307).

Hydrology and Water Temperature The hydrology of Graves Creek is characteristic of low order, headwater streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns in the lower reaches during extreme water years. The water temperature regime is relatively low, which is also typical for this type of stream in the LCFR drainage, and does not typically exceed levels suitable for salmonid populations.

Hydrology - In 1994, tributary discharge monitored periodically at RM 2.1 averaged 0.5 m^3/sec, ranging from 0.2 m^3/sec in January and February to 0.8 m^3/sec during April and May (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish throughout the stream.

Water Temperature - Water temperatures measured at RM 2.1 during 1994 averaged 5.5° C (Appendix C, Table C-2), ranging from a minimum of -0.04° C in November (Appendix C, Table C-3) to a maximum of 11.9° C in June (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 5.5° C, ranging from 4.6 to 10.2° C; in summer (June - August), temperatures averaged 8.0° C, ranging from 4.9 to 11.9° C; during fall (September - November), they averaged 5.2° C, ranging from -0.04 to 9.8° C; and in the winter months (December - February), water temperatures averaged 3.4° C, ranging from 0.3 to 4.4° C.

Sediment Survey

Major Stream Features - Conducted in June 1994, the survey of major stream features in Graves Creek extended from the mouth at Graves Creek Bay upstream to Graves Creek Falls. Reach one was a C-3 channel type and extends upstream to the section line of section 1 (RM 1.1). Reach two was a B-3 channel type that continued upstream to approximately RM 2.1. Reach three is as an A-2 channel type, extended to the base of Graves Creek Falls (RM 2.7) and was not surveyed. Graves Creek Road follows the length of the stream with several dwellings being present in the riparian area.

Reach one was a gravel reach that was laterally unstable and contains extensive riffles. Spawning gravels were common. Several large sediment sources were present approximately 0.2, 0.6, and 0.9 km up from the stream mouth. The riparian zone was mostly unforested with grass and alders being the dominant vegetation. Some grazing has occurred in the riparian zone and several old roads and fill sites were present. Some LWD was incorporated in the stream and created most of the complexity. This reach had 3 percent undercut banks, 6 percent eroding bank, a width/depth ratio of 16.

Reach two had slightly more gradient and less sinuosity than reach one with a riparian area influenced similarly to reach one. This reach was more stable, substrate and spawning gravels were common. Large woody debris was limited and concentrated in debris jams. The Graves Creek Road has channelize the stream in several locations and crossed the stream with a bridge. This reach has no undercut or eroding banks and a width/depth ratio of 15.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Graves Creek was 25 percent, ranging from 29 percent in reach one to 33 percent in reach two (Appendix B, Figure B-308). Fine sediment levels in spawning gravels on Graves Creek were relatively low when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 39 percent, ranging from 28 percent in reach two to 33 percent in reach one. For bull trout, predicted embryo survival to emergence was 43 percent, ranging from 32 percent in reach two to 38 percent in reach one

(Appendix B, Figure B-309). When compared to the LCFR drainage a
survival to emergence for cutthroat and bull trout in Graves Creek was relat

Riffle Stability Index (RSI) - Graves Creek is a larger fourth order stream
reaches with RSI values ranging from 33 to 84. The RSI values were not c
because the channel type was inconsistent with RSI methodology criteria.

Reach one was a C-3 channel type with an average Wolman particle distribu
30 percent gravels, 51 percent cobble, and 9 percent boulder. The mean gra
particles averages 125 mm, ranging from 120 to 129 mm. The RSI values are
mouth of Graves Creek was aggraded with large gravel bars and are mostly riffl
LWD were available for channel stability. Approximately halfway up the rea
the channel into a riffle area. The slightly lower RSI values at site two and th
near these roads. Several large sources of sediment and eroding banks were pre
stabilization. These sites were actively supplying gravels into the stream.

Reach two was a B-3 channel type with an average Wolman particle distribution
19 percent gravel, 58 percent cobble, and 18 percent boulder. The mean grain
particles averages 100 mm, ranging from 93 to 110 mm. The RSI values are 45,
lower RSI values in reach two indicated downcutting of the channel.

Spawning Habitat Availability There are an estimated 425 m^2 of suitable habitat
salmonids in Graves Creek. This equates to 0.164 m^2/m of stream length and 2.2 pe
stream area. This habitat can accommodate an estimated 118 adfluvial or 266 re
redds. When compared with the average for the LCFR drainage, the amount of spaw
meter of stream was relatively high.

Rearing Habitat Availability In Graves Creek, there was approximately 1,896 r
rearing habitat. This equates to 0.730 m^2/m of stream length and 9.7 percent of the to
When compared with the average for the LCFR drainage, the amount of rearing habit
stream was relatively high.

Productivity

Primary Productivity - We monitored periphyton accumulation in Graves Creek for 39 days. The average autotrophic index was 10.43, ranging from 0.0 to 96.65; average chlorophyll content was 0.95 mg/m^2, ranging from 0.0 mg/m^2 to 2.86 mg/m^2; net productivity averages 0.07 mg/m^2/day, ranging from 0.0 mg/m^2/day to 0.38 mg/m^2/day. The autotrophic index was relatively high while the chlorophyll content and net productivity values were lower than the average values for the LCFR drainage.

Secondary Productivity - Benthic invertebrate populations in Graves Creek consist primarily of members from the order Ephemeroptera (76%) followed by Plecoptera (9%) and Diptera (8%) (Appendix B, Figure B-310). Aquatic benthic invertebrate densities average 362/m^2 and range from 294/m^2 in reach three to 477/m^2 in reach two (Appendix B, Figure B-311). There was no statistically significant difference in invertebrate densities among reaches (ANOVA, $P < 0.50$). Invertebrate species richness for the stream was 18, ranging from 12 in reach three to 18 in reach two (Appendix B, Figure B-312). The invertebrate species diversity index (SDI) for the stream was 2.290, ranging from 1.639 in reach three to 2.060 in reach two (Appendix B, Figure B-313). Invertebrate densities were relatively low while species richness and SDI values were similar to the average values for the LCFR drainage.

5.18.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in Graves Creek were relatively high for cutthroat trout and bull trout; and relatively low for brown trout and brook trout (Appendix B, Figure B-314). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in Graves Creek are limited by a combination of low amounts of LWD, and spawning and rearing habitat. Stream sections with relatively unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found in reach two and three of Graves

Creek. In Graves Creek there are an estimated 2,717 westslope cutthroat trout, 17 brook trout, 738 bull trout, and 15 brown trout (Appendix C, Table C-68). Fish densities were high for cutthroat trout and relatively low for brown and brook trout (Tukey test, P<0.05) (Appendix C, Table C-69).

Westslope Cutthroat Trout - Westslope cutthroat trout were present throughout the surveyed section of Graves Creek, and were the most abundant species in reaches two and three (Appendix C, Table C-68). Cutthroat trout densities average 1.046 fish/m of stream, ranging from 0.667 to 1.381/m (Appendix C, Table C-69); densities were high in reach two (t-Test, P <0.010).

Cutthroat trout densities are relatively high in pool habitat; and relatively low in cascade habitat (Appendix C, Table C-70). There was no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-71).

Bull Trout - Bull trout were present throughout the surveyed section of Graves Creek, and were the most abundant trout in reach three and second most abundant in reach two (Appendix C, Table C-68). Bull trout densities average 0.284/m and range from 0.168 to 0.403/m (Appendix C, Table C-69); densities were high in reach three (t-Test, P <0.019).

Bull trout densities are relatively high in low gradient riffle habitat types and relatively low in high gradient riffle and run habitat types (Appendix C, Table C-70). There was no statistically significant difference in the distribution of bull trout among habitat types (ANOVA, P <0.20) (Appendix C, Table C-71). Bull trout were not found in glide habitat types.

Brown Trout - Brown trout were present in reach two and, of the species present, were the least abundant species (Appendix C, Table C-68). Brown trout densities average 0.006 fish/m for the stream and 0.011 fish/m in reach two (Appendix C, Table C-69). Brown trout were not found in reach three. Brown trout were only present in run habitats (Appendix C, Table C-70, C-71).

Brook Trout - Brook trout are present throughout the surveyed section and were the third most abundant trout in reaches two and three (Appendix C, Table C-68). Densities average 0.006/m and range from 0.007/m in reach three to 0.006/m in reach two (Appendix C, Table C-69). There was no significant difference in brook trout densities between tributary reaches (t-Test, P <0.564). Brook

trout in this stream were found only in low gradient riffle or run habitat types (Appendix C, Table C-70, C-71).

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in Graves Creek is higher than the average for the drainage with the oldest fish sampled being age V+. Growth of cutthroat trout in Graves Creek was relatively moderate when compared with the average growth rate for the drainage with age I+ fish reaching a length of 66 mm (2.6 in) and age III+ a length of 184 mm (7.3 in) (Appendix B, Figure B-315). The instantaneous survival rate of 28 percent was similar to the average for the drainage.

Bull Trout - Bull trout growth in Graves Creek was relatively high when compared with the drainage average with age I+ fish reaching an average length of 78 mm (3.1 in) and age III+ fish a length of only 179 mm (7.2 in) (Appendix B, Figure B-316). The instantaneous survival rate of bull trout to age III+ was 62 percent and was higher than the average for the drainage.

Brown Trout - Age, growth, and survival estimates for brown trout in Graves Creek were not possible due to the small size of the data set.

Brook Trout - Age, growth, and survival estimates for brook trout in Graves Creek were not possible due to the small size of the data set.

Rare Fish Genetics Fish populations in Graves Creek have not been sampled for electrophoretic testing.

Adfluvial Fish Spawning Counts for brown and bull trout redds were conducted for the first time in 1993. Counts were conducted from the base of Graves Falls to the stream mouth or where the stream channel went dry. One bull trout redd and no brown trout redds were found during the surveys. Brown trout redd counts were not attempted in 1994 due to high flows. Bull trout redd counts were conducted in 1994 and no redds were found. Because of high flows, the 1994 bull trout redd count could be of questionable value.

5.19 Vermilion River

The Vermilion River flows approximately 23.5 km from the southwestern slopes of the Cabinet Mountains to its confluence with Noxon Reservoir, approximately 6.0 km east of Trout Creek, Montana (Figure 5-13). The Vermillion River drainage covers about 7,122 ha. Major streams in the drainage include Canyon Creek, Lyons Gulch, Sims Creek, and Willow Creek. Stream gradient within various reaches of the Vermilion River determines stream morphology. For the river section surveyed, between the confluence and Vermilion Falls, the average elevation drop is about 36 m/km. Elevation loss varies within the stream length. In reach one, from the confluence at Noxon Reservoir to China Gorge (RM 5.2), the average drop is approximately 40 m/km; in reach two, China Gorge (RM 5.2 to RM 5.4), the change in elevation is about 120 m/km; for reach three, China Gorge to Vermilion Falls (RM 10.5), the stream drops approximately 30 m/km.

5.19.1 Fish Habitat

Fish habitat in Vermilion River consists primarily of low gradient riffle, high gradient riffle, and run habitat types; a substrate mix dominated by rubble and gravel; low amounts of fine sediment; a largely non-functional and altered riparian zone; a riparian vegetation mix consisting primarily of low-cover and upper canopy vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for the Vermilion River included three tributary reaches (two of which were technically surveyed) and extended from the confluence at Noxon Reservoir to a permanent fish barrier at Vermilion Falls (RM 10.5).

Habitat Composition - Fish habitat on Vermilion River consists primarily of low gradient riffle, high gradient riffle, and run habitat types. Reach one was predominately high gradient riffle and low gradient riffle habitat; reach two was not surveyed but consists of a pool/cascade complex; and reach three was mainly run and low gradient riffle habitat types (Appendix B, Figure B-317).

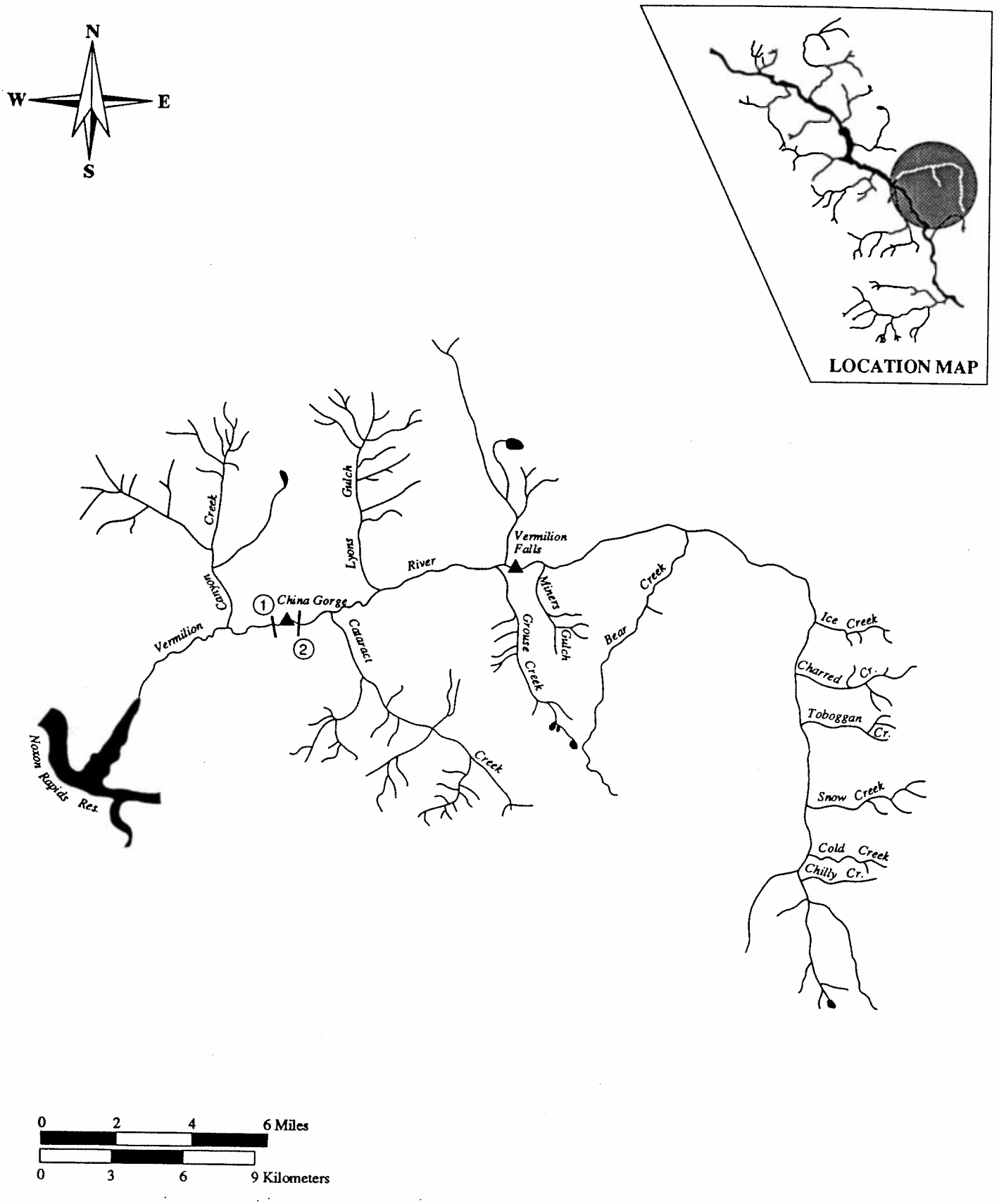

Figure 5-13. Map of the Vermilion River drainage showing major tributaries and reach breaks.

When compared with the overall habitat composition mix for streams in the LCFR drainage, the Vermilion River had similar amounts of glide, run, and high gradient riffle habitat; relatively high amounts of low gradient riffle habitat; and relatively low amounts of pool, and cascade habitat types (Appendix B, Figure B-318). Habitat composition varies with stream channel gradient and confinement. Tributary reaches that were relatively high gradient and confined, contain high amounts of cascade and riffle habitat; while relatively low gradient and unconfined tributary reaches contain high amounts of run, pool, and glide habitat types.

Substrate Composition - Substrate composition in Vermilion River was predominately rubble and gravel (Tukey test, $P<0.05$). Reach one contains significant amounts of rubble, cobble, and gravel (Tukey test, $P<0.05$); reach two was not surveyed but consists of predominately boulder and bedrock; and reach three contains a high percentage of gravel and rubble (Tukey test, $P<0.05$) (Appendix B, Figure B-319).

When compared with the average substrate composition for the drainage, the Vermilion River contains similar amounts of peagravel, cobble, boulder, and bedrock; relatively high amounts of gravel and rubble; and relatively low amounts of sand/silt (Appendix B, Figure B-320). Substrate composition varies with stream channel gradient. Tributary reaches that were relatively high gradient typically contain high amounts of cobble and boulder; while relatively low gradient tributary reaches contain high amounts of gravel and sand/silt.

Surface Fines - Surface fines for the Vermilion River were statistically different between reaches, averaging 8 percent and ranging from 5 percent in reach one to 10 percent in reach two (T-test, $P< 0.001$). Surface fines were also statistically different between slow (15%) and fast water (5%) habitat types (t-Test, $P< 0.001$). Surface fines in the Vermilion River were lower than the drainage average.

Riparian Vegetation - Riparian vegetation along the Vermilion River consists primarily of grass/forbs (Tukey test $P<0.05$) (Appendix B, Figure B-321). When compared with the average riparian vegetation mix for the drainage, Vermilion River contains similar amounts of upland shrub and riparian tree; relatively high amounts of grass/forbs; and relatively low amounts of sedge/rush, riparian shrub, and upland tree (Appendix B, Figure B-322).

The amount of vegetative bank cover on the Vermilion River is relatively low when compared with the drainage average. The presence of vegetative bank cover on the Vermilion River is similar in all reaches, averaging 56 percent and ranging from 51 percent in reach three to 59 percent in reach one (T-test, P <0.578).

Large Woody Debris - In the Vermilion River, single pieces of LWD <3.0 m in length average 0.57/100 m and range from 0.56/100 m in reach three to 0.59/100 m in reach one. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 88 percent, 9 percent, and 2 percent respectively.

Single pieces of LWD >3.0 m in length average 0.36/100 m and range from 0.28/100 m in reach one to 0.45/100 m reach three. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 61 percent, 24 percent, and 15 percent respectively.

Aggregations of LWD average 0.08/100 m and range from 0.07/100 m in reach one to 0.09/100 m in reach three. The number of single pieces of LWD found in aggregations average 1.2 for the combined tributary reaches and range from 2 to 5 pieces per aggregation. The distribution of root-wads averages 0.10/100 m of stream, ranging from 0.07/100 m in reach one to 0.13/100 m in reach three.

When compared with the average for the drainage, amounts of LWD in the Vermilion River were relatively low for all classifications (Appendix B, Figure B-323).

Hydrology and Water Temperature The hydrology of Vermilion River is characteristic of large, high order streams in the LCFR drainage that experience periodic high flow events and are not subject to intermittent flow patterns. The water temperature regime is relatively high (also typical for this type of stream in the LCFR drainage) and although borderline at times, does not typically exceed levels suitable for salmonid populations.

Hydrology - Tributary discharge monitored periodically at RM 0.6 during 1994 averaged 3.4 m^3/sec, ranging from 1.6 m^3/sec in February to 6.8 m^3/sec during April (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish throughout the stream.

Water Temperature - During 1994, water temperatures measured at RM 0.6 averaged 7.8° C (Appendix C, Table C-2), ranging from a minimum of 1.4° C in December (Appendix C, Table C-3) to a maximum of 18.4° C in July (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 7.2° C, ranging from 5.7 to 8.6° C; in summer (June - August), temperatures averaged 11.7° C, ranging from 6.1 to 18.4° C; during fall (September - November), they averaged 7.7° C, ranging from 1.9 to 14.8° C; and in the winter months (December - February), water temperatures averaged 4.6° C, ranging from 1.4 to 7.0° C.

Sediment Survey

Major Stream Features - Conducted in 1994 and 1995, the survey of major stream features in the Vermilion River extended from the mouth of the river at Vermilion Bay to China Gorge in section 8. Reach one was a C-3 channel type that meandered from the mouth to the lower falls at China Gorge (RM 5.2). Reach two is a short A-2 channel type that cascades through China Gorge. Reach three is as C-3 channel type and extended to the lower end of the Vermilion Falls cascade complex (RM 10.5).

Reach one was a cobble dominated reach that had slightly smaller substrate in the lower portion of the reach. The riparian zone was characterized by a broad flood plain with scattered conifers, brush, and forbs. Large woody debris was limited in the channel and created the only complexity in this stream. Spawning gravels were common throughout the channel. Considerable bedload deposits were present throughout the reach. The Vermilion River Road follows the length of the reach with several dwellings in the flood plain. Approximately 3.5 km up the channel, an old riparian road was present with rip-rap that channelizes the stream. The upper portion of the reach was more stable than the lower. This reach had no undercut bank, 1 percent eroding bank, and a width/depth ratio of 25.

Reach two was a high gradient boulder, cascading reach with steep canyon walls and a width/depth ratio of 9. This reach was not technically surveyed.

Reach three was similar to reach one, cobble dominated with relatively smaller substrate in the lower section of the reach. The upper portion of the reach was more stable than the lower. The riparian zone was characterized by a broad flood plain with scattered conifers, and riparian shrub. Large

woody debris was limited in the channel and created the majority of the habitat complexity in this stream. Spawning gravels were common though scattered into isolated depositional areas. Considerable bedload deposits were present throughout the reach. The Vermilion River Road follows the length of the reach. Placer mining occurs at several locations and riparian roads, some dwellings, and associated out-buildings were present in the lower sections of this reach. This reach has 1 percent undercut bank, 7 percent eroding bank, and a width/depth ratio of 13.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Vermilion River was 27 percent and was consistent between reaches at 32 percent. Fine sediment levels in spawning gravels on Vermilion River were relatively low when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 36 percent, ranging from 29 percent in reach one to 30 percent in reach three. For bull trout, predicted embryo survival to emergence was 40 percent, ranging from 33 percent in reach one to 34 percent in reach three. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in the Vermilion River was relatively high.

Riffle Stability Index (RSI) - The Vermilion River is a fifth order river and had one surveyed reach with RSI values ranging from 61 to 74. The RSI values were not calculated for reach two because the channel type was inconsistent with RSI methodology criteria. The RSI data were not collected from reach three.

Reach one was a C-3 channel type with an average Wolman particle distribution of 5 percent sand, 27 percent gravel, 59 percent cobble, and 6 percent boulder. The mean grain size of the mobile particles averages 129 mm, ranging from 127 to 134 mm. The RSI values are 74, 70, and 61. Reach one appeared laterally unstable with channel movement, mid-channel bars, and lateral instability. The RSI values for the first reach were influenced by channelization and were slightly lower than expected. This reach was characterized by a broad flood plain with scattered conifers, roads, dwellings, and channelizing. Large woody debris in the channel for stabilization was not abundant. A cursory look at the headwaters indicated there has been extensive timber harvesting and road

building for most of the length of the river. These conditions have most likely increased the magnitude of high flow events in the lower tributary reaches.

Spawning Habitat Availability There are an estimated 496 m^2 of suitable habitat for fall-spawning salmonids in the Vermilion River. This equates to 0.030 m^2/m of stream length and 0.3 percent of the total stream area. This habitat can accommodate an estimated 138 adfluvial or 310 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively low.

Rearing Habitat Availability In the Vermilion River, there was approximately 2,481 m^2 of salmonid rearing habitat. This equates to 0.150 m^2/m of stream length and 1.3 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of rearing habitat per meter of stream was relatively low.

Productivity

Primary Productivity - We monitored periphyton accumulation in the Vermilion River for 40 days. The average autotrophic index was 7.02, ranging from 1.87 to 18.73; average chlorophyll content was 1.55 mg/m^2, ranging from 0.30 mg/m^2 to 3.84 mg/m^2; net productivity averages 0.34 $mg/m^2/day$, ranging from 0.13 $mg/m^2/day$ to 0.63 $mg/m^2/day$. When compared with the average values for the LCFR drainage, the autotrophic index and net productivity was relatively moderate; and chlorophyll content was relatively low.

Secondary Productivity - Invertebrate samples were not successfully obtained from reaches two and three in the Vermilion River. In reach one, benthic invertebrate populations consists primarily of members from the order Ephemeroptera (35%) followed by Diptera (24%), Plecoptera (18%), and Trichoptera (18%) (Appendix B, Figure B-324). Aquatic benthic invertebrate densities were $188/m^2$. Species richness was 14 and species diversity (SDI) was 2.463. When compared with average values for the LCFR drainage, invertebrate densities and species richness were low while species diversity was relatively similar.

5.19.3 Fish Populations

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were attempted in all reaches and habitat types found in the Vermilion River. Efforts by Washington Water Power Company and Montana Department of Fish, Wildlife and Parks personnel to obtain fish population data were not successful. Flow conditions and river channel width prevented collection of accurate snorkel count or electrofishing data. However, in the tributary sections that were sampled westslope cutthroat, brown, brook, and bull trout were found.

Age, Growth and Mortality Sampling of fish populations was not successful in the Vermilion River. As a result, it was not possible to obtain sufficient numbers of fish or scale samples to determine growth rates or develop a length frequency distribution for these populations.

Rare Fish Genetics Cutthroat trout populations were sampled in the Vermilion River above Vermilion Falls in 1983; and from two tributaries below the falls, Cataract Creek during 1985-87, and Canyon Creek in 1991. Cutthroat trout in Vermilion River above the falls were classified as pure westslope cutthroat trout that could have been part of the State of Montana's brood stock. Fish from Cataract Creek were determined to be a true hybrid swarm of westslope/Yellowstone cutthroat trout and were classified as hybridized. Cutthroat from Canyon Creek had a genetic mix containing pure westslope cutthroat and hybridized westslope cutthroat/rainbow trout. However, this population is as pure westslope cutthroat for management purposes. With the exception of Vermilion Falls, there are no barriers to the upstream movement of fish and possible sources of hybridization in the lower reaches of this drainage.

Adfluvial Fish Spawning Historical information indicated that bull trout had access to approximately ten miles of the Vermilion River to the base of Vermilion Falls. However, only the lower four miles of the river were thought accessible to spawning brown trout. The blockage for brown trout was thought to be the 'China Gorge' which is a narrow box canyon with a six foot high falls, followed by a 15-20 foot long chute. The Vermilion River above the gorge had been checked for brown trout redds in 1987 and 1988 and none were found. However, during counts in 1993 six brown trout redds were found in the upper river section (Huston 1995).

Brown Trout - Brown trout redd counts on the Vermilion River have been conducted from the first helicopter landing to the stream mouth since 1986. An additional reach from Vermilion Falls to China Gorge was included in the annual counts during 1987 and 1988, and on an ongoing basis beginning in 1993.

Brown trout redd counts for 1986 through 1988 averaged 26 per year, ranging from a low of 12 in 1986 and a high of 40 in 1988. These data show an increasing trend in the number of brown trout redds found in this stream during this time period. Redd count data from 1991 to 1994 were not believed to be an accurate representation of brown trout spawning activity for this time period. Redd counts were not conducted during 1989 and 1990 due to high flow conditions. Counts in 1991 were incomplete as brown trout had not completed spawning by the time the counts were conducted. The count for 1993 was believed artificially high due to miscounted redds and the 1994 count was incomplete due to high flow conditions (Appendix C, Table C-10).

Bull Trout - Bull trout redd counts were conducted for the first time in 1993. Two bull trout redds were found in the river section below the China Gorge and 25 were found above the gorge. In 1994, nine redds were found below the gorge but the counts were incomplete because of high flows (Appendix C, Table C-11).

5.20 Prospect Creek

Prospect Creek flows approximately 17.8 km from the southeastern slopes of the Bitterroot Range to its confluence with Noxon Reservoir approximately 0.9 km west of Thompson Falls, Montana (Figure 5-14). The drainage covers about 43,771 ha. Major tributaries include Clear Creek, Twenty-four Mile Creek, Blossom Creek, Evans Gulch, Cooper Gulch, Crow Creek, and Wilkes Creek. Average elevation drop is about 14 m/km. In reach one, from the confluence at Noxon Reservoir to RM 0.8, the average drop is approximately 30 m/km; in reach two (RM 0.8 to RM 1.1) the change in elevation is about 50 m/km; for reach three (RM 1.1 to RM 2.3), the stream drops approximately 21 m/km; and in reach four (RM 2.3 to RM 2.9), the average drop is <1 m/km; in reach five (RM 2.9 to RM 13.5), elevation change is 9 m/km; for reach six (RM 13.5 to RM 15.3), change in elevation averages 28 m/km; and in reach seven (RM 15.3 to RM 16.8), the stream drops 45 m/km.

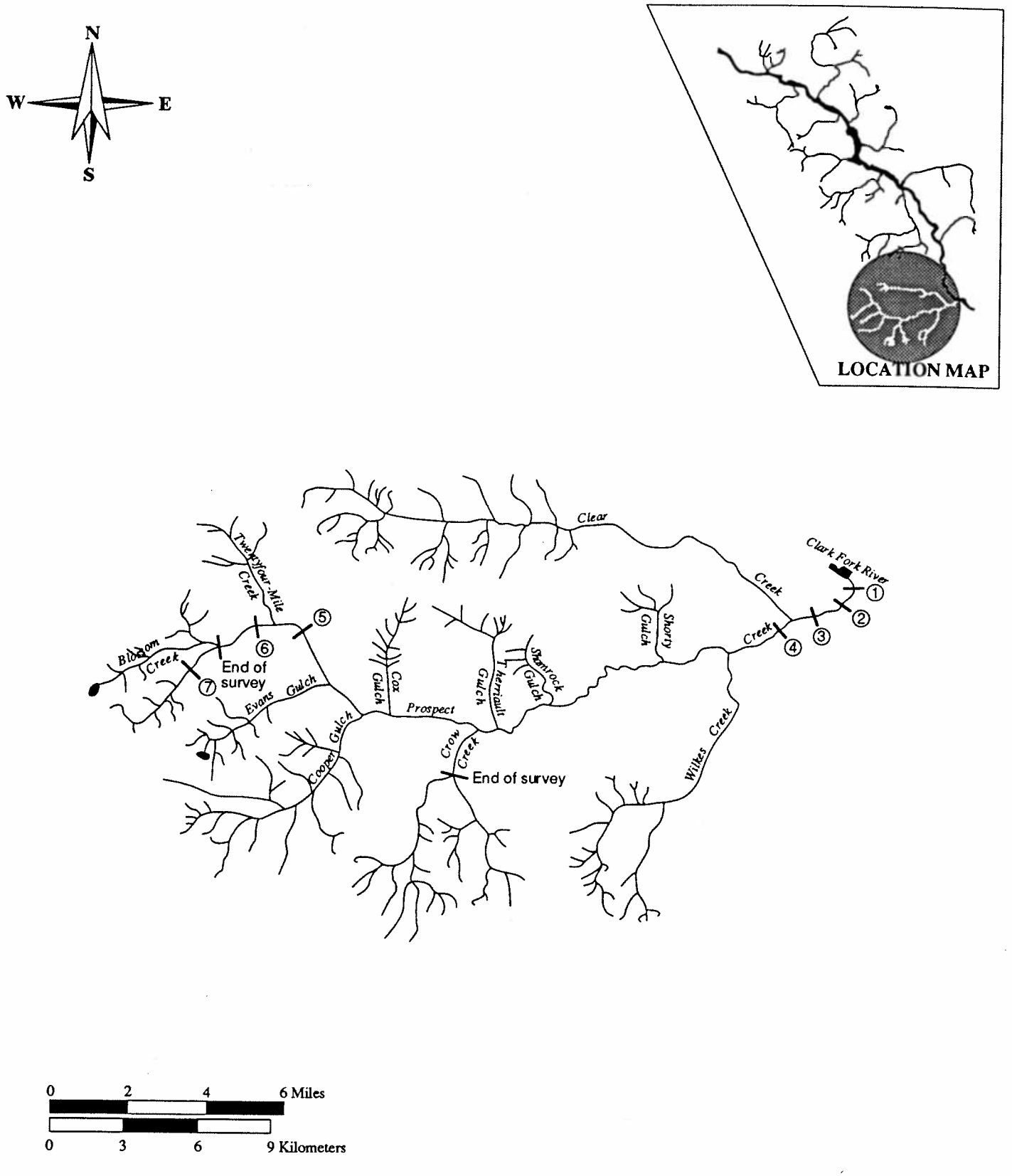

Figure 5-14. Map of the Prospect Creek drainage showing major tributaries and reach breaks.

5.20.1 Fish Habitat

Fish habitat in Prospect Creek consists of primarily low gradient riffle and run habitat types; a substrate mix dominated by gravel and rubble; low amounts of fine sediment; a largely non-functional and altered riparian zone; a riparian vegetation mix consisting of a relatively even mix of vegetation types; and relatively low amounts of LWD.

Habitat Survey The habitat survey for Prospect Creek included seven tributary reaches and extended from the confluence with Noxon Reservoir to what is likely a man-made fish barrier at RM 16.8.

Habitat Composition - Fish habitat on Prospect Creek consists primarily of low gradient riffle and run habitat types. Reach one was predominately cascade and low gradient riffle habitat; reach two was mainly cascade, low gradient riffle, and pool habitat types; reach three was dominated by cascade, and pocket water habitat; reach four contains primarily run and pocket water habitat; reach five was predominately low gradient riffle and run; reach six was mainly high gradient riffle and pool habitats; and reach seven was primarily cascade, pocket water, and high gradient riffle habitat types (Appendix C, Table C-72).

When compared with the overall habitat composition mix for streams in the LCFR drainage, Prospect Creek had similar amounts of glide, and cascade habitats; relatively high amounts of run and low gradient riffle habitats; and relatively low amounts of pool and high gradient riffle habitat types (Appendix B, Figure B-325). Habitat composition varies with stream channel gradient and confinement. Tributary reaches that were relatively high gradient and confined, contain high amounts of cascade and riffle habitat; while relatively low gradient and unconfined tributary reaches contain high amounts of run, pool, and glide habitat types.

Substrate Composition - Substrate composition in Prospect Creek was primarily gravel and rubble (Tukey test, $P < 0.05$). Reach one and two contains relatively high quantities of gravel and rubble (Tukey test, $P < 0.05$); reach three contains a high percentage of rubble and cobble (Tukey test, $P < 0.05$); reach four appeared to contain relatively high amounts of rubble and gravel; reaches five and six contain a high percentage of gravel and rubble (Tukey test, $P < 0.05$); and reach seven contains

high amounts of rubble and cobble (Tukey test, P <0.05) (Appendix C, Table C-73). Although statistically significant differences in substrate composition in reach four were found (ANOVA, P<0.05), the data set was insufficent to statistically characterize the differences (Tukey test, inconclusive).

When compared with the average substrate composition for the drainage, Prospect Creek contains similar amounts of cobble, boulder, and bedrock; relatively high amounts of gravel and rubble; and relatively low amounts of sand/silt and peagravel (Appendix B, Figure B-326). Substrate composition varies with stream channel gradient. Tributary reaches that were relatively high gradient typically contain high amounts of cobble and boulder; while relatively low gradient tributary reaches contain high amounts of gravel and sand/silt.

Surface Fines - Surface fines in Prospect Creek average 10 percent and range from 5 percent in reach three to 16 percent in reach one and five (Appendix B, Figure B-327). Although statistically significant differences in the distribution of surface fines among tributary reaches were found (ANOVA, P<0.001), the data set was insufficent to statistically characterize the differences (Tukey test, inconclusive). Percent surface fines were significantly different between slow (18%) and fast water (6%) habitat types (t-Test, P< 0.001). Surface fines in Prospect Creek were lower than the drainage average.

Riparian Vegetation - Riparian vegetation on Prospect Creek consists primarily of grass/forbs (Tukey test, P<0.05). Vegetation in reach one is predominately grass/forbs, riparian tree, and upland tree (Tukey test, P <0.05); reach two was primarily riparian tree, grass/forbs, upland tree, and riparian shrub (Tukey test, P <0.05); reaches three, four, and five contains a high percentage of grass/forbs (Tukey test, P <0.05); reach six was predominately riparian tree, riparian shrub, upland tree, and grass/forbs (Tukey test, P <0.05); and reach seven contains a high percentage of riparian tree (Tukey test, P <0.05) (Appendix C, Table C-74).

When compared with the average riparian vegetation mix for the drainage, Prospect Creek contains similar amounts of upland shrub, and upland tree; relatively high amounts of grass/forbs and riparian tree; and relatively low amounts of sedge/rush and riparian shrub (Appendix B, Figure B-328).

The presence of vegetative bank cover on Prospect Creek is relatively moderate when compared with the drainage average. The presence of vegetative bank cover on Prospect Creek averages 76 percent and is high in reaches two, three, and seven (Appendix B, Figure B-329). Although the differences between tributary reaches are statistically significant (ANOVA, $P<0.001$), the data set is insufficent to statistically characterize the differences (Tukey test, inconclusive).

Large Woody Debris - In Prospect Creek, single pieces of LWD <3.0 m in length average 2.23/100 m and range from 0.2/100 m in reach five to 6.75/100 m in reach four (Appendix B, Figure B-330). Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 88 percent, 6 percent, and 6 percent respectively.

Single pieces of LWD >3.0 m in length average 3.40/100 m and range from 0.2/100 m in reach five to 8.31/100 m in reach two (Appendix B, Figure B-331). Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 56 percent, 29 percent, and 15 percent respectively.

Aggregations of LWD average 0.56/100 m and range from 0.03/100 m in reach five to 1.73/100 m in reach two (Appendix B, Figure B-332). The number of single pieces of LWD found in aggregations average 2.0 for the combined tributary reaches and range from 2 to 9 pieces per aggregation. The distribution of root-wads averages 0.50/100 m of stream, ranging from 0.06/100 m in reach five to 2.03/100 m in reach four (Appendix B, Figure B-333).

Amounts of LWD in Prospect Creek were low in all classifications when compared with the average for the LCFR drainage (Appendix B, Figure B-334).

Hydrology and Water Temperature The hydrology of Prospect Creek is characteristic of large, high order streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns through the mid-reaches. The water temperature regime is relatively high (which is also typical for this type of stream in the LCFR drainage) and although borderline at times, does not typically exceed levels suitable for salmonid populations.

Hydrology - Tributary discharge monitored periodically at RM 0.2 during 1994 averaged 2.3 m^3/sec, ranging from 7.6 m^3/sec in May to 0.7 m^3/sec during October (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish in the stream sections between the stream mouth - RM 7.7, RM 9.6 - RM 10.2, and RM 14.3 - headwaters. Stream sections between RM 7.7 - RM 9.6 and RM 10.2 - RM 14.3 begin to go dry in early July.

Water Temperature - In 1994, water temperatures measured at RM 0.2 averaged 7.3° C (Appendix C, Table C-2), ranging from a minimum of 3.5° C in December (Appendix C, Table C-3) to a maximum of 17.2° C in July (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 6.7° C, ranging from 5.9 to 12.6° C; in summer (June - August), temperatures averaged 11.4° C, ranging from 6.6 to 17.2° C; during fall (September - November), they averaged 7.3° C, ranging from 4.2 to 10.6° C; and in the winter months (December - February), water temperatures averaged 3.8° C, ranging from 3.5 to 4.1° C.

Sediment Survey

Major Stream Features - Conducted in July 1994, the survey of major stream features in Prospect Creek extended from the mouth of Prospect Creek upstream through seven reaches to the headwaters (RM 18.4). The overall characteristics of this stream are the result of man-caused impacts. Most of the length of this stream has been influenced by timber harvest, roads, power lines, gas lines, mining, and grazing. Reach one is an A-2 channel type from the mouth upstream to the gauging station (RM 0.8). Reach two was a B-3 channel type in the vicinity of Dry Creek Bridge that extended to RM 1.1. Reach three was an A-2 channel that began just above the Dry Creek Bridge and extended to RM 2.3. Reach four is a B-3 channel type and extended to below the Wilkes Bridge (RM 2.9). Reach five, a C-4 channel type, began below Wilkes Bridge and extended to RM 13.5. Reach six was a B-3 channel type that was located around the highway crossing in section 22 ending at RM 15.3. Reach seven was a B-2a channel type that contains the end point of the habitat survey (RM 16.8) and extended to Trailhead 701.

Reach one contains a confined channel of bedrock and boulders making it a very stable reach with low amounts of spawning gravels being concentrated behind boulders. Steep banks or shear cliffs vegetated with grasses and moss characterize the riparian zone. No LWD was present and

recruitment of wood into the channel is limited. This reach had no undercut banks, 1 percent eroding banks, and a width/depth ratio of 9.

Reach two was a relatively short reach with accumulated gravels deposited from upper reaches. The Dry Creek Road influenced this reach by constricting the channel. Two large, deep pools with noticeable spawning gravels were characteristic of this reach. Large woody debris was non-existent. This reach had no undercut or eroding banks and a width/depth ratio of 20.

Reach three consists of a confined channel with some LWD present. The reach flows below an open conifer canopy with no undercut or eroding banks and a width/depth ratio of 14. Spawning gravels were not abundant and isolated behind obstructions.

Reach four was of slightly lower gradient than reach three. The riparian zone consists of open conifers and brush. Salmonid spawning gravels are restricted to pockets behind obstructions. Large woody debris is scarce and where present, usually oriented parallel to the stream channel. This reach has 35 percent undercut banks, 12 percent eroding banks, and a width/depth ratio of 19.

Reaches five and six were relatively long, meandering, unstable, aggraded reaches through a riparian zone of mostly grass and brush of which alder was the dominant species. Large gravel bars of deposited material were present. This reach has been impacted by a gas line laid across the channel; a power line that follows the length of the reach; dwellings and roads that influence the channel at various sites; mining, grazing, and deforestation due to both fire and timber harvest. Spawning gravels are common throughout the reach, but LWD is not. At the time of survey, the stream was dry near the confluence of Cox Creek but resurfaced again just below reach seven. This reach had 1 percent undercut banks, 5 percent eroding banks, and a width/depth ratio of 32.

Reach seven was a more entrenched reach under a canopy of cedar trees. The channel appeared more complex with LWD being common and recruitment of wood to the channel good. Gabion baskets and metal retaining walls from the road influences the stream by entrenching the channel. The culvert under the highway crossing with the associated bedrock ledge above could be a fish barrier at certain times of the year. Spawning gravels were not abundant. This reach contains the end

point of the habitat survey and had 5 percent undercut banks, 6 percent eroding banks, and a width/depth ratio of 20.

Reach eight was subject to high water flow leaving the channel with loose gravels and cobbles. The riparian zone was well vegetated under a canopy of conifers, but the LWD in the channel was concentrated into debris jams that don't appear to be adding much to habitat complexity. Amounts of spawning gravels were low to non-existent. This reach had 1 percent undercut banks, 16 percent eroding banks, and a width/depth ratio of 16.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Prospect Creek was 34 percent, ranging from 23 percent in reach four to 38 percent in reach six (Appendix B, Figure B-335). Fine sediment levels in spawning gravels on Prospect Creek were relatively moderate when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 27 percent, ranging from 22 percent in reach six to 41 percent in reach four. For bull trout, predicted embryo survival to emergence was 31 percent, ranging from 25 percent in reach six to 46 percent in reach four (Appendix B, Figure B-336). When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout was relatively moderate.

Riffle Stability Index (RSI) - Prospect Creek is a fifth order stream that had six surveyed reaches with RSI values ranging from 21 to 94. Prospect Creek showed extensive impacts from land use and management. The RSI values were not calculated for reaches one and three because the channel type was not consistent with RSI methodology criteria.

Reach two was a B-3 channel type with an average Wolman particle distribution of 9 percent sand, 42 percent gravel, 34 percent cobble, and 17 percent boulder. The mean grain size of the mobile particles averages 111 mm, ranging from 98 to 123 mm. The RSI values are 79 and 55. Reach two was a short reach that had accumulated gravels that are quickly transported through to reach one.

Reach four was a B-3 channel type with an average Wolman particle distribution of 5 percent sand, 19 percent gravel, 39 percent cobble, and 36 percent boulder. The mean grain size of the mobile

particles averages 82 mm, ranging from 76 to 85 mm. The RSI values are 23, 32, and 40. This reach had a relatively stable, long, entrenched channel that was fairly deep with scattered boulders.

Reaches five and six were classified as C-4 channel types with average Wolman particle distributions of 7 percent sand, 57 percent gravel, and 35 percent cobble. The mean grain size of the mobile particles averages 109 mm, ranging from 104 to 116 mm. The RSI values are 88, 92, and 94.

Reach five was a long, unstable aggraded reach with stored gravels. The stream meanders through an extensively impacted flood plain vegetated mostly by brush. Most notable was an underground gas line that appeared to have been buried right under the channel. Roads, mining, deforestation, dwellings, grazing and fires appeared to have impacted this channel. Large gravel bars and unstable banks were noted with little large woody debris being available for stream stability. Some sections of reach five were dry during the survey.

In reach six, road rip-rap and retaining walls influenced the stream by constricting flow. This was a relatively stable reach that flowed under a conifer canopy with the highway crossing with a large culvert in good condition.

Reach seven was a B-3 channel type with an average Wolman particle distribution of 2 percent sand, 26 percent gravel, 53 percent cobble, and 18 percent boulder. The mean grain size of the mobile particles averages 147 mm, ranging from 137 to 152 mm. The RSI values are 54, 62, and 64. This reach had low RSI values that could indicate downcutting of the channel with excessive water flows. The stream flows under a mature canopy of conifers (with LWD in large jams) and jackpots, loose cobbles and salmonid spawning gravels were limited.

Reach eight was a B-2a channel type with average Wolman particle distribution of 3 percent sand, 22 percent gravel, 42 percent cobble, and 33 percent boulder. The mean grain size of the mobile particles averages 96 mm, ranging from 81 to 125 mm. The RSI values are 21, 28, and 68.

Spawning Habitat Availability There are an estimated 770 m^2 of suitable habitat for fall-spawning salmonids in Prospect Creek. This equates to 0.118 m^2/m of stream length and 1.8 percent of the total stream area. This habitat can accommodate an estimated 214 adfluvial or 481 resident salmonid

redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively high.

Rearing Habitat Availability In Prospect Creek, there was approximately 1,306 m^2 of salmonid rearing habitat. This equates to 0.200 m^2/m of stream length and 3.0 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of rearing habitat per meter of stream was relatively low.

Productivity

Primary Productivity - We monitored periphyton accumulation in Prospect Creek for 39 days. The average autotrophic index was 3.64, ranging from 0.0 to 9.87; average chlorophyll content was 3.94 mg/m^2, ranging from 1.13 mg/m^2 to 8.80 mg/m^2; net productivity averages 0.75 mg/m^2/day, ranging from 0.12 mg/m^2/day to 1.33 mg/m^2/day. The autotrophic index was relatively low while the chlorophyll content and net productivity values were high when compared with the average values for the LCFR drainage.

Secondary Productivity - Benthic invertebrate populations in Prospect Creek consist primarily of members from the order Ephemeroptera (39%) followed by Trichoptera (34%) and Diptera (14%) (Appendix B, Figure B-337). Invertebrate densitities average 555/m^2, ranging from 205/m^2 in reach seven to 913/m^2 reach five (Appendix B, Figure B-338). There was no statistically significant difference among reaches (ANOVA, $P < 0.20$). Invertebrate species richness for the stream was 22, ranging from 10 in reach seven to 22 in reach one (Appendix B, Figure B-339). The invertebrate species diversity index (SDI) for the stream was 2.772, ranging from a low of 1.843 to a high of 2.620 (Appendix B, Figure B-340). Due to field crew safety considerations, invertebrate samples were not obtained for reach three. The invertebrate species diversity index and richness was relatively high while invertebrate densities were moderate when compared with average values for the LCFR drainage.

5.20.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in Prospect Creek were relatively high for bull trout; relatively moderate for cutthroat trout; and relatively low for brown and brook trout (Appendix B, Figure B-341). Species composition and abundance of salmonids varies among reaches. In general, salmonid populations in Prospect Creek are limited by a combination of channel instability, stream intermittency, low amounts of LWD, and spawning and rearing habitat. Stream sections that were relatively stable and contain year-around flows, unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities and a more diverse species mix than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found in reaches two, three, four, six, and seven. Due to crew safety considerations, it was not possible to obtain accurate fish population estimates in reach one. Reach five was dry during the time period in which fish population estimates were conducted.

In Prospect Creek, self-sustaining populations of both westslope cutthroat and rainbow trout were present. Although in most cases, field personnel were able to discern differences between the two species based on phenotypic characteristics, it was not possible to determine the true genetic composition of species in the field. Because of this, westslope cutthroat trout, rainbow trout, and suspected hybrids (WCTxRBT) were classified as cutthroat/rainbow for the purpose of this evaluation.

In Prospect Creek there are an estimated 4,761 cutthroat/rainbow trout, 1,592 bull trout, 557 brook trout, and 172 brown trout (Appendix C, Table C-75). Fish densities were high for cutthroat/rainbow trout (0.557 fish/m) and relatively low for bull trout (0.186 fish/m), brook trout (0.065 fish/m), and brown trout (0.020 fish/m) (Tukey test, $P < 0.05$) (Appendix C, Table C-76).

Cutthroat/rainbow Trout - Cutthroat/rainbow trout were present throughout the surveyed portion of Prospect Creek and were the most abundant trout in reaches two, three, four, six, and seven (Appendix C, Table C-75). Densities average 0.557/m and range from 0.242 to 1.039/m (Appendix

C, Table C-76). Although statistically significant differences in the distribution of cutthroat/rainbow trout among habitat types were found (ANOVA, P<0.05), the data set was insufficent to statistically characterize the differences (Tukey test, inconclusive).

Cutthroat/rainbow trout densities are relatively high in run and low gradient riffle habitat types; and relatively low in high gradient riffle habitat (Appendix C, Table C-77). There was no statistically significant difference in the distribution of cutthroat/rainbow trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-78).

Bull Trout - Bull trout were only present in reaches six and seven; and were the second most abundant species in these reaches. Although adfluvial bull trout have been found spawning in reaches two and three, juvenile bull trout were not (Appendix C, Table C-75). Bull trout densities average 0.186 fish/m of stream, ranging from 0.304 fish/m in reach six to 0.349 fish/m in reach seven (Appendix C, Table C-76). For the reaches in which they were found, bull trout densities were not statistically different between tributary reaches (t-Test, P <0.621).

Bull trout densities are relatively high in pocketwater, pool, and cascade habitat types and relatively low in low gradient riffle habitat (Appendix C, Table C-77). However, there was no statistically significant difference in the distribution of bull trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-78).

Brown Trout - Brown trout were present in reaches two, three, and four; they were the second most abundant species in reach two and the third most abundant in reaches three and four (Appendix C, Table C-75). Brown trout densities average 0.020 fish/m of stream, ranging from 0.026 fish/m in reach four to 0.071 fish/m in reach three (Appendix C, Table C-76). Although statistically significant differences in the distribution of brown trout among reaches were found (ANOVA, P <0.001), the data set was insufficent to statistically characterize the differences (Tukey test, inconclusive).

Brown trout densities are relatively high in low gradient riffle and run habitat types and relatively low in pocket water habitat (Appendix C, Table C-77). There was no statistically significant

difference in the distribution of brown trout among habitat types (ANOVA, P <0.20) (Appendix C, Table C-78). Brown trout were not found in high gradient riffle or cascade habitat types.

Brook Trout - Brook trout were present in reaches two, three, and four; they were the least abundant species in reach two and second most abundant in reaches four and three (Appendix C, Table C-75). Brook trout densities average 0.065 fish/m of stream, ranging from 0.021 fish/m in the second reach to 0.241 fish/m in reach four (Appendix C, Table C-76). Although statistically significant differences in the distribution of brook trout among reaches were found (ANOVA, P <0.001), the data set was insufficent to statistically characterize the differences (Tukey test, inconclusive).

Brook trout densities are relatively high in pool habitat and relatively low in cascade habitat (Appendix C, Table C-77). There was no statistically significant difference in the distribution of brook trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-78).

Age, Growth and Mortality

Cutthroat /rainbow Trout - Longevity of cutthroat/rainbow trout in Prospect Creek was higher than the average for the drainage with the oldest fish sampled being age IV+. Growth of cutthroat/rainbow trout in Prospect Creek was relatively low when compared with the average growth rate for the drainage with age I+ fish reaching a length of 62 mm (2.5 in) and age III+ a length of 155 mm (6.2 in) (Appendix B, Figure B-342). The instantaneous survival rate of 27 percent was similar than the average for the drainage.

Bull Trout - Bull trout growth in Prospect Creek is moderate when compared with the drainage average with age I+ fish reaching an average length of 68 mm (2.7 in) and age III+ fish a length of only 155 mm (6.2 in) (Appendix B, Figure B-343). The instantaneous survival rate of bull trout to age III+ was 17 percent which was lower than the average for the drainage.

Brown Trout - The number of fish sampled in Prospect Creek was not sufficient to complete the age and growth analysis for brown trout in this stream. However, when calculated from the length

frequency distribution (Appendix B, Figure B-344), the instantaneous survival rate for brown trout was 28 percent which was somewhat lower than the average for the drainage.

Brook Trout - The number of brook trout sampled was not sufficient to complete the age and growth analysis for brook trout in Prospect Creek. However, when calculated from the length frequency distribution (Appendix B, Figure B-345), the instantaneous survival rate for brook trout was 42 percent which was higher than the average for the drainage.

Rare Fish Genetics In the Prospect Creek drainage, cutthroat trout were obtained for electrophoretic testing from the West Fork of Dry Creek and Cooper Creek in 1987 and from Evans Gulch, Blossom Creek, and the mainstem of Prospect Creek in the vicinity of Twenty-three Mile Creek during 1994. Results of the electrophoretic analysis showed all the tested populations to contain genetically pure aboriginal westslope cutthroat trout.

In Blossom Creek, a headwater stream within the Prospect Creek drainage, the sample contains 21 pure westslope cutthroat trout and one pure rainbow trout. The most likely source of the rainbow trout found in this stream was from lower Blossum Lake. This lake was stocked with approximately 300 McConaughy rainbow in 1988 and 300 Kamloops rainbow in 1990. These introduced fish are the most likely source of the rainbow trout found in Blossum Creek. If hybridization has not already occurred, the presence of these fish will most certainly lead to future hybridization not only in Blossum Creek but throughout the Prospect Creek drainage. If pure strains of westslope cutthroat trout are to be maintained in the upper reaches of this drainage, removal of the rainbow trout from Blossum Lake was highly recommended (Sage 1995).

Although cutthroat trout were not sampled for electrophoretic testing from the lower reaches of Prospect Creek. The presence of relatively large numbers of rainbow trout in these stream sections indicate that the cutthroat trout population is undoubtedly hybridized.

Adfluvial Fish Spawning

Brown Trout - Brown trout redd counts have been conducted on Prospect Creek, beginning at Shorty Gulch and proceeding downstream to Clear Creek, since 1986. Between 1986 and 1993 the number

of brown trout redds counted averaged 12 per year, ranging from a low of six in 1993 to a high of 40 in 1988 (Appendix C, Table C-10). Counts were not conducted in 1989 and 1990 because of high flows. The 1991 count was incomplete because brown trout had not completed spawning by the time the counts were conducted. In 1992, the brown trout had not completed spawning so the count was canceled. The 1994 count was incomplete due to high flows.

Bull Trout - Bull trout redd counts were conducted on Prospect Creek for the first time in 1993; nine bull trout redds were found. In 1994, ten redds were found but this count was incomplete because of high flow conditions (Appendix C, Table C-11).

5.21 Crow Creek

Crow Creek flows approximately 2.0 km from the northeastern slopes of the Bitterroot Range to its confluence with Prospect Creek (Figure 5-14). The drainage covers approximately 3,885 ha. Major streams in the drainage include the East Fork and West Fork Crow Creek. For the stream section surveyed, between the mouth at Prospect Creek and the confluence with the East Fork and West Fork Crow Creek, the average elevation drop is about 17 m/km.

5.21.1 Fish Habitat

Fish habitat in Crow Creek consists of primarily high gradient riffle habitat; a substrate mix dominated by gravel; high amounts of fine sediment; a functional although altered riparian zone; a riparian vegetation mix consisting of a relatively even mix of vegetation types; and relatively moderate amounts of LWD.

Habitat Survey The habitat survey for Crow Creek included one tributary reach and extended from the mouth at Prospect Creek to a location where flows were insufficient to allow passage of adfluvial fish (RM 1.3).

Habitat Composition - Fish habitat in Crow Creek consists primarily of high gradient riffle habitat. When compared with the overall habitat composition for streams in the LCFR drainage, Crow Creek

had similar amounts of run and low gradient riffle habitat; relatively high amounts of glide and high gradient riffle habitats; and relatively low amounts of pool habitat (Figure B-346).

Substrate Composition - Substrate composition in Crow Creek was primarily gravel (Tukey test, P <0.05). When compared with the average substrate composition for the drainage, Crow Creek contains similar amounts of rubble and cobble; relatively high amounts of peagravel and gravel; and relatively low amounts of sand/silt and boulder (Appendix B, Figure B-347).

Surface Fines - Surface fines in Crow Creek average 17 percent and were statistically different between slow (26%) and fast water (10%) habitat types (t-Test, P< 0.017). Surface fines in Crow Creek were higher than the drainage average.

Riparian Vegetation - Riparian vegetation on Crow Creek was predominately grass/forbs (Tukey test, P <0.05). When compared with the average riparian vegetation mix for the drainage, Crow Creek contains similar amounts of grass/forbs and upland shrub; relatively high amounts of riparian tree; and low amounts of sedge/rush and upland tree (Appendix B, Figure B-348). The presence of vegetative bank cover averages 88 percent and is relatively moderate when compared with the drainage average.

Large Woody Debris - In Crow Creek, single pieces of large woody debris (LWD) <3.0 m in length average 9.05/100 m. Size distribution for LWD <3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 59 percent, 27 percent, and 14 percent respectively.

Single pieces of LWD >3.0 m in length average 10.16/100 m. Size distribution for LWD >3.0 m in length and <25 cm, 25-60 cm, and > 60 cm in diameter was 28 percent, 34 percent, and 38 percent respectively.

Aggregations of LWD average 1.65/100 m. The number of single pieces of LWD found in aggregations average 5.0 pieces per aggregation. The distribution of root wads averages 3.69/100 m.

Amounts of LWD in Crow Creek were similar in all classifications when compared with the average values for the LCFR drainage (Appendix B, Figure B-349).

Hydrology and Water Temperature The hydrology of Crow Creek is characteristic of intermediate order, mid-reach streams in the LCFR drainage that experience periodic high flow events and are subject to intermittent flow patterns in the lower reaches. The water temperature regime is relatively high, which is not typical for this type of stream in the LCFR drainage, and does not typically exceed levels suitable for salmonid populations (but may have a propensity to do so).

Hydrology - Tributary discharge monitored at RM 1.0 during 1994 averaged 0.4 m^3/sec, ranging from 0.06 m^3/sec in February to 1.8 m^3/sec during May (Appendix C, Table C-1). During normal water years, flows are sufficient to support fish throughout the stream section surveyed.

Water Temperature - During 1994, water temperatures measured at RM 1.0 averaged 7.5° C (Appendix C, Table C-2), ranging from a minimum of 3.6° C in November (Appendix C, Table C-3) to a maximum of 12.3° C in August (Appendix C, Table C-4). In the spring (March - May), water temperatures averaged 6.5° C, ranging from 6.0 to 7.1° C; in summer (June - August), temperatures averaged 9.3° C, ranging from 5.2 to 12.3° C; during fall (September - November), they averaged 8.4° C, ranging from 3.6 to 11.8° C; and in the winter months (December - February), water temperatures averaged 5.9° C, ranging from 4.2 to 8.3° C.

Sediment Survey

Major Stream Features - Conducted in November 1994, the survey of major stream features in Crow Creek extended from the confluence with Prospect Creek upstream to the confluence with the West Fork of Crow Creek (RM 1.3). The surveyed reach was a C-3 channel type and was characterized by riparian disturbance; channelizing, undeveloped roads, Road 7709, and an electric power line crossing. The riparian zone was largely deforested with brush and grass being the dominate vegetation type. At the time of the survey, the first section of the stream was dry. Where flowing, aquatic vegetation was common while spawning gravels were available and most often located in depositional areas behind obstructions. Large woody debris was available but limited to stumps and slash with recruitment of wood in the stream being predominately small stems. The crossing of Road 877 was the bridge where the survey ended. This reach had 5 percent undercut banks, 9 percent eroding banks, and a width/depth ratio of 11.

Spawning Area Substrate Composition - The median percent fine sediment (<6.35 mm) for spawning substrate in Crow Creek was 31 percent. Fine sediment levels in spawning gravels on Crow Creek were relatively moderate when compared with the average for the LCFR drainage.

Predicted embryo survival to emergence for westslope cutthrout trout was 31 percent. For bull trout, predicted embryo survival to emergence was 35 percent. When compared to the LCFR drainage average, predicted embryo survival to emergence for cutthroat and bull trout in Crow Creek was moderate.

Riffle Stability Index (RSI) - Crow Creek is a smaller fourth order tributary to Prospect Creek and had one surveyed reach. Reach one was a C-3 channel type with an average Wolman particle distribution in the riffles of 5 percent sand, 45 percent gravel, 49 percent cobble and 10 percent boulder. The mean grain size of the mobile particles averages 67 mm, ranging from 63 mm to 72 mm. The RSI values are 35, 68, and 54.

This reach was impacted by riparian roads, deforestation, and an overhead power line. Site one contains channelization that could explain the lower value at this site. Large woody debris was available but is mostly stumps and logging slash. The stream did appear to have the ability to stabilize. The stream was dry near the confluence with Prospect creek which could indicate bedload deposition and subsurface flow. Sites two and three contained a large amount of aquatic vegetation that helped to slow water velocity and anchor substrate.

Spawning Habitat Availability There are an estimated 77 m^2 of suitable habitat for fall-spawning salmonids in Crow Creek. This equates to 0.088 m^2/m of stream length and 1.9 percent of the total stream area. This habitat can accommodate an estimated 22 adfluvial or 49 resident salmonid redds. When compared with the average for the LCFR drainage, the amount of spawning habitat per meter of stream was relatively high.

Rearing Habitat Availability In Crow Creek, there was approximately 380 m^2 of salmonid rearing habitat. This equates to 0.430 m^2/m of stream length and 9.1 percent of the total stream area. When compared with the average for the LCFR drainage, the amount of rearing habitat per meter of stream was relatively moderate.

Productivity

Primary Productivity - We monitored periphyton accumulation in Crow Creek for 39 days. The average autotrophic index was 7.63, ranging from 0.81 to 33.05; average chlorophyll content was 1.83 mg/m^2, ranging from 0.15 mg/m^2 to 4.30 mg/m^2; net productivity averages 0.17 mg/m^2/day, ranging from 0.04 mg/m^2/day to 0.40 mg/m^2/day. The autotrophic index and chlorophyll content of the periphyton samples were similar while the net productivity values were relatively low when compared with the average values for the LCFR drainage.

Secondary Productivity - Benthic invertebrate populations in Crow Creek consist primarily of members from the order Ephemeroptera (56%) followed by Trichoptera (18%) and Plecoptera (14%) (Appendix B, Figure B-350). Benthic invertebrate densities were 267/m^2, species richness was 15, and species diversity (SDI) 2.062. Invertebrate densities were lower while species richness and SDI were similar to the average values for the LCFR drainage.

5.21.2 Fish Populations

Compared with the averages for the LCFR drainage, fish densities in Crow Creek were relatively low for bull trout and relatively moderate for cutthroat trout (Appendix B, Figure B-351). In general, salmonid populations in Crow Creek are limited by a combination of low amounts of LWD, spawning and rearing habitat. Stream sections with relatively unsedimented spawning gravels, suitable amounts of LWD, and unembedded cobble substrate had higher fish densities than stream sections without these components.

Abundance and Habitat Utilization Multiple-pass electrofishing and single-pass snorkel count fish population estimates were conducted in all habitat types found on Crow Creek. In Crow Creek there are an estimated 988 westslope cutthroat trout and 74 bull trout. Fish densities were high for cutthroat trout (0.480 fish/m) and relatively low for bull trout (0.036 fish/m) (t-Test, $P < 0.014$).

Westslope Cutthroat Trout - Westslope cutthroat trout were present throughout Crow Creek and of the two trout species present, were the most abundant. Densities are relatively high in pool habitat and relatively low in run and low gradient riffle habitat types (Appendix C, Table C-79). There was

no statistically significant difference in the distribution of cutthroat trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-80).

Bull Trout - Bull trout are also present throughout Crow Creek, but are less abundant than the cutthroats. Bull trout densities are relatively high in run habitat and relatively low in pool habitat. There was no statistically significant difference in the distribution of bull trout among habitat types (ANOVA, P <0.50) (Appendix C, Table C-79, C-80). Bull trout were not found in glide habitat types.

Age, Growth and Mortality

Westslope Cutthroat Trout - Longevity of cutthroat trout in the East Fork is higher than the average for the drainage with the oldest fish sampled being age V+. Growth of cutthroat trout in Crow Creek is relatively high when compared with the average growth rate for the drainage with age I+ fish reaching a length of 71 mm (2.8 in) and age III+ a length of 174 mm (7.0 in) (Appendix B, Figure B-352). The instantaneous survival rate from age II of 18 percent is lower than the average for the drainage.

Bull Trout - Bull trout growth in Crow Creek is similar to the drainage average with age I+ fish reaching an average length of 70 mm (2.8 in) and age III+ fish a length of 176 mm (7.0 in) (Appendix B, Figure B-353). The instantaneous survival rate for bull trout could not be calculated due to the relatively low number of fish sampled .

Rare Fish Genetics Samples of cutthroat trout were obtained from Crow Creek in 1987. Results of the electrophoretic analysis indicated that this population contains genetically pure aboriginal westslope cutthroat trout. Aside from seasonal intermittency in the lower stream section, there are no barriers to upstream movement of fish and possible sources of hybridization in this stream. The presence of rainbow trout in the headwaters of the Prospect Creek drainage places this westslope cutthroat trout population at risk of hybridization.

Adfluvial Fish Spawning Redd counts for adfluvial stocks of brown and bull trout were not conducted on Crow Creek during late fall and early winter 1992-1994.

Section 6
Recommendations

6.1 Tributary System Summary

Substantial opportunities exist to improve habitat conditions and thereby increase trout populations in the LCFR tributaries. Recent information presented by Bilby and Likens (1980), Schlosser (1982), and Reeves (1993) indicate that channel equilibrium and large woody debris are important to stream ecosystems. Bisson and Sedell (1982) suggested that unstable stream channels result in mostly riffle habitat, with few pools and minimal amounts of stable, large woody debris. Grazing and other land management uses and activities have been shown to have detrimental effects on stream systems (Platts 1983). All of the conditions addressed by these other studies, and therefore the implicit restoration and enhancement opportunities, exist to varying degrees in the surveyed tributaries of the Clark Fork River.

General recommendations for tributary enhancement, restoration and overall improvement of watershed condition and habitat suitability for salmonid fish species include:

- development of Stream Management Zones (SMZ);
- developing riparian area buffer zones consisting of conifer species or other native vegetation;
- riparian road improvement;
- large woody debris input;
- pool and cover creation;
- substrate and bank stabilization;
- spawning and rearing habitat enhancement or creation;
- fish population protection, enhancement, or removal(non-native); and
- minimizing or eliminating detrimental land use activities and allowing the stream to recover naturally.

Streams are dynamic ecosystems consisting of a complex interrelationship of multiple physical and biological factors. Restoration or enhancement activities should be considered only after careful analysis of the anticipated effects to a stream's biological and hydraulic functions. Procedures for large woody debris input, cover complexity, substrate stabilization, pool creation, bank stabilization, road culvert and road removal have already been developed and utilized by the U.S. Forest Service, Region One, Idaho Panhandle National Forest and in the "Wildlife and Fisheries Habitat Improvement Handbook" (USDA 1986).

In 1991, the Montana legislature passed the Stream Management Zone Law which offers guidelines for establishing riparian buffer zones. These streamside management zones (SMZ) should be considered for the forested areas alongside all of the surveyed tributaries.

Riparian planting of trees or shrubs should also be considered where necessary to restore a more functional riparian buffer zone. Planting of conifer species is suggested since land clearing and timber harvesting typically has removed these species from the riparian zone.

Experimental and closely monitored pilot projects to address common enhancement opportunities such as stream bank stabilization, substrate stabilization, culvert and road improvement, large woody debris input, and pool creation are recommended. Emphasis should be given to understanding the stream specific implications of proposed activities and closely documenting results to ensure that restoration and enhancement efforts are adjusted as necessary and continue to move towards meeting desired management objectives.

Outlined below are stream specific enhancement recommendations that should be considered in developing any land management or stream enhancement and restoration plans. These are summarized by stream and enhancement activity in Table 6-1.

Table 6-1. Stream specific recommendations for the enhancement and restoration of fish habitat. Lower Clark Fork River drainage, Montana. Tributary survey, 1992-1994.

Stream	Recommendations										
	Development of Stream Management Zones (SMZ).	Develop riparian buffer zones.	Riparian road improvement or removal.	Large woody debris (LWD) input.	Pool and cover creation.	Channel substrate and bank stabilization.	Spawning and rearing habitat creation or enhancement.	Fish population protection, removal, or enhancement.	Removal of beaver dam complex.	Monitoring of placer mining operations in flood plain.	Monitoring of sources of water quality degradation.
Bull River	•	•		•		•	•	•			
East Fork Bull River	•	•	•	•		•	•	•			
North Fork Bull River	•		•	•	•	•	•				
South Fork Bull River	•		•	•		•	•	•			
Middle Fork Bull River	•						•				
East Fork Blue Creek	•	•	•		•	•	•				
Elk Creek	•	•		•	•	•	•				•
East Fork Elk Creek	•	•	•	•	•	•	•				
West Fork Elk Creek	•	•	•	•	•	•	•				
Pilgrim Creek	•	•		•	•	•	•				•
Rock Creek	•	•		•		•	•	•			•
West Fork Rock Creek	•		•					•			
Swamp Creek	•	•	•	•	•	•	•				
Marten Creek	•	•	•	•	•	•	•		•		
North Branch Marten Creek	•		•	•		•					
South Branch Marten Creek	•	•	•	•		•	•				
Graves Creek	•	•	•	•	•	•	•	•			
Vermilion River	•	•	•	•	•	•	•	•		•	
Prospect Creek	•	•	•	•	•	•	•	•			•
Crow Creek	•	•	•	•		•	•	•			

6.2 Mainstem Bull River

- Development of a SMZ for the entire river;
- revegetation/protection of the riparian zone;
- placement of large woody debris and creation of pool and cover habitat; and
- stabilization of channel substrate in reaches two, four, and five to improve fish spawning and rearing habitat.

6.3 East Fork Bull River

- Development of a SMZ in reaches one and two;
- conifer reforestation in the riparian zone;
- removal or improvement of riparian roads;
- introduction of large woody debris and creation of pool habitat; and
- stabilization of channel substrate and unstable bank in reaches one and two to improve fish spawning and rearing habitat.

6.4 North Fork Bull River

- Development of a SMZ in reaches one and two;
- removal or improvement of riparian roads;
- introduction of large woody debris and other pool and cover enhancement in reaches one and two;
- stabilization of channel substrate; and
- stream bank stabilization in reach one to improve fish spawning and rearing habitat.

6.5 South Fork Bull River

- Establishing a SMZ in reaches one, two, and three;
- removal or improvement of roads;

- stabilization of off-stream sources of sedimentation to improve spawning habitat areas; and
- stabilization of channel substrate and input of large woody debris for rearing habitat enhancement.

6.6 Middle Fork Bull River

- Development of a SMZ for reach one; and
- protection of fish spawning habitat in the lower stream reaches.

6.7 East Fork Blue Creek

- Development of SMZ in reaches one and two;
- revegetation of riparian zone;
- removal or improvement of riparian roads (Forest Road 2745 crosses the stream with two culverts and should be considered for redesign);
- creation of additional pool habitat in reach two; and
- stabilization of channel substrate and eroding banks to improve fish spawning and rearing habitat.

6.8 Elk Creek

- Development of a SMZ in reaches two, three, and four;
- revegetation of the riparian zone;
- localized introduction of large woody debris in reach four;
- bank stabilization to improve fish spawning and rearing habitat in reach four; and
- monitoring possible sources of water quality degradation.

6.9 East Fork Elk Creek

- Development of a SMZ for the entire stream;

- revegetation of the riparian zone;
- removal or improvement of riparian roads (Forest Road 2273 which follows the stream in reach four with three culvert crossings and should be considered for redesign);
- introduction of large woody debris and creation of pool and cover habitat in reach four;
- stabilization of channel substrate and unstable bank in reaches one and two; and
- protection and enhancement of fish spawning and rearing habitat in reaches one and two.

6.10 West Fork Elk Creek

- Development of a SMZ in reach one;
- revegetation of the riparian zone;
- removal or improvement of riparian roads;
- introduction of large woody debris and enhancement of pool habitat in reach one; and
- stabilization of channel substrate and unstable bank for the protection and enhancement of fish spawning and rearing habitat in reach one.

6.11 Pilgrim Creek

- Development of a SMZ in reaches one and three;
- revegetation of the riparian zone in reaches one and three;
- introduction of large woody debris;
- creation of additional and improvement of existing pool habitat;
- monitoring possible sources of water quality degradation; and
- stabilization of channel substrate and unstable bank to improve fish spawning and rearing habitat in reach three. Special consideration should be given to stabilization of the old water works dam.

6.12 Rock Creek

- Development of a SMZ in reaches one and two;
- introduction of large woody debris and creation of pool habitat in reach two;
- stabilization of channel substrate and unstable bank to improve fish spawning and rearing habitat

in reach two;

- revegetation of the riparian zone in reaches one and two; and
- monitoring of possible sources of water quality degradation.

6.13 West Fork Rock Creek

- Development of a SMZ for the entire stream; and
- removal or improvement of existing road network.

6.14 Swamp Creek

- Development of a SMZ in reaches two and three;
- revegetation of the riparian zone including establishment of a conifer buffer strip along the stream;
- removal or improvement of riparian roads and irrigation canals;
- introduction of large woody debris and creation of additional pool habitat in reaches one and two; and
- stabilization of channel substrate in reaches one and two, and bank stabilization in reach two to improve fish spawning and rearing habitat.

6.15 Mainstem Marten Creek

- Development of a SMZ in reaches one and two;
- removal of beaver dam complex near stream mouth to provide access to upper stream reaches for adfluvial fish species;
- revegetation of the riparian zone and establishment of a conifer buffer strip along the stream in reach one;
- removal or improvement of riparian roads;
- introduction of large woody debris and creation of additional pool habitat; and
- stabilization of channel substrate in reaches one and two, and unstable bank in reach one to improve fish spawning and rearing habitat.

6.16 North Branch Marten Creek

- Development of a SMZ in reaches one and two;
- removal or improvement of riparian roads with emphasis on headwater road networks;
- introduction of large woody debris in reach one; and
- stabilization of channel substrate in reach one with additional substrate stabilization in the headwater areas.

6.17 South Branch Marten Creek

- Development of a SMZ in reaches one and two;
- revegetation of the riparian zone in reaches one and two;
- removal or improvement of roads in the riparian zone and in the drainage headwaters;
- introduction of large woody debris in reaches one and two; and
- stabilization of channel substrate in reaches one and two as well as the headwaters to improve fish spawning and rearing habitat.

6.18 Graves Creek

- Development of a SMZ in reaches one and two;
- revegetation of the riparian zone in reaches one and two;
- removal or improvement of riparian roads in reach one;
- introduction of large woody debris and creation of pool and cover habitat;
- stabilization of channel substrate in reaches one, two, and three;
- stabilization of stream bank in reaches one, two, and three with additional efforts to stabilize large sediment sources in reaches one and two; and
- protection and enhancement of fish spawning and rearing habitat.

6.19 Vermilion River

- Development of a SMZ in reach one;
- reduction and/or monitoring of placer mining operations in flood plain;
- revegetation of the riparian zone in reaches one and three;
- removal or improvement of riparian roads;
- introduction of large woody debris, creation of pool and cover habitat in reach one;
- stabilization of channel substrate in reaches one and three;
- stabilization of stream bank in reaches one and three; and
- protection and enhancement of fish spawning and rearing habitat in reaches one and three.

6.20 Prospect Creek

- Development of a SMZ for the entire stream;
- hill slope revegetation in reach five;
- revegetation of the riparian zone in reach five;
- removal or improvement of riparian roads in reach five;
- introduction of large woody debris, creation of pool and cover habitat in reaches five, six, and seven;
- stabilization of channel substrate in reaches five, six, and seven;
- stabilization of stream bank in reach five;
- protection and enhancement of fish spawning and rearing habitat; and
- identification and monitoring of possible sources of water quality degradation.

6.21 Crow Creek

- Development of a SMZ in reach one;
- revegetation of riparian zone with a conifer buffer strip in reach one;
- removal or improvement of riparian roads;
- introduction of large woody debris;

- stabilization of channel substrate;
- stabilization of stream bank in reach one; and
- protection and enhancement of fish spawning and rearing habitat.

Section 7
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