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Instream Flow Characterization of Upper Salmon River Basin Streams, Central Idaho, 2004

Scientific Investigations Report 2005–5212

U.S. Department of the Interior
U.S. Geological Survey

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Gale A. Norton, Secretary

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Conversion Factors, Datums, and Acronyms

Conversion Factors

Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second (m/s)
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8×°C)+32$$

Datums

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Acronyms

ASTM	American Society of Testing and Materials
AVDEPTH/AVPERM	Hydraulic parameter option in PHABSIM for Windows
BIA	Bureau of Indian Affairs
BiOp	Biological Opinion
CI	Composite index
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
HABTAE	Habitat program option in PHABSIM for Windows
HSC	Habitat suitability criteria
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IFIM	Instream Flow Incremental Methodology
ITWG	Interagency Technical Workgroup
MAD	Mean annual discharge
MANSQ	Manning's equation
MDAT	Maximum daily-average temperature
MDMT	Maximum daily-maximum temperature
MWMT	Maximum weekly-maximum temperature
MWAT	Maximum weekly-average temperature
NOAA	National Oceanic and Atmospheric Administration

PHABSIM	Physical Habitat Simulation System model
Q.20	Daily mean discharge exceeded 20 percent of the time during a specified month
Q.50	Daily mean discharge exceeded 50 percent of the time during a specified month (same as median discharge)
Q.80	Daily mean discharge exceeded 80 percent of the time during a specified month
SI	Suitability index
SNRA	Sawtooth National Recreation Area
SRA	Snake River Adjudication
SSTEMP	Stream Segment Temperature Model
STGQ	Stage-discharge relation
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSP	Water-surface profile
WUA	Weighted usable area
WY03	Water year 2003
WY04	Water year 2004

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Abstract

Anadromous fish populations in the Columbia River Basin have plummeted in the last 100 years. This severe decline led to Federal listing of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*) stocks as endangered or threatened under the Endangered Species Act (ESA) in the 1990s. Historically, the upper Salmon River Basin (upstream of the confluence with the Pahsimeroi River) in Idaho provided migration corridors and significant habitat for these ESA-listed species, in addition to the ESA-listed bull trout (*Salvelinus confluentus*). Human development has modified the original streamflow conditions in many streams in the upper Salmon River Basin. Summer streamflow modifications resulting from irrigation practices, have directly affected quantity and quality of fish habitat and also have affected migration and (or) access to suitable spawning and rearing habitat for these fish.

As a result of these ESA listings and Action 149 of the Federal Columbia River Power System Biological Opinion of 2000, the Bureau of Reclamation was tasked to conduct streamflow characterization studies in the upper Salmon River Basin to clearly define habitat requirements for effective species management and habitat restoration. These studies include collection of habitat and streamflow information for the Physical Habitat Simulation System model, a widely applied method to determine relations between habitat and discharge requirements for various fish species and life stages. Model results can be used by resource managers to guide habitat restoration efforts by evaluating potential fish habitat and passage improvements by increasing streamflow.

In 2004, instream flow characterization studies were completed on Salmon River and Beaver, Pole, Champion, Iron, Thompson, and Squaw Creeks. Continuous streamflow data were recorded upstream of all diversions on Salmon River and Pole, Iron, Thompson, and Squaw Creeks. In addition, natural summer streamflows were estimated for each study site using regional regression equations.

This report describes Physical Habitat Simulation System modeling results for bull trout, Chinook salmon, and steelhead trout during summer streamflows. Habitat/discharge relations were summarized for adult and spawning life stages at each study site. Adult fish passage and discharge relations were evaluated at specific transects identified as a potential low-streamflow passage barrier at each study site.

Continuous summer water temperature data for selected study sites were summarized and compared with Idaho Water Quality Standards and various water temperature requirements of targeted fish species. Continuous summer water temperature data recorded in 2003 and streamflow relations were evaluated for Fourth of July Creek using the Stream Segment Temperature model that simulates mean and maximum daily water temperatures with changes in streamflow.

Results of these habitat studies can be used to prioritize and direct cost-effective actions to improve fish habitat for ESA-listed anadromous and native fish species in the basin. These actions may include acquiring water during critical low-flow periods by leasing or modifying irrigation delivery systems to minimize out-of-stream diversions.

Introduction

Rivers, streams, and lakes in the upper Salmon River Basin (defined as the area upstream of the confluence with the Pahsimeroi River) historically provided migration corridors and significant spawning and rearing habitat for anadromous Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*Oncorhynchus nerka*), and steelhead trout (*Oncorhynchus mykiss*). Wild salmon and steelhead trout in the basin migrate nearly 900 mi between the mountain streams at altitudes of 7,000 ft or more where they spawn, hatch, and rear, and the Pacific Ocean where they mature to adulthood. High-elevation spawning and rearing and extensive migration represent a life-history strategy unique among Columbia River Chinook salmon and steelhead trout and may be important for long-term survival of these species.

However, anadromous fish populations in the Columbia River Basin have plummeted in the last 100 years (Chapman, 1986; Thurow, 2000; Thurow and others, 2000). This severe decline led to listing these salmon and steelhead trout stocks as endangered or threatened under the Federal Endangered Species Act (ESA) in the 1990s. Most remaining populations are severely depressed; fewer than 2 percent of drainage basins in the Columbia River Basin are classified as supporting strong, wild populations of steelhead trout or Chinook salmon (Thurow and others, 2000). In addition, at least 214 stocks of anadromous salmonids are on the decline or at risk of extinction in the Pacific Northwest and California (Nehlsen and others, 1991).

Wild salmon and steelhead trout continue to migrate into the upper Salmon River Basin and depend on available spawning and rearing habitat. Resident bull trout (*Salvelinus confluentus*) also inhabit many rivers and streams in the Salmon River Basin. However, human development has modified the original streamflow conditions in many streams in the basin. Summer streamflow modifications (July through September) have directly affected the quantity and quality of fish habitat and also have affected migration and (or) access to suitable spawning and rearing habitat for these fish (Munther, 1974; Scott and others, 1981). Reduced summer streamflows may reduce juvenile rearing space resulting in poor growth and survival (Quinn, 2005).

Reduced streamflows resulting from diversions also may contribute to increased water temperatures that may be unsuitable for native salmonids in the Sawtooth National Recreation Area (SNRA; M. Moulton, U.S. Forest Service, oral commun., 2003). Stream temperatures vary both spatially, throughout a stream, and temporally, over time. Many factors, both natural and human, can affect stream temperature. Stream temperatures are controlled naturally by interactions between solar radiation, ambient air temperature, streamflow, channel geomorphology, and riparian vegetation. Stream temperature tends to increase as water travels downstream. Human activities such as removal of riparian shading and alteration of streamflow can accentuate this increased water temperature.

High water temperatures generally coincide with high ambient air temperatures and usually occur during July and August. Diversions of streamflow for agricultural purposes are at their highest and streamflows generally are at their lowest during July and August. This reduction in streamflow, coupled with high ambient air temperatures, can have severe negative effects on the distribution, health, and survival of coldwater fish species. A one-dimensional stream-segment temperature model was developed to assist resource managers in predicting the consequences of stream and drainage basin manipulation on water temperatures (Bartholow, 2002). This model simulates daily mean and maximum stream water temperatures as a function of discharge, stream distance, and environmental heat flux for a single period, usually a single day.

Most Pacific Northwest fish are ectothermic (cold blooded), and their survival depends on water temperatures that are within their optimal range. When water temperature exceeds an organism's optimal range, the organism can experience adverse health effects such as reduced growth or increased susceptibility to disease (Coutant, 1976; Beitinger and others, 2000; McCullough and others, 2001; Sauter and others, 2001; Selong and others, 2001). Different species have unique water temperature requirements, and an individual species may have a unique water temperature requirement for each of its life stages. For example, salmonids require varying water temperatures to initiate and carry out spawning, incubation, juvenile growth, and adult migration activities (Poole and others, 2001). For Chinook salmon, optimal water temperatures range from 10.0º to 17.0ºC. Adult spawning activities are triggered at water temperatures from 7.0º to 14.0ºC. Water temperatures greater than 21.0ºC can create thermal barriers that can block adult migration to spawning grounds (Poole and others, 2001). These thermal barriers can be created by diverting streamflow for irrigation during summer when air temperatures are highest. Exposure to water temperatures greater than 21.0ºC for more than 1 week usually is fatal to adult Chinook salmon, whereas constant temperatures greater than 16.0ºC have been shown to be intolerable for bull trout (Poole and others, 2001). Ott and Maret (2003) predicted a higher probability of bull trout occurrence in streams in the Salmon River Basin where daily maximum water temperatures range from 10.0º to 15.0ºC. Bull trout passing into tributary streams to spawn in late summer may decrease when water temperatures exceed 13.0ºC and may be blocked when water temperatures exceed 18.0ºC. (J. Dunham, U.S. Forest Service, written commun., 2004).

The Bureau of Reclamation was tasked through Reasonable and Prudent Alternative Action 149 of the National Oceanic and Atmospheric Administration (NOAA) Fisheries Biological Opinion (BiOp) of 2000 on the operation of the of the Federal Columbia River Power System (FCRPS) to address streamflow deficiencies in 16 priority subbasins in the Columbia River Basin (National Oceanic and Atmospheric Administration, 2000). Flow characteristic studies were done to evaluate streamflow requirements of ESA-listed fish. Results of these studies will be used to prioritize and direct cost-effective actions to improve fish habitat for ESA-listed anadromous and native fish species in the basin. These actions may include acquiring water during critical low-flow periods by leasing or modifying irrigation delivery systems to minimize out-of-stream diversions. Bureau of Reclamation considers flow characterization studies an integral part of information needed to correct flow deficiencies within the 10-year timeframe allotted for studies in each subbasin (Spinazola, 2002).

On November 30, 2004, NOAA Fisheries issued a new BiOp for the FCRPS in response to a court order in June 2003. Action 149 objectives are restated in specific metric goals in selected subbasins for entrainment (screens), streamflow, and channel morphology (passage and complexity) in the 2004 BiOp.

Many landowners, Federal, State, and Tribal governments, and other local and private parties have completed or are completing projects to maintain, improve, and restore riparian habitat, water quality, fish passage, and other environmental conditions to protect and restore ESA-listed anadromous and native fish species in the basin (Spinazola, 2002). In addition, the Idaho Department of Fish and Game (IDFG) has completed annual redd counts and fish population assessments on the upper Salmon River and many of its major tributaries (P. Murphy, Idaho Department of Fish and Game, oral commun., 2003). The livelihoods of many people inhabiting the basin also depend on streamflows used for agricultural, domestic, commercial, municipal, industrial, recreational, and other purposes. Developing an approach to meet the needs of both people and fish rests on understanding how much streamflow is needed by each. Water quantities needed for human uses frequently can be determined from available information; however, streamflow quantities needed for ESA-listed fish habitat conservation are difficult to identify because relevant information rarely is available.

Numerous methods can be used to determine streamflow needs for fish and wildlife (Instream Flow Council, 2004), but one of the most widely used is the Instream Flow Incremental Methodology (IFIM), developed in the 1970s by the U.S. Fish and Wildlife Service (USFWS). IFIM integrates water-supply planning concepts, analytical hydraulic engineering models, and empirically derived habitat/discharge relations to address water-use and instream-flow issues, questions concerning life-stage-specific effects on selected species, and the general well-being of aquatic biological populations. Accepted by many resource managers as an excellent process for establishing habitat/discharge relations, IFIM is the most widely used method to determine streamflow needs for fish and wildlife in the United States (Instream Flow Council, 2004).

A major component of IFIM is a collection of computer algorithms called the Physical Habitat Simulation System (PHABSIM) model. This model incorporates hydrology, stream morphology, and microhabitat preferences to create relations between streamflow and habitat availability (Bovee and others, 1998). Habitat availability is measured by the weighted usable area (WUA) index, which is the wetted area of a stream weighted by its suitability for use by an organism (expressed as the number of square feet of usable habitat per 1,000 ft of stream). PHABSIM simulates habitat/discharge relations for various species and life stages and allows quantitative habitat comparisons at different discharges.

Streamflow restoration projects developed and completed in the headwaters of the upper Salmon River will provide immediate localized benefits by restoring quality, quantity, and access to important spawning and rearing habitats. As more studies are completed in order of biological priority, and more restoration projects are implemented based on streamflow study results, streamflows needed for migration, spawning, and rearing for all fish will be systematically improved. Furthermore, the restored streamflows have the potential for improving spawning and rearing habitat within downstream reaches of the mainstem of the Salmon River. Additionally, if streamflows obtained from these projects are protected from downstream diversion, these benefits can be increased by improved conditions for survival throughout the Salmon River migration corridor, thereby improving long-term fish productivity.

Purpose and Scope

This report summarizes instream flow characterization results for selected streams in the upper Salmon River Basin, Idaho. Natural streamflows were characterized using continuous summer streamflow data collected upstream of diversions at selected sites. Comparisons were reported between these data and monthly discharge exceedance estimates, based on regional regression analyses.

Purposes of this report are to (1) compile, review, and analyze hydrologic and biologic data for selected streams; (2) assemble habitat suitability curves for targeted species and life stages needed to complete PHABSIM modeling and analysis; (3) provide instream flow characterization results for selected streams to identify streamflow needs from July to September to provide fish passage and support various life stages of bull trout, Chinook salmon, and steelhead trout; and (4) evaluate effects of diversions on water temperature for the selected streams.

The ultimate goal is to provide streamflow and fish habitat information to water-resource managers so informed decisions can be made to enhance instream habitat needs of ESA-listed fish species. A Web page maintained by the U.S. Geological Survey (USGS) that provides supporting data and modeling results can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow/.

Previous Studies

Previous instream flow studies in the upper Salmon River Basin consisted of investigations for the Snake River Adjudication (SRA) process, which were funded by the Bureau of Indian Affairs (BIA) and U.S. Forest Service (USFS). The BIA funded a number of fishery studies in the Salmon River Basin that focused on development of instream flow recommendations for preservation of important fishery resources. Between 1989 and 1992, BIA contracted with EA Engineering, Science, and Technology, Inc., to develop instream flow recommendations for important fishery resources and prepared suitability criteria, conducted instream flow studies, made recommendations, and filed water right claims as part of the SRA (EA Engineering, Science, and Technology, Inc., 1989, 1991a, 1991b, 1992a, 1992b, 1992c). In cooperation with the BIA, the USGS classified Salmon River subbasins based on basin and hydrologic characteristics to assist in filing water right claims (Lipscomb, 1998). R2 Resource Consultants (2004) recently published a report about the SRA process describing methods, results, and flow recommendations for about 1,100 drainages primarily in the Salmon and Clearwater River Basins, Idaho.

Investigations by the USFS also were done by Hardy and others (1992) for protection of fishery resources on public lands. More recent (1997-98) instream flow studies also were completed by the USFS on selected streams in the upper Salmon River Basin (M. Combs, Utah State University, oral commun., 2003). These data also were collected for the SRA to evaluate minimum and maintenance streamflows for the protection of important fishery resources; however, these data were not published. The USGS completed instream flow studies on upper Salmon River Basin tributaries in 2003 (Maret and others, 2004). In addition, Sutton and Morris (2004) completed instream flow studies on Big Timber Creek in the Lemhi Basin.

Various methods have been developed to estimate streamflow needs for fish. Tennant (1976) offered one of the first methodologies for determining instream flows to protect aquatic resources. This simple approach proposes minimum stream discharges based on a percentage of mean annual discharge (MAD) that varies with the level of resource protection from poor to outstanding. Hatfield and Bruce (2000) developed equations for predicting optimum (maximum) discharge for selected salmonid life stages in western North America streams by using results from 127 PHABSIM studies. They concluded that MAD was the best predictor of optimum discharge. However, the 95-percent error estimates around the optimum predicted discharge could be substantial. NOAA Fisheries has draft protocols to estimate tributary streamflows to protect ESA-listed salmon (D. Arthaud, National Oceanic and Atmospheric Administration, written commun., 2001). These protocols offer specific guidelines based on percentages of mean monthly streamflow and PHABSIM optimum predictions.

Hydrologic studies by the USGS have provided streamflow statistics and geomorphology for streams in the Salmon River Basin. Hortness and Berenbrock (2001) developed regional regression equations that may be used to relate monthly and annual streamflow statistics to various basin characteristics (for example, basin area, basin elevation, percentage of forest cover in the basin, mean annual precipitation, and average basin slope). These equations can be useful for predicting streamflow statistics in ungaged basins. Emmett (1975) evaluated hydrology, geomorphology, and water-quality characteristics of selected streams in the Salmon River Basin.

Habitat suitability curves for depth, velocity, and substrate are available for most native fish species of the Salmon River Basin. Rubin and others (1991) empirically determined suitability curves for juvenile Chinook salmon and steelhead trout for small Salmon River tributary streams. Cochnauer and Elms-Cockrum (1986) developed suitability curves for a number of Idaho salmonid species and their life stages by using guidelines provided by Bovee and Cochnauer (1977). EA Engineering, Science, and Technology, Inc. (1991a) developed a complete set of habitat suitability curves for depth, velocity, and substrate for most native fish species in the Salmon River Basin for the BIA as part of the SRA. These curves were developed following guidelines presented by Crance (1985), which consisted of a Delphi approach. This approach involved formal meetings among fishery experts to reach a consensus on suitability curves for various species and life stages.

Until recently, no significant stream water temperature study in the Salmon River Basin had been done. In 2000, the USGS, in cooperation with the Idaho Department of Environmental Quality (IDEQ), initiated studies in the Salmon River Basin to document the natural spatial and temporal variability of stream water temperature and to examine relations among stream water temperature, environmental variables, and aquatic biota in streams minimally disturbed by human activities. Results showed that temperatures in these minimally disturbed streams commonly exceeded current State and Federal stream water temperature standards.

During the summer of 2000, Donato (2002) studied the water temperature regime of 183 minimally disturbed streams in the Salmon and Clearwater River Basins to develop a predictive stream water temperature model. A major finding of this study was that water temperatures in 100 percent (119 of 119) of the streams in the Salmon River Basin failed to meet the IDEQ 9.0ºC maximum daily-average temperature (MDAT) and the 13.0ºC maximum daily-maximum temperature (MDMT) criteria for the protection of salmonid spawning. Results also showed that stream temperatures in 33 percent (39 of 119) of the streams in the upper Salmon River Basin exceeded the IDEQ 19.0ºC MDAT criterion, and temperatures in 39 percent (47 of 119) of the streams exceeded the 22.0ºC MDMT criterion for the protection of cold water biota.

In 2001, Ott and Maret (2003) studied 34 minimally disturbed streams in the Salmon River Basin to document the temperature regime, characterize the aquatic biota distribution in streams representing a gradient of temperature, and describe the relations between environmental variables and benthic invertebrate and fish assemblages. Study results showed that the maximum weekly maximum temperature (MWMT) in 100 percent (33 of 33) of the streams for which water temperature data were available exceeded the U.S. Environmental Protection Agency (USEPA) criterion of 10ºC for bull trout spawning and juvenile rearing. The MDMT in 91 percent (30 of 33) of the streams exceeded the IDEQ criterion of 13.0ºC for the protection of salmonid spawning; and the MDAT in all 33 streams exceeded the 9.0ºC criterion for the protection of salmonid spawning. Results also showed that water temperatures in 9 percent (3 of 33) of the streams exceeded the IDEQ 19.0ºC MDAT and the 22.0ºC MDMT criteria for the protection of coldwater biota.

Even though temperatures in all streams exceeded at least one water temperature criterion, Ott and Maret (2003) concluded that these same streams support populations of coldwater indicator species. They also concluded that a single stream temperature standard is difficult to apply across a broad area such as the State of Idaho because streams differ in environmental complexity and biological diversity.

Description of Study Area

The upper Salmon River Basin (fig. 1) is in central Idaho and extends 121 mi from the headwaters on the east side of the Sawtooth Range to the confluence with the Pahsimeroi River near the town of Ellis, Idaho, draining an area of about 2,428 mi^2. The basin contains large areas designated as wilderness, several national forests, and the SNRA. These features make the basin a popular destination for fishing, hiking, whitewater rafting, and other outdoor activities.

Elevation above sea level ranges from 11,815 ft at Castle Peak to 4,640 ft at the confluence of the Salmon and Pahsimeroi Rivers. Mean elevation of the basin is 7,570 ft. Climate in most of the basin is semiarid and annual precipitation averages 24 in/yr. Precipitation primarily is snow, and peak flows in streams generally result from spring snowmelt.

The upper Salmon River Basin is in the Idaho Batholith and Middle Rockies ecoregions (McGrath and others, 2001), which consist primarily of coniferous forests in upper elevations and sagebrush and grasslands in the valleys. Pine and fir predominate, covering 44 percent of the basin; rangeland covers the remaining 56 percent.

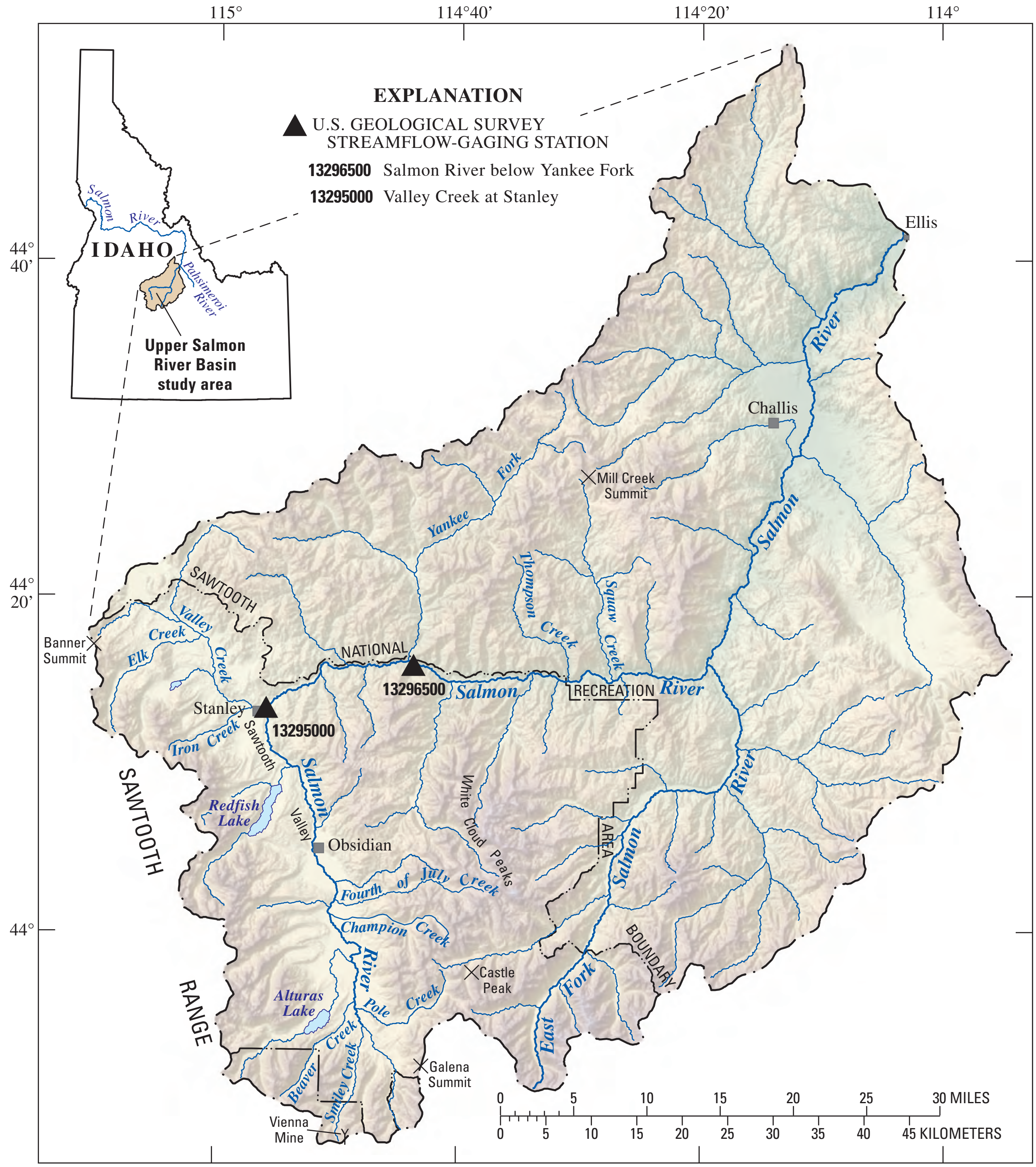
The upper Salmon River Basin geology consists primarily of metamorphic and sedimentary rocks, granite, volcanic rocks, and alluvium (King and Beikman, 1974). Much of the basin is characterized by stream channels deeply incised in bedrock and bordered by steep terrain.

Streams in the upper parts of drainage basins in the Salmon River Basin typically have high water clarity, coarse-grained substrates (cobble and boulders), high stream gradients (>0.5 percent), well-defined riffles and pools, and very sparse macrophyte growth. Designated aquatic life beneficial uses of these study streams include cold water biota and salmonid spawning (Idaho Department of Environmental Quality, 2003). Limited water-quality sampling on small tributaries of the upper Salmon River Basin has indicated few signs of human activities (Ott and Maret, 2003). Based on IDEQ's total maximum daily load assessments, higher elevation streams were not water-quality limited and all beneficial uses were fully supporting (Idaho Department of Environmental Quality, 2003). In a few areas in the upper part of the basin, the effects of historical logging, mining, and cattle-grazing activities are noticeable. In contrast, lower elevation streams of the basin typically have lower water clarity, more fine-grained sediments, lower stream gradients, and generally denser macrophyte growth. These streams frequently are subjected to channelization, loss of riparian habitat by cattle grazing, and diversions for irrigation.

Ground water's impact on streams in the area, especially smaller tributary streams, is important to the overall hydrology and biology. As is typical with streams in mountainous terrains, streamflow between precipitation and snowmelt periods generally is sustained by discharge from the local ground-water system. This is important because the area typically receives little precipitation during the late summer and early autumn months, which results in streamflows (baseflows) that can be directly related to local ground-water conditions. In addition, the discharge of relatively cold ground water into streams during baseflow conditions can have a significant impact on the overall water temperature of the stream.

According to SNRA biologists, the greatest impacts on anadromous fish and their habitat in the upper Salmon River Basin are the effects of water diversions and related instream flow problems (Scott and others, 1981). Of about 497 diversions in the basin, about 189 are within the SNRA boundary (M. Moulton, U.S. Forest Service, written commun., 2004). However, the actual amount of water diverted is unknown. The effects of dewatering these streams include losing valuable spawning and rearing habitats; blocking access to historical spawning and rearing habitat; and disrupting the aquatic ecosystem brought about by annual recurrence of unnaturally low streamflows. Most irrigation diversions in the study area are screened to prevent loss of fish. Water for irrigation in the basin generally is diverted from July through September and, because of the high elevation (>7,000 ft), the resulting growing season is only about 80 days.

Invertebrates and fish in the Salmon River and its tributaries consist primarily of cold water species. The most common benthic invertebrate orders are Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), and Diptera (true flies); the most common fish families are Salmonidae (trout), Cottidae (sculpins), Cyprinidae (minnows), and Catostomidae (suckers). The most common fish species in the upper Salmon River Basin include bull trout, Chinook salmon, resident rainbow (*Oncorhynchus mykiss*) and steelhead trout, brook trout (*Salvelinus fontinalis*), cutthroat trout (*Oncorhynchus clarki*), mountain whitefish (*Prosopium williamsoni*) longnose dace (*Rhinichthys cataractae*), and shorthead sculpin (*Cottus confusus*). Little historical information exists prior to irrigation on upper Salmon River tributary streams use by anadromous fish for spawning and rearing. According to IDFG, most tributary streams of the upper Salmon River offer cold water refugia for juvenile salmonid rearing when the Salmon River water temperatures are not suitable (P. Murphy, Idaho Department of Fish and Game, oral commun., 2004). The endangered sockeye salmon once was found in five lakes in the upper Salmon River Basin; however, it now returns only to Redfish Lake, where active recovery efforts are in operation (National Oceanic and Atmospheric Administration, 2002).



Base from U.S. Geological Survey digital data; 1998; 1:40,000,
Transverse Mercator projection; Factor at central meridian: 0.99960;
Longitude of central meridian: -114°00'; Latitude of origin: 42°00'
False easting (meters): 500,000; False northing (meters): 100,000
Hydrography from U.S. Geological Survey; 1999; 1:500,000

Figure 1. Location of upper Salmon River Basin, Idaho.

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Data Collection Methods

Site Selection

A list of priority streams based on input from the Interagency Technical Workgroup was provided by the Bureau of Reclamation. USGS conducted a reconnaissance on each stream to locate diversions and select potential study sites. The Bureau of Reclamation and USFS assisted in identifying private landowners and obtaining permission to access their land. PHABSIM study sites in the upper Salmon River Basin were selected following guidelines described by Bovee (1997). According to these guidelines, a geographic hierarchy is used to represent a study area in PHABSIM. The first-order subdivision of the study area is the stream segment. Stream segments typically are long sections of stream with a uniform flow regime and consistent geomorphology. Each stream segment, can have several habitat-related subdivisions, including representative reaches, mesohabitats, and microhabitats.

Representative reaches and mesohabitat types describe the stream segment and make up the second-order division of the study area. A representative reach is about 10 to 15 channel widths in length and typically contains many or all of the mesohabitat types present in the entire segment. Proportions of the mesohabitat types in the reach also are assumed to be the same as their proportions in the segment. Mesohabitats are short sections of stream, usually with a length about the same magnitude as the width, and have unique characteristics that distinguish them from other mesohabitat types. Mesohabitat types are identified through a process known as mesohabitat typing, which is an inventory of each mesohabitat proportion in a segment. Mesohabitat types commonly are delineated by localized slope, channel shape, and structure and generally are described as runs, riffles, or pools. Collectively, all the mesohabitat types represent the stream segment.

Either the representative reach or mesohabitat typing typically is used to describe the stream segment. In this study, mesohabitat typing, using a cumulative-lengths approach was used to describe the stream segment. In the cumulative-lengths approach, the length of each mesohabitat type is measured during the inventory, and the proportion of a particular mesohabitat type in a segment is calculated as the cumulative length of all similar mesohabitat types divided by the total length of the segment that was surveyed.

Although a mesohabitat type often is described simply as a run, riffle, or pool, it can be stratified into finer subdivisions to describe the stream segment more accurately. Often, these finer subdivisions take into account varying degrees of slope, width, velocity, and depth. Eight mesohabitat categories were used in this study and represent backwater (pools) and varying degrees of slopes (riffles and runs) in both narrow and wide channels (fig. 2). Specifically, these mesohabitats included shallow and deep pools representing backwater with a hydraulic control. Slopes, designated as low, moderate, or high were measured qualitatively based on professional judgment and are not transferable between streams (for example, high slopes on one stream may or may not compare to high slopes on another). Because of the large variation in stream types, mesohabitat typing was based on relative changes within each stream. The overall goal of this approach was to categorize major habitat types present in each segment and represent them in the PHABSIM modeling by weighting their relative importance.

PHABSIM study sites, the third-order division of a study area, describe either the representative reaches or the mesohabitat types. The study sites are divided longitudinally by stream cells and transects. Cell boundaries are defined by transects and verticals perpendicular to streamflow. When mesohabitat types are used to describe the stream segment, transects are established at the study site to represent the mesohabitat type and are weighted according to the proportion of the mesohabitat type in the segment. The segment is represented by all transects from all mesohabitat types. Mesohabitats making up less than 10 percent of the stream segment generally were not included in the assessment.

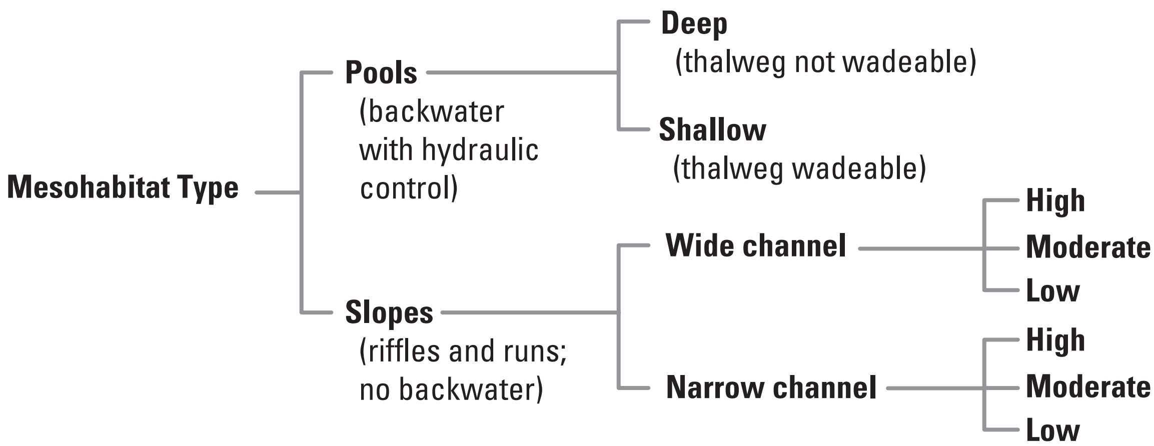

Figure 2. Hierarchical habitat classification used in this study. Mesohabitats are equivalent to geomorphic channel units such as pools, riffles, and runs.

Transects, the fourth-order division of a study area, are subdivided by lateral stream cells with longitudinal boundaries and verticals along which measures of microhabitat are made. Microhabitats usually are shorter than one channel width and represent a relatively homogeneous area used by an individual fish (Bovee, 1997). Examples of microhabitat include undercut banks, velocity shelters behind boulders, and woody debris.

Stream sites were established downstream of all diversions on each stream to evaluate the cumulative impact of multiple diversions. Additional study sites on the same stream were selected downstream of other upstream diversions if significant amounts of water (>10 percent of streamflow) were being diverted.

Shallow riffle habitats that potentially could create a bottleneck to passage were evaluated at each study site. One or more transects were placed across these areas at each study site to evaluate discharge relations and stream depth across the entire stream width.

Environmental Variables

Physical Habitat

Data were collected at verticals along transects to represent hydraulic and geomorphologic conditions in each cell in a mesohabitat type. Water-surface elevations were determined at each transect for at least two measured discharges. One additional stage-discharge pair was collected at some transects when cross-sectional data were collected at verticals in the transect.

Data were collected at about 30 to 40 verticals to define the habitat features of each transect. At each vertical in a transect, depth and mean velocity were measured, and cover and substrate types were determined. Cell width was determined from the spacing of the verticals. Channel structure and hydraulic variables were collected using standard USGS procedures described by Benson and Dalrymple (1967) and Rantz (1982).

Hydrologic information for each study site was expressed using the estimated monthly 80-, 50-, and 20-percent exceedance discharge statistics. These statistics were estimated for each site using regional regression equations from Hortness and Berenbrock (2001). The regional regression equations use basin characteristics such as drainage area, precipitation, and basin slope to estimate streamflow statistics at ungaged sites. Exceedance discharges indicate the discharge that is expected to be equaled or exceeded a specific percentage of the time for a specific month or other time period. Estimates generated by these regional regression equations represent natural or unregulated streamflows.

Substrate and cover were also recorded. Substrate types were identified by visual observation and were classified as organic detritus, silt, sand, small gravel, coarse gravel, cobble, boulder, bedrock, and aquatic vegetation. When more than one substrate type was observed at the vertical, such as gravel and cobble, the dominant substrate was determined. Instream cover that provided velocity shelter and (or) protection from predators for fish was determined across each transect. Types of cover included woody debris, undercut banks, large substrate (for example large gravel, boulder or large cobble), aquatic vegetation, and overhanging vegetation (Raleigh and others, 1986). To characterize stream shading, percent canopy opening was estimated at each transect with a clinometer following procedures described Fitzpatrick and others (1998).

Stream Temperature

Digital data loggers (StowAway TidbiT™; Onset Computer Corporation, Pocasset, Mass.) were used to record stream temperature at several locations throughout the study area. Data logger deployment and data collection followed procedures outlined by Stevens and others (1975) and Zaroban (2000). Data loggers used in this study measured water temperature to within ± 0.4ºC and record temperature within a range of -0.5º to 37ºC. Prior to deployment of the data loggers, a calibration audit was done using an ice water and ambient temperature bath. Audit results showed that all data loggers recorded temperature to within ± 0.4ºC of the audit temperatures as determined by a thermometer calibrated in accordance with American Society of Testing and Materials (ASTM) standards.

To capture the natural thermal regime and to assess the effects of diversions on stream temperature, data loggers were deployed spatially throughout each stream. A data logger generally was placed far enough upstream of all diversions to avoid possible effects of diversions, at study site locations, and near the stream's mouth. Deployment consisted of selecting a well-mixed location in the stream, usually in the thalweg below a riffle, and attaching the data logger to a steel rod that was driven into the streambed. Data loggers were placed at mid-depth out of direct sunlight when possible and were programmed to record stream temperature hourly.

Analytical Methods for Instream Flow Characterization

Physical Habitat Simulation Model

Hydraulic and habitat simulation models contained in PHABSIM (Waddle, 2001) were used to characterize instream physical attributes (depth, velocity, substrate, and cover) during expected summer (July through September) streamflow. To estimate fish habitat available over a range of discharges, hydrologic and habitat data were collected at a few targeted discharges representing the range of discharges for the period of interest at each study site. These data were used to calibrate a hydraulic model, which then was used to predict the stream hydraulic attributes (depth and velocity) over the range of discharges of interest. The biological importance of the stream hydraulic attributes then was assessed with the suitability criteria for each species and life stage to produce a relation between habitat availability and discharge. The final output was expressed as WUA for a representative stream segment. To facilitate interpretation, the WUA results were normalized to a percentage of maximum for the range of discharges simulated.

Hydraulic Modeling and Calibration

The hydraulics portion of the PHABSIM model includes the water-surface elevations and velocity distributions. Data required in this part of the model and collected in the field are: channel geometry, Manning's roughness (*n*) values, water-surface elevations, water velocities, and stream discharges. Water-surface elevations can be calculated using one or any combination of the following methods: (1) stage-discharge relation or rating curve (STGQ), (2) Manning's equation (MANSQ), or (3) step-backwater water-surface profile (WSP) (Waddle, 2001). In most cases, the stage-discharge relation method is used only when three or more discharges and corresponding water-surface elevations are available. In both the stage-discharge relation and Manning's equation methods, the individual transects are independent of each other. In the WSP method, the individual transects are hydraulically connected.

The hydraulic portion of the PHABSIM model is calibrated in two steps. First, attempts are made to match simulated water-surface elevations with measured elevations for the calibration discharges. Calibration is done by adjusting the *n* values or related roughness variables within a realistic range as observed in the field until simulated water-surface elevations match or nearly match measured elevations. A difference of 0.02 ft or less between the simulated and measured values typically is desirable (Waddle, 2001). Second, attempts are made to match simulated velocities at each transect with measured velocities for the calibration discharges. This calibration is done by adjusting local *n* values in specific cells until simulated velocities match or nearly match measured velocities. It may be unrealistic to exactly simulate a measured velocity distribution. However, in relatively smooth, uniform channels, it may be possible to closely simulate a measured velocity. Velocity distributions for fairly rough, nonuniform channels are more difficult to simulate, and the final calibration values are based on the user's selection of the simulation that best represents the measured values (J. Henriksen, U.S. Geological Survey, oral commun., 2004). Velocity adjustment factors that generally increase with increasing discharge (Waddle, 2001) also were used to evaluate model performance.

Habitat Modeling

Selection of Target Species and Habitat Suitability Criteria

PHABSIM use requires target species selection, life stages present during the period of stream use (periodicity), and habitat suitability criteria (HSC). This information was derived from previous SRA studies by the BIA and USFS in the Salmon River Basin (EA Engineering, Science, and Technology, Inc., 1991a and 1991b; R2 Resource Consultants 2004; Rubin and others, 1991). Upon review of this information, the Interagency Technical Workgroup (ITWG) (see "Acknowledgments" for list of members) directed the USGS to target the ESA-listed species bull trout, Chinook salmon, and steelhead trout for juvenile, adult, and spawning life stages (J. Spinazola, Bureau of Reclamation, written commun., 2005). The endangered sockeye salmon was not selected as a target species because its habitat in the upper Salmon River Basin generally is not directly affected by diversions. The ITWG also directed the USGS to not include the fry life stage (<50 mm, or about 2 in.) because of the inability to accurately measure microhabitat parameters at a meaningful scale.

Species-specific HSC that accurately reflect habitat requirements during the life stage of interest are essential to developing meaningful and defensible instream flow recommendations. Suitability criteria quantify the relative importance of depth, velocity, and channel index (substrate) for specific life stages of each species. HSC are interpreted using a suitability index (SI) on a scale of 0 to 1, with zero being unsuitable and one being most used or preferred. The best approach is to develop site-specific HSCs for each species and life stage of interest. Alternatively, HSCs can be developed from existing literature.

Because time and budget constraints precluded developing stream-specific HSC, ITWG also directed the USGS to use existing HSC developed SRA processes. The HSC selected for this study were developed in the Pacific Northwest and Idaho. The HSC and periodicity (period of stream use) for the various fish species and life stages targeted in this study can be accessed at [http://id.water.usgs.gov/projects/salmon_streamflow/habitat_curves.](http://id.water.usgs.gov/projects/salmon_streamflow/habitat_curves)

Maximum juvenile WUAs and median (Q.50) summer (July and August) streamflow data collected by Maret and others (2004) from Fourth of July, Pole, Elk, and Valley Creeks revealed that maximum preferred juvenile salmonid habitat predicted by the model often was less than summer median streamflow. For example, a summer streamflow comparison from streams in the upper Salmon Basin established on average that maximum WUA for juvenile Chinook salmon were only 33 and 63 percent of the July and August Q.50, respectively. Similar relations between streamflow and maximum WUA also were determined for juvenile steelhead and bull trout. Reasons for this likely result from HSCs that were developed during drought conditions (Rubin and others, 1991) and the potential inability to accurately measure microhabitat parameters at a scale that would be meaningful using PHABSIM. Therefore, modeling results for the juvenile life stage are not presented.

ITWG recommended a July through September study period because water is diverted for irrigation mostly during summer. High streamflows for channel maintenance generally have not been a problem in the upper Salmon River Basin (Bohn and King, 2000; M. Moulton, U.S. Forest Service, oral commun., 2003).

The habitat program HABTAE within PHABSIM was used to estimate WUA for the simulated discharges of interest. HABTAE uses the SI values derived from each cell in a transect for depth, velocity, and substrate. The geometric mean calculation was used to derive the composite index (CI) score for each cell at a transect. The CI was calculated as the geometric mean of the input variable:

$$\mathrm{CI} = (\mathrm{SI}_{depth} \times \mathrm{SI}_{velocity} \times \mathrm{SI}_{substrate} \ldots \times \mathrm{SI}_{n})^{1/n},$$

where SI_n is the suitability index value for variable n, and n is the number of input variables (Waddle, 2001). Calculating the CI based on the geometric mean allows for more compensatory relations among variables than an arithmetic mean (J. Henriksen, U.S. Geological Survey, oral commun., 2003). For example, if two of three individual composite suitabilities are high (close to 1.0) and the third is low, the third individual composite suitability has a reduced effect on CI computation. The resulting CI value, combined with the surface area measured for various discharge scenarios, represents the weighted suitability, where a value of 1.0 indicates maximum habitat for the target species and life stage. The WUA is the sum of the products of CI values and surface area for all transect cells representing the study area.

Mean column velocities (0.6 ft of the depth) and default settings were used to compute SI scores for all species and life stages, except bull trout. Nose velocity settings were used for adult bull trout as recommended by EA Engineering, Science, and Technology, Inc. (1991b). Specific settings for nose velocity consisted of estimates of Manning's *n*, which ranged from 0.04 to 0.06 for the study sites, 0.2-ft depth from the stream bottom, and use of a power law to calculate nose velocity from mean column velocity (Waddle, 2001).

Passage Criteria

For adult passage, the minimum depth criterion must be present greater than 25 percent of the total stream width and contiguous greater than at least 10 percent of the stream width at a representative transect (Thompson, 1972). This criterion represents a minimum depth over relatively short stream distances, generally less than 20 ft (Arthaud and others, 2001). The minimum depth criterion recommended by Thompson (1972) is 0.8 ft for Chinook salmon. According to SNRA biologists, this criterion is too high for marginally acceptable anadromous adult fish passage in the upper Salmon River Basin (Scott and others, 1981). Therefore, a 0.6-ft depth criterion (Scott and others, 1981) was used in this study to assess anadromous fish passage. Shallower water depths can allow passage. On August 15, 2002, adult Chinook salmon were observed moving through a shallow riffle that was 0.2-ft deep on Valley Creek. Depths that would provide marginal adult Chinook passage also would meet the passage requirements for other adult and juvenile fish.

A hydraulic parameter option within PHABSIM called AVDEPTH/AVPERM was used to characterize the hydraulic properties of each passage transect (Waddle, 2001). Stream depth criteria between 0.4 and 0.8 ft were used to evaluate the stream width available for passage at the simulated discharges for each transect. Simulated discharge results graphically displays the relation between discharge and the specified depth criteria over stream width.

Stream Temperature

Stream temperature data were inspected for obvious errors such as data logger malfunction and exposure to air temperatures. Data collected prior to deployment and after retrieval were removed from the data set. Time-series plots and other graphical displays were used to inspect the data and to compare data sets. Temperature metrics, which characterize the thermal regime of stream temperatures, were calculated for all data sets and consisted of MDAT, MDMT, MWMT, and maximum weekly-average (7-day) temperature (MWAT). Maximum 7-day metrics were derived from the 7-day moving average of daily (maximum or average) temperatures.

To ensure that stream temperatures stay within the optimal range, State and Federal regulatory agencies have established stream temperature standards. IDEQ is tasked with establishing and enforcing water-quality standards, which include stream temperature criteria. In the early 1990s, the IDEQ established stream temperature criteria of 22.0ºC MDMT and 19.0ºC MDAT for the protection of coldwater biota, and 13.0ºC MDMT and 9.0ºC MDAT for the protection of salmonid spawning (Grafe and others, 2002). In addition to the Idaho water-quality standard stream temperature criteria, the USEPA imposed a site-specific rule on water bodies where bull trout are present (40 CFR 131.E.1.i.d, 1997). This rule set a criterion of 10.0ºC MWMT during June through September for protection of bull trout spawning and juvenile rearing in natal streams.

Although these stream temperature criteria have been established, a single stream temperature criterion for all streams may not accommodate the natural temperature variation within and among streams or the existence of naturally warm water. Consequently, temperatures in Idaho streams commonly exceed the criteria (Essig, 1998; Maret and others, 2001; Donato, 2002; Ott and Maret, 2003).

The Stream Segment Temperature (SSTEMP) model (Bartholow, 2002), developed to assist resource managers predict consequences of stream and drainage basin manipulation on water temperatures, was used to estimate the effects of diversions on water temperature in Fourth of July Creek in 2003. SSTEMP is a mechanistic, one-dimensional, heat-transport model that predicts daily mean and maximum stream water temperatures as a function of discharge, stream distance, and environmental heat flux for a single time period, usually one day. The model calculates net heat flux as the sum of heat to or from a stream by using long-wave atmospheric radiation, direct short-wave solar radiation, convection, conduction, evaporation, shading, streambed fluid friction, and water back radiation. The model also incorporates ground-water influx. SSTEMP is based on the dynamic temperature steady-flow equation and assumes that all input data, including meteorological and hydrological variables, can be represented by daily averages. SSTEMP can be used to predict natural stream temperatures at a location that then can be compared with measured water temperatures affected by dewatering of the stream by diversions. Ultimately, this model can be used to identify streamflows required to minimize temperature effects on the targeted fish species.

Guidelines for Using Study Results

The study results presented in this report summarize the hydrology, habitat, and temperature characteristics of each stream in the study area. PHABSIM, the primary analysis tool used, provides WUA output in relation to discharge for target species and life stages. WUA is thought to be proportional to habitat availability (Bovee and others, 1998). This output can be illustrated with a series of graphs showing curves for each life stage for the fish species of interest. The highest point on each curve represents the discharge at which WUA is maximized for adult or spawning life stages. These maximum values rarely coincide among life stages for any one species or for several species. Furthermore, the habitat/discharge relation does not address water availability. Even natural unregulated flow may not provide the discharge approaching the maximum WUA or water depth sufficient for adult passage. The amount of WUA lost or gained can be determined by comparison with a reference, or unregulated, streamflow condition. Maximum, percentiles, or inflections typically are chosen from these curves at the protection level desired or at points above which greater flow amounts provide only minor gains in usable habitat. In streams with more than one species of interest, study results should be reviewed to ensure that recommended flows are beneficial to all species and harmful to none.

Discharge/depth relations for adult fish passage were evaluated at each study site at selected transects across wide, shallow areas. These areas were identified during the stream mesohabitat typing phase and represent potential passage barriers or “bottlenecks.” If available, results from multiple passage transects can be averaged to represent overall passage conditions and streamflow needs for a particular stream segment. Relative percentage of mesohabitat types representing selected passage transects can be used to approximate the amount of potential passage habitat in various stream segments. This information may help identify those streams that have a relatively large amount of wide, shallow habitat that may restrict adult fish passage. Passage transects not representative of mesohabitats and (or) not perpendicular to the streamflow were not included in PHABSIM habitat modeling.

The mechanisms by which the various components are integrated and the relative importance they are assigned within the water-management decision process is a matter of professional judgment and beyond the scope of this study. Failure to provide adult fish passages connecting to the Salmon River would preclude success of improved conditions for spawning, therefore ensuring enough water for adult fish passage would be foremost in management priorities. Water depth for adult passage is an additional consideration for the adult life stage. If possible, target flows should not reduce the water depth below that required for adult fish passage.

Discharge estimates providing maximum WUA for juvenile salmonid life stages are usually less than summer base flows, indicating a disconnect between the PHABSIM model results and actual juvenile salmonid needs (Maret and others, 2004). PHABSIM studies on streams in Washington demonstrated that streamflows estimated to produce maximum WUA for juvenile Coho salmon (*Oncorhynchus kisutch*) were less than streamflows determined to actually increase juvenile recruitment (H. Beecher, Washington Department of Fish and Wildlife, oral commun., 2004). When estimated flow for maximum juvenile WUA is less than estimated unimpaired summer base flow, the unimpaired summer base flow should be considered optimum until stream-reach-specific fish population and streamflow relations can be obtained (J. Morrow, National Oceanic and Atmospheric Administration, written commun., 2004).

Reasons for the apparent disparity between juvenile WUA curves and actual fish population and flow relations may include: inability to accurately measure and (or) quantify habitat parameters such as velocity, cover (including escape cover), and substrate at a scale that is meaningful for small fish; inability to accurately quantify side channels, bank indentations, riparian wetlands, or other lateral habitat essential for rearing juvenile salmonids; inability to adequately incorporate temperature or other water-quality parameters into the model; and use of habitat suitability criteria that do not consider importance of high-velocity water in adjacent cells. Hampton (1988) determined that water velocity is the critical hydraulic parameter that determines microhabitat selection for juvenile Chinook salmon and steelhead trout. For example, juvenile Chinook salmon are strongly associated with pool habitat with little or no velocities (Hillman and others, 1987; Roper and others, 1994). However, stream salmonids have been observed to reside in, and forage from, shielded microhabitat locations, but adjacent to high-velocity water (Everest and Chapman, 1972). Likewise, foraging models that address improved foraging conditions associated with high-velocity flow near cover are correlated with growth and survival of juvenile Atlantic salmon (*Salmo salar*) (Nislow and others, 2004). Accurately modeling WUA for juvenile stream salmonids may require using habitat suitability criteria developed from foraging models (Baker and Coon, 1997) and (or) more comprehensive habitat parameter modeling.

To focus integration of the various modeling results and relevant species and life stages, a priority species and life stage ranking approach should be developed for each stream and period of concern. For example, the USFS prioritized ESA-listed anadromous species with the highest ranking, followed by Species of Special Concern, in their adjudication of water right claims for selected streams in central Idaho (Hardy, 1997). Prioritizing life stages present for the month or period of concern would benefit the target flow selection using the assumption that the priority life stage would require higher streamflows than other life stages would. This priority ranking generally would be (from high to low) for small tributary streams of the upper Salmon River Basin: passage > spawning > adult > juvenile. The ranking approach should involve discussions among resource-management agency representatives familiar with the streams of interest (J. Spinazola, Bureau of Reclamation, written commun., 2005). Once the priority species and life stage are ranked, each study site should be examined to determine streamflow and passage conditions for the period of interest. Results from PHABSIM provide a science-based linkage between biology and river hydraulics; however, no one single answer can be determined from this approach.

Habitat results are presented for each target species and life stage over an incremental range of discharges, allowing flexibility in interpretation. Because the streams studied are relatively small tributaries (basin size <80 mi^2) to the Salmon River, a greater discharge proportion is required to provide suitable water depths for fish habitat and connectivity for passage than larger streams (Hatfield and Bruce, 2000). Once an adequate number of sites have been characterized using PHABSIM, it may be feasible to develop habitat/discharge relations for streams with similar basin characteristics within specific geographic locations. This could provide a regional planning tool that could eliminate intensive, site-specific studies.

The natural hydrograph also needs to be considered when developing flow targets. In drought years, summer flows that provide maximum possible habitat may not be attainable because of the hydrologic limits on the stream. In addition, PHABSIM does not estimate flow or downstream migrants habitat needs or spring runoff conditions necessary for channel morphology maintenance or riparian zone functions. Arthaud and others (2001) have shown that downstream migrant survival can increase significantly with discharge; therefore, high spring flows that mimic the natural hydrograph should be considered in managing streamflows outside PHABSIM analysis.

Climatic and Hydrologic Conditions During 2004

Climatic and hydrologic conditions in the upper Salmon River Basin generally were below normal (30-year record, 1971–2000 for climatic conditions; long-term means for hydrologic conditions) during water year 2004 (WY04). Monthly snowpack levels were significantly below normal between January 1 and June 1, 2004. The average air temperature during WY04 was slightly higher than the 30-year average, whereas the average monthly air temperatures were both above and below average. Annual mean streamflows in the basin were significantly below the long-term means, whereas monthly mean streamflows were both above and below the long-term means.

Climatic Conditions

Average monthly snowpack levels for the Salmon River Basin upstream of Salmon, Idaho, ranged from 25 to 97 percent of normal from January 1 to June 1, 2004. Average snowpack value for this area on April 1, 2004, was 69 percent of normal (Natural Resources Conservation Service, 2005b). The April 1 value is the most commonly used snowpack condition indicator since in most years it is the final value calculated before snowmelt begins. Observation sites in the general vicinity of the study sites include the Banner Summit (near the headwaters of Valley Creek), Galena Summit (at the headwaters of the Salmon River), Mill Creek Summit (at the headwaters of Yankee Fork), and Vienna Mine (at the headwaters of Smiley Creek). Specific snowpack levels at these sites on April 1, 2004, were: Banner Summit, 75 percent of normal; Galena Summit, 79 percent of normal; Mill Creek Summit, 73 percent of normal; and Vienna Mine, 79 percent of normal (Natural Resources Conservation Service, 2005a).

Mean air temperature at Stanley, Idaho, during WY04 was about 2.17ºC (35.9ºF), slightly higher than the 30-year (1971-2000) mean of 1.78ºC (35.2ºF). Mean daily air temperatures generally were higher during June and July and lower during August and September 2004, than during the long-term (1971–2000) record (fig. 3). Mean monthly air temperatures during the period when snowpack generally accumulates (October through April) were somewhat variable. Mean air temperatures during November and February were below the 30-year mean; those during October, December, January, March, and April were above the 30-year mean (Western Regional Climate Center, 2005).

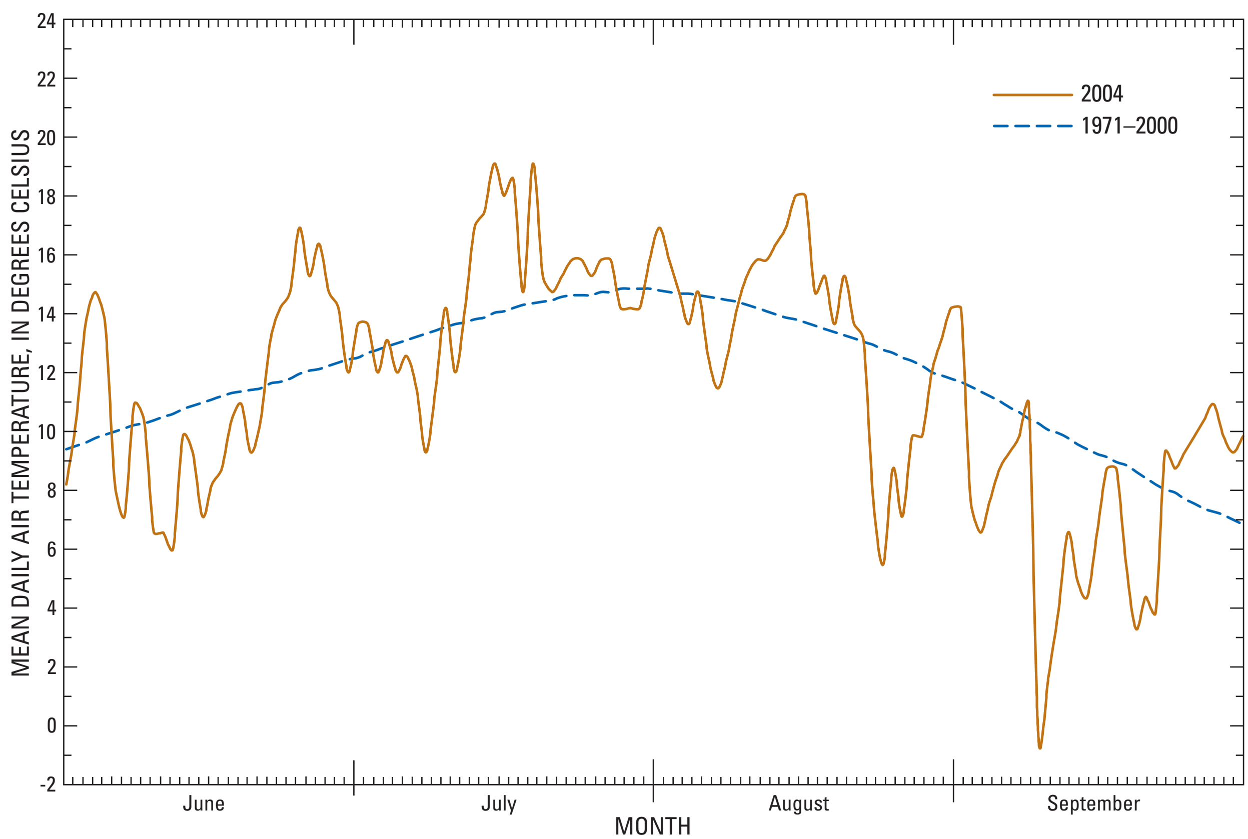

Figure 3. Relation between mean daily air temperatures measured at Stanley Ranger Station for June through September 2004 and long-term values (1971 through 2000), upper Salmon River, Idaho.

Hydrologic Conditions

Annual mean streamflows at the long-term USGS streamflow-gaging stations on Valley Creek at Stanley (13295000; 64 years of record) and on the Salmon River below Yankee Fork (13296500; 74 years of record) for WY04 were about 26 and 27 percent below the long-term means, respectively. Annual mean streamflow at Valley Creek at Stanley was 147 ft^3/s compared to the long-term mean of 199 ft^3/s; and, the annual mean streamflow at the Salmon River below Yankee Fork was 707 ft^3/s, compared to the long-term mean of 974 ft^3/s. Monthly mean streamflows for Valley Creek at Stanley generally were below the long-term means, except those for March and September, which were slightly above the long-term means. Similarly, monthly mean streamflows at the Salmon River below Yankee Fork were below the long-term means, except those for March and April, which were slightly above the long-term means.

Results of Study Site Investigations

PHABSIM investigations were done on the Salmon River and six tributaries during summer and autumn 2004. Data were collected at eight study sites (table 1): two sites on the Salmon River including one site above Beaver Creek (SR2) and one site above Alturas Lake Creek (SR1), one site on lower Beaver Creek (BC1), one site on lower Pole Creek (PC1), one site on lower Champion Creek (CC1), one site on lower Iron Creek, north channel (IC1), one site on lower Thompson Creek (TC1), and one site on lower Squaw Creek (SC1). Permission was not granted to access private lands on Champion Creek for data collection from additional study sites upstream. A plan view of each PHABSIM study site showing locations of specific transects are shown in the appendixes, figs. A1, A5, B1, C1, D1, E1, F1, and G1. PHABSIM WUA results are presented for adult and spawning bull trout, Chinook salmon, and steelhead trout for each study site. Because of the concerns about PHABSIM modeling results for juveniles, they are not presented in this report. Passage transects also were evaluated for various depth criteria at each study site.

In addition to instantaneous streamflow data collected at these study sites, continuous streamflow was recorded at USGS streamflow-gaging stations upstream of all diversions on the Salmon River (SRG), Pole Creek (PCG), Fourth of July Creek (JCG), Iron Creek (ICG), Thompson Creek (TCG), and Squaw Creek (SCG). In addition to these USGS data, continuous streamflow data were summarized from Idaho Power Company streamflow-gaging stations operated in 2004 on Beaver Creek at Highway 75 (BCHWY75), Salmon River at Highway 75 (SRHWY75), and Fourth of July Creek at Highway 75 (JCHWY75). Long-term streamflow information is lacking in the upper Salmon River Basin, especially for basins smaller than 20 to 30 mi^2, .Additional streamflow data collected in these smaller basins not only would provide much needed information, but also could improve the accuracy of regression equations used to estimate streamflows at ungaged sites.

Continuous summer water temperatures were recorded at SRG, SR2, upper Beaver Creek (BC), BCHWY75, BC1, PCG, PC1, SR1, SRHWY75, Champion Creek above Highway 75 (CC), CC1, JCG, JCHWY75, ICG, IC1, TCG, TC1, SCG, and SC1. Continuous temperature and streamflow relations were evaluated for Fourth of July Creek on July 31, 2003, using the temperature model SSTEMP that simulates mean and maximum daily water temperatures resulting from changes in streamflow. Previous PHABSIM investigations on Fourth of July Creek were completed in 2003 and can be found in Maret and others (2004).

Salmon River

The two study sites on the main stem of the Salmon River are in the upper part of the basin upstream of Alturas Lake Creek (fig. 1). This part of the basin covers about 105 mi^2, of which about 54 percent is forest. Mean elevation in the basin is about 8,110 ft above sea level and the basin receives an average of 33.6 in/yr of precipitation.

Hydrology

A short-term streamflow-gaging station (Salmon River at Pole Creek Road; 13292280; SRG) was installed and operated on the Salmon River about 2 mi upstream of the confluence with Beaver Creek from May 1 through October 6, 2003, and again from April 16 through October 4, 2004 (fig. 4). This gaging station was upstream of all active diversions and active pump withdrawals in the Upper Salmon River Basin. A plot of the continuous daily mean discharge data collected during WY04 is presented in figure 5, along with markers indicating the times when field data were collected study sites SR2 and SR1. Study site (SR2) was just upstream of the confluence with Beaver Creek and study site (SR1) was about 3 mi upstream of the confluence with Alturas Lake Creek.

Additional analyses were completed to relate streamflows in the upper Salmon River during WY04 to long-term mean streamflows. Comparisons of monthly mean discharge during WY04 with long-term monthly mean discharge measured at the Valley Creek at Stanley streamflow-gaging station (13295000) showed that WY04 monthly mean discharges were 39.8 and 28.1 percent below the long-term monthly means for July and August, and 7.7 percent above the long-term monthly mean discharge for September. The below average values for July and August likely are result from below average snowpack, as well as residual conditions from previous years. In this case, several years of below-average streamflow in the upper Salmon River Basin prior to WY04 likely contributed to the below-average summer base flows.

Table 1. Basin and site characteristics for streamflow-gaging stations, diversions, and study sites, in the upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Site type:** C, continuous streamflow recorded; D, diversion site; M, instantaneous streamflow measured; P, Physical Habitat Simulation (PHABSIM) study site; T, continuous water temperature recorded; W, surface-water pump withdrawal. **Latitude and longitude**, in degrees, minutes, and seconds. **Abbreviations**: USGS, U.S. Geological Survey; USFS, U.S. Forest Service; mi^2, square mile, in., inch; –, no data]

Site No.	Site name	Site type	Latitude	Longitude	Basin area (mi^2)	Basin slope percent-age	Mean elevation (feet above sea level)	Percent forest	Mean annual precipi-tation (in.)	Stream segment represented by PHABSIM/ study site
SRG 13292280	Salmon River at USGS gage	C, M, T	435407	1144724	27.5	35	8,300	65	36	–
SRD2	Upper Salmon River diversion below Pole Creek Road	D	435408	1144725	–	–	–	–	–	–
SRDP2	Salmon River pump withdrawal at Smiley Creek Airport	W	435441	1144750	–	–	–	–	–	–
SRDP1[1]	Salmon River pump withdrawal above Smiley Creek	W	435502	1144812	–	–	–	–	–	–
SR2	Salmon River above Beaver Creek	M, P, T	435528	1144833	48.3	34	8,220	59	36	Beaver Creek upstream to Smiley Creek
BC	Upper Beaver Creek	T	435420	1144912	–	–	–	–	–	–
BCD2	Upper Beaver Creek diversion	D	435442	1144854	–	–	–	–	–	–
BCD1	Lower Beaver Creek diversion	D	435443	1144854	–	–	–	–	–	–
BCP2[1]	Beaver Creek pump withdrawal	W	435500	1144903	–	–	–	–	–	–
BCHWY75	Beaver Creek at Highway 75	C[2], M[2], T	435510	1144852	14.8	36	8,270	57	42	–
BCP1[1]	Beaver Creek pump withdrawal	W	435513	1144848	–	–	–	–	–	–
BC1	Lower Beaver Creek	M, P, T	435529	1148110	15.2	35	8,240	57	41	Mouth upstream to diversion
PCG 13292380	Pole Creek at USGS gage	C, M, T	435436	1144524	18.4	38	8,487	74	30	–
PCD1	Pole Creek diversion	M	435435	1144526	–	–	–	–	–	–
PC1	Lower Pole Creek	M, P, T	435530	1144744	20.4	35	8,370	68	30	Mouth upstream to a small road culvert, approximately 1.1 miles
SR1	Salmon River above Alturus Lake Creek	M, P, T	435833	1144827	94.3	33	8,180	57	35	Latitude 435838 longitude 1144828 upstream to latitude 435824 longitude 1144822
SRHWY75	Salmon River at Highway 75	C[2], M[2], T	440003	1145000	105	31	8,110	54	34	–
CCD6	Upper Champion Creek diversion	D	440050	1144644	–	–	–	–	–	–
CCD5	Upper middle Champion Creek diversion	D	440051	1144723	–	–	–	–	–	–
CCD4	Middle Champion Creek diversion	D	440049	1144749	–	–	–	–	–	–
CCD3	Lower Champion Creek diversion	D	440059	1144841	–	–	–	–	–	–

Table 1. Basin and site characteristics for streamflow-gaging stations, diversions, and study sites in the upper Salmon River Basin, Idaho, 2004—Continued

[Site location shown in figure 1. **Site type:** C, continuous streamflow recorded; D, diversion site; M, instantaneous streamflow measured; P, Physical Habitat Simulation (PHABSIM) study site; T, continuous water temperature recorded; W, surface-water pump withdrawal. **Latitude and longitude**, in degrees, minutes, and seconds. **Abbreviations**: USGS, U.S. Geological Survey; USFS, U.S. Forest Service; mi^2, square mile, in., inch; –, no data]

Site No.	Site name	Site type	Latitude	Longitude	Basin area (mi^2)	Basin slope percentage	Mean elevation (feet above sea level)	Percent forest	Mean annual precipitation (in.)	Stream segment represented by PHABSIM/study site
CC	Champion Creek above Highway 75	T	440103	1144909	–	–	–	–	–	–
CC1	Lower Champion Creek	M, P, T	440128	1145016	17.1	37	8,580	74	33	Mouth upstream to USFS boundary[3]
SRD1	Salmon River diversion above Fourth of July Creek	D	440156	1145010	–	–	–	–	–	–
JCG 13293350	Fourth of July Creek at USGS gage	C, M, T	440226	1144520	15.8	40	8,934	72	33	–
JCD3	Upper Fourth of July Creek diversion	D	440228	1144523	–	–	–	–	–	–
JCD2	Middle Fourth of July Creek diversion	D	440146	1144803	–	–	–	–	–	–
JCD1	Lower Fourth of July Creek diversion	D	440145	1144942	–	–	–	–	–	–
JCHWY75	Fourth of July Creek at Highway 75	C[2], M[2], T	440149	1144960	–	–	–	–	–	–
ICG 13294880	Iron Creek at USGS Gage	C, M, T	441210	1145922	7.1	45	7,930	52	31	–
ICD2	Iron Creek diversion	D	441250	1145836	–	–	–	–	–	–
ICD1	Iron Creek diversion	D	441257	1145815	–	–	–	–	–	–
IC1	Lower Iron Creek, north channel	M, P, T	441308	1145802	7.7	42	7,820	54	30	Highway 75 upstream to diversion
IC	Lower Iron Creek, south channel	M	441308	1145802	7.7	42	7,820	54	30	–
TCG 13297330	Thompson Creek at USGS gage	C, M, T	441614	1143059	29.5	48	7,620	69	23	–
TCD1	Thompson Creek diversion	D	441521	1143055	–	–	–	–	–	–
TC1	Lower Thompson Creek	M, P, T	441513	1143054	30.2	48	7,600	69	22	From mouth upstream to diversion
SCG 13297355	Squaw Creek at USGS gage	C, M, T	441726	1142818	71.6	36	7,730	73	25	–
SCD2	Squaw Creek diversion	D	441542	1142736	–	–	–	–	–	–
SCD1	Squaw Creek diversion	D	441526	1142732	–	–	–	–	–	–
SC1	Lower Squaw Creek	M, P, T	441458	1142722	78	37	7,670	70	24	From mouth upstream to diversion

[1]Diversion or pump withdrawal not active in 2004.

[2]Continuous streamflow recorded and instantaneous streamflow measured by Idaho Power Company.

[3]Access on private land restricted stream segment length.

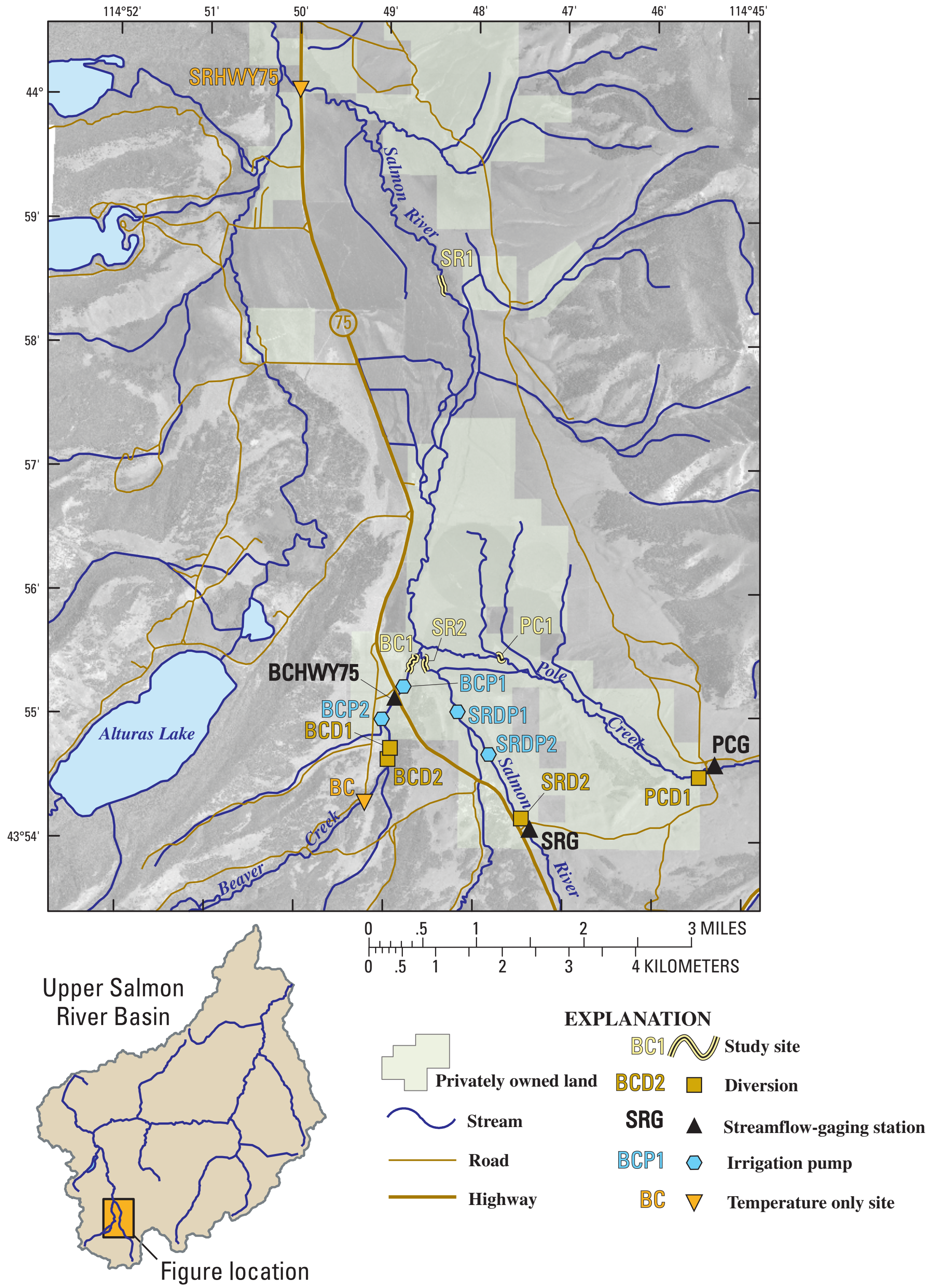

Figure 4. Location of study sites on Beaver and Pole Creeks and Salmon River, diversions, streamflow-gaging stations, irrigation pumps, and temperature monitoring locations, upper Salmon River Basin, Idaho, 2003–04.

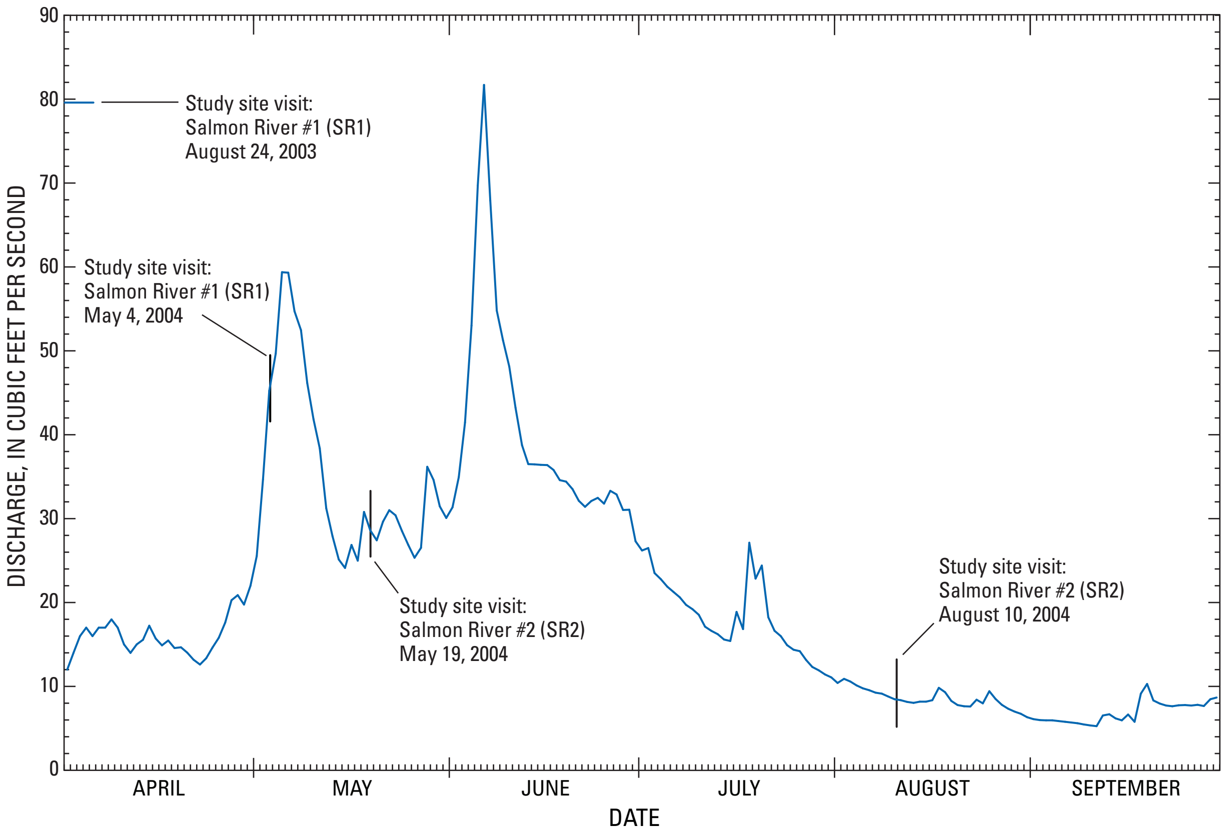

Figure 5. Daily mean discharge at Salmon River at Pole Creek Road above diversions, near Obsidian (13292280), upper Salmon River Basin, Idaho, April 1 through September 30, 2004.

To determine an estimated long-term daily mean (normal year) hydrograph for the Salmon River at Pole Creek Road streamflow-gaging station, the daily mean discharge values for July, August, and September 2004 were adjusted on a monthly basis by the percentage of differences calculated for the Valley Creek at Stanley streamflow-gaging station. All daily mean values for the upper Salmon River for July were increased by 39.8 percent; all August values were increased by 28.1 percent; and all September values were decreased by 7.7 percent. Berenbrock (2003) confirms using the Valley Creek at Stanley streamflow-gaging station as an “index” station for short-term gaging stations in the Upper Salmon River basin. Figure 6 shows the July, August, and September 2004 daily mean discharge hydrograph for Salmon River at Pole Creek Road (13292280) and the estimated long-term daily mean discharge hydrograph. Estimated monthly streamflow exceedance statistics for the streamflow-gaging station based on regional regression equations developed by Hortness and Berenbrock (2001) also are shown in figure 6. The statistical values plotted in figure 6 include the 80-, 50- (median), and 20-percent exceedance discharge estimates. The median estimate indicates long-term average streamflow conditions. During base-flow periods that are absent of peaks, the median and mean streamflow values should be similar. The other estimates indicate the probable variation in streamflows at this location.

The 80-, 50-, and 20-percent monthly exceedance discharge values were estimated on the basis of WY04 daily mean discharge values and estimated long-term daily mean discharge values at the Salmon River at Pole Creek Road streamflow-gaging station (13292280) (table 2). Exceedance estimates using the equations from Hortness and Berenbrock (2001), along with the confidence limits, also are presented in table 2. The confidence limits for the regression equations are based on one standard error of the estimate, which may be wrong on average about one time out of three (Ezekial and Fox, 1959). They also are referred to as the 67-percent confidence limits. Comparison between the estimated long-term daily mean discharge values and values calculated on the basis of the regression equations can provide some insight as to the applicability of the regression equations for this part of the Salmon River. As shown in figure 6, the regression estimates tend to be higher than the estimated long-term values, indicating that the equations, to some degree, could overestimate streamflow conditions in the upper Salmon River Basin.

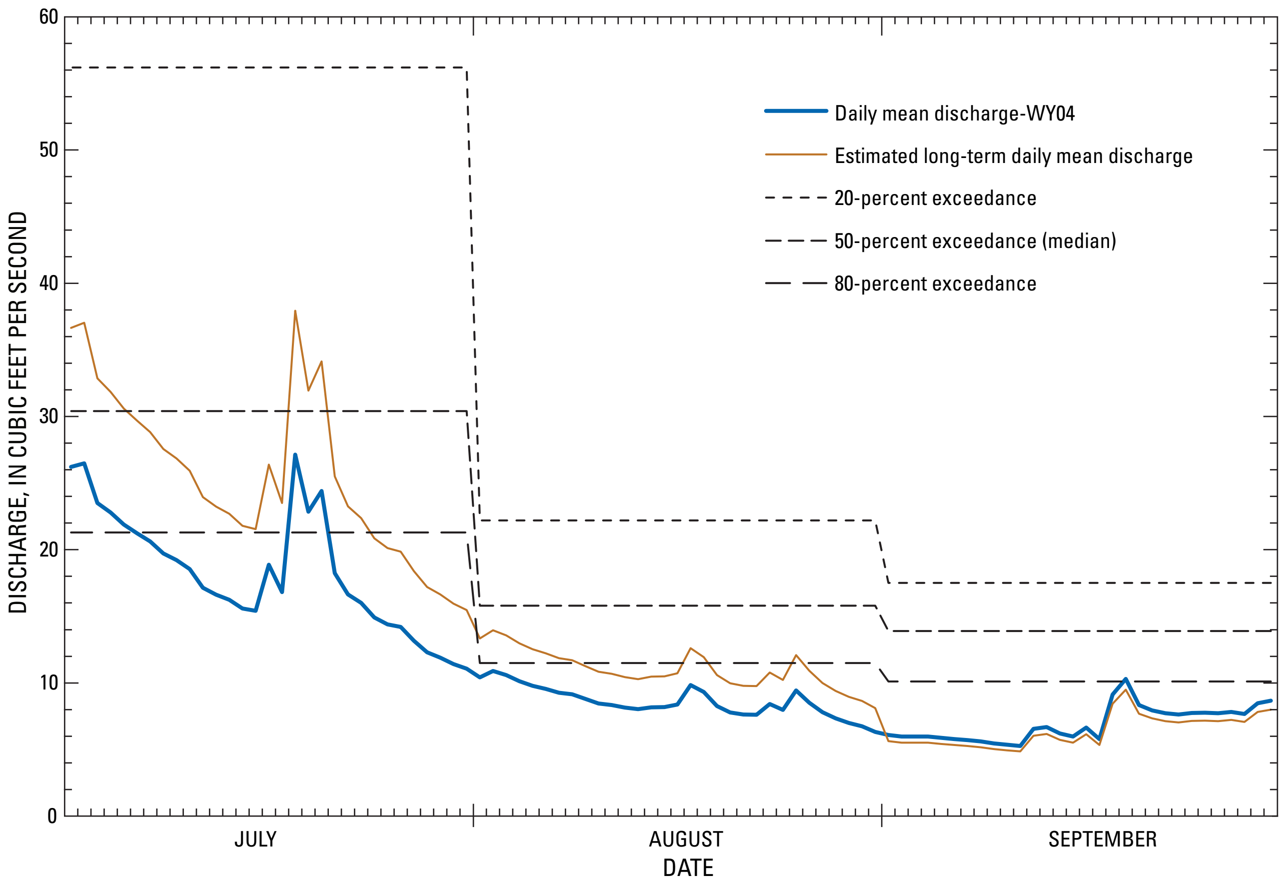

Figure 6. Daily mean discharge for water year 2004, estimated long-term daily mean discharge, and estimated 80-, 50-, and 20-percent exceedance statistics at Salmon River at Pole Creek Road above diversions, near Obsidian (13292280), upper Salmon River Basin, Idaho, July 1 through September 30.

Table 2. Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Salmon River at Pole Creek Road above diversions, near Obsidian (13292280), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Estimated long term:** Based on comparisons between water year 2004 and long-term monthly mean discharges at Valley Creek at Stanley (13295000)]

	July			August			September		
	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20
Water year 2004	14.4	17.1	22.8	7.78	8.37	9.54	5.79	6.60	7.85
Estimated long term	20.1	24.0	31.9	10.0	10.7	12.2	5.34	6.09	7.24
Regional regression equations									
Upper confidence limit	32.9	44.0	78.4	19.6	25.0	33.2	17.7	20.2	24.7
Estimate	21.3	30.4	56.2	11.5	15.8	22.2	10.1	13.9	17.5
Lower confidence limit	13.8	21.0	40.3	6.74	10.0	14.8	5.77	9.57	12.4

Although seepage analyses were not within the scope of this project, instantaneous discharge measurements provide some indication of streamflow being diverted during the study period. A summary of all discharge measured in the Salmon River upstream of Alturas Lake Creek during the study period is presented in table 3.

Table 3. Summary of instantaneous and mean daily discharge for the Salmon River upstream of Alturas Lake Creek, upper Salmon River Basin, Idaho, water year 2004.

[Site locations shown in figure 1. **Discharge:** Values presented in cubic feet per second; daily mean discharge values are underlined. **Abbreviations:** –. no data available]

Date	Discharge			
	SRG	SR2	SR1	SRHWY75
04-21-04	13.2	–	–	54.0
05-04-04	49.7	–	122	–
05-19-04	28.6	49.9	–	[1]111
05-26-04	25.3	–	–	87.0
06-23-04	32.1	–	–	114
07-14-04	15.6	–	–	36.4
08-10-04	8.50	9.10	–	[1]23.3
08-17-04	9.80	–	–	26.0

[1] Data from Idaho Power Company.

Habitat Modeling and Passage Criteria

The Salmon River above Beaver Creek (SR2) discharges required for maximum WUA ranged from 24 to 60 ft^3/s for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 4). Discharges required for adult passage over two shallow riffle habitat transects were 33 and 21 ft^3/s for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 27 and 12 ft^3/s greater than 10 percent of the contiguous channel width, respectively (see transects 1 and 8 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Scott and others (1981) using similar passage criteria estimated that a discharge of 29 ft^3/s would provide marginal passage for Chinook salmon on the Salmon River about 2 mi downstream of study site SR2. Appendix A provides more information summarizing these study results.

Summer (July through September) discharges for SR2 were estimated on the basis of regression equations and are listed in table 4. Median discharge (Q.50) estimates were 44.4 ft^3/s for July, 23.3 ft^3/s for August, and 20.9 ft^3/s for September. The mean annual discharge estimate was 64.9 ft^3/ s. As shown in figure 6, the regression estimates tend to be higher than the estimated long-term values, indicating that the equations, to some degree, could overestimate streamflow conditions in the upper Salmon River Basin.

The Salmon River above Alturas Lake Creek (SR1) discharges required for maximum WUA ranged from 35 to 100 ft^3/s for bull trout, 85 to 90 ft^3/s for Chinook salmon, and 85 to 90 ft^3/s for steelhead trout adult and spawning life stages (table 4). Discharges required for adult passage over a shallow riffle habitat transect was 50 and 40 ft^3/s for the 0.6 ft depth criterion greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively (see transect 4 photograph at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix A provides more information summarizing these study results.

Summer (July through September) discharges for SR1 were estimated on the basis of regression equations and are listed in table 4. Median discharge (Q.50) estimates were 74.8 ft^3/s for July, 40.2 ft^3/s for August, and 36.7 ft^3/s for September. Mean annual discharge estimate was 112.0 ft^3/s.

Stream Temperature

Temperature recording data loggers were deployed at several locations in the upper Salmon River Basin in 2003 and 2004 (fig. 4). These locations included SRG, SR2 (2004 only), SR1 (2003 only), and SRHWY75 All data loggers were deployed in June 2003 and 2004, except the data logger at SRHWY75, which was deployed in July 2003.

All data loggers were retrieved in late September 2003 and 2004 with the exception of SR1 in 2004, which was missing. Data downloaded from the data loggers were reviewed and determined to be complete and useable, except 2004 data from site SRHWY75, which was repeatedly exposed to air temperatures starting July 11, 2004. Data recorded after this date was compromised and not used

In 2003, the period of record June 20 through September 28 (101 days) was selected for calculating stream temperature metrics at SRG and SR1, and the period of record July 18 through September 28 (73 days) was selected for calculating stream temperature metrics at SRHWY75 (fig. 7). In 2004, the period of record June 9 through September 30 (114 days) was selected for calculating stream temperature metrics at SRG and SR2, and the period of record June 9 through July 10 (32 days) was selected for calculating stream temperature metrics at SRHWY75 (fig. 8).

Comparison of the average stream temperature from SRG for June 20 through September 28, 2003, indicated the average temperature was slightly higher (+0.05ºC) in 2003 than in 2004.

Analysis of the 2003 stream temperature records for the Salmon River indicated a slight warming trend downstream of SRG to SR1 and then an obvious cooling trend downstream of SR1 to SRHWY75 (fig. 7). This cooling trend probably is due to inflow from several springs and subsurface inflow of cold ground water to the Salmon River just upstream of the Highway 75 bridge where the Salmon River flood plain constricts.

Table 4. Summary of habitat and hydrologic measurements for Salmon River above Beaver Creek (SR2) and Salmon River above Alturas Lake Creek (SR1), upper Salmon River Basin, Idaho, 2004.

[Values presented in cubic feet per second. **Discharge passage criteria:** Passage criteria taken from Thompson (1972) and Scott and others (1981); both width criteria must be met to ensure passage. **Discharge estimates:** Based on regional regression equations using basin and climatic characteristics (Hortness and Berenbrock, 2001); Q.xx, daily discharge exceeded xx percent of the time during the specified month; Qa, mean annual discharge; **Channel width:** Represents measurements at two transects. **Abbreviations:** WUA; weighted usable area; WUA optimum discharge estimates were based on PHABSIM (Physical Habitat Simulation) model output; ND, not determined]

Lifestage	Discharge required for maximum WUA			Discharge required for adult salmonid passage 0.6-foot depth criterion: Channel width		Discharge estimates									
						July			August			September			
	Bull trout	Chinook salmon	Steelhead trout	Greater than 25 percent (total)	Greater than 10 percent (contiguous)	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Qa
Salmon River above Beaver Creek (SR2)															
Adult	24	60	60	33, 21	27, 12	30.9	44.4	82.7	16.8	23.3	32.9	14.9	20.9	26.3	64.9
Spawning	60	60	60	ND	ND										
Salmon River above Alturus Lake Creek (SR1)															
Adult	35	85	85	50	40	52.0	74.8	140.0	28.6	40.2	56.6	25.9	36.7	46.2	112.0
Spawning	[1]100	90	90	ND	ND										

[1] Best estimate taken from initial maximum peak approaching 100 percent.

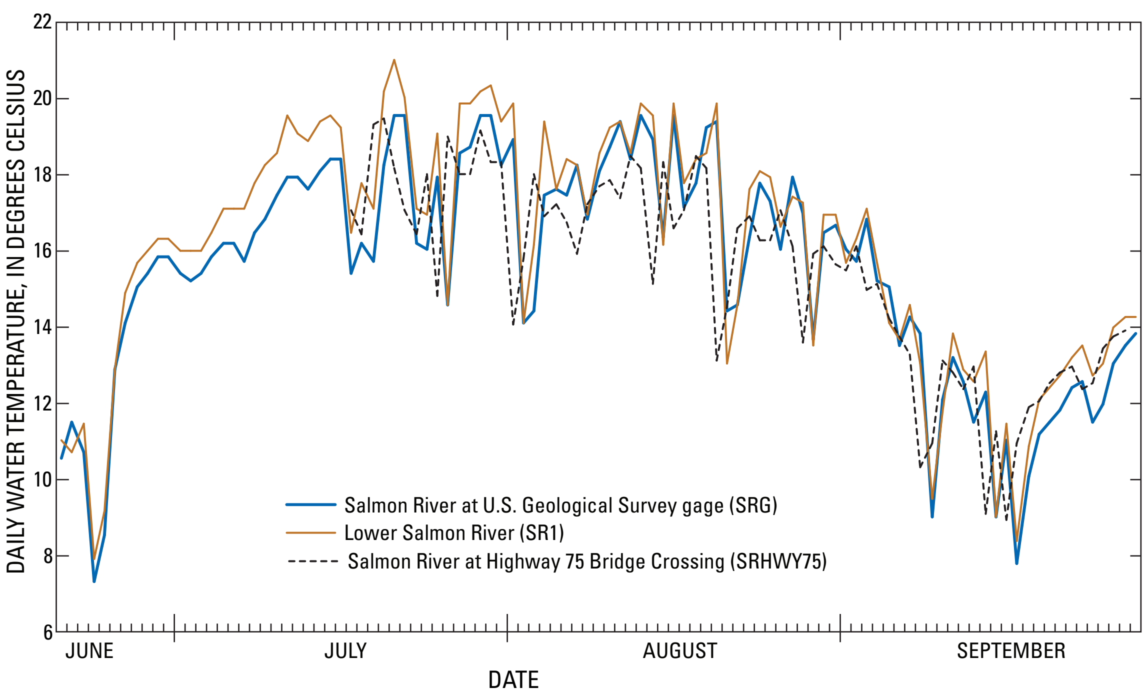

Figure 7. Maximum daily water temperature at Salmon River, upper Salmon River Basin, Idaho, June 20 through September 28, 2003.

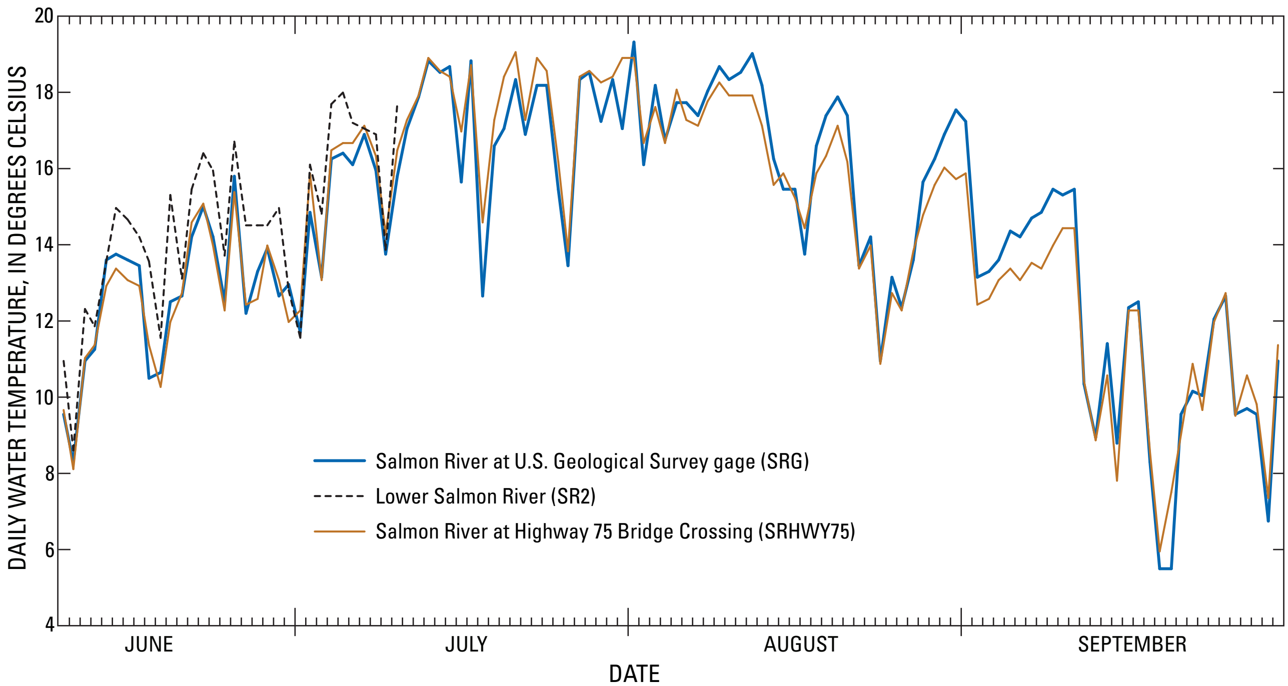

Figure 8. Maximum daily water temperature, at Salmon River, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

Analysis of the 2004 stream temperature records indicated a slight cooling trend downstream of SRG to SR2. This cooling trend is perhaps the result of cooler water from the Smiley Creek tributary entering the Salmon River just upstream of SR2.

Individual metric calculation results for 2003 showed the MDAT was 14.8ºC at SRG, 15.2ºC at SR1, and 15.0ºC at SRHWY75. The MDMT was 19.6ºC at SRG, 21.0ºC at SR1, and 19.5ºC at SRHWY75. Individual metric calculation results for 2004 showed the MDAT was 14.3ºC at SRG and 14.8ºC at SR2. The MDMT was 19.3ºC at SRG and 19.1ºC at SR2.

The MDAT during 2003 and 2004 at all sites was below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

The MDMT during 2003 and 2004 at all sites was at or slightly below the MDMT threshold of 21.0ºC that, according to Poole and others (2001), can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. However, the MDMT during 2003 and 2004 at all sites exceeded the 18.0ºC threshold that may block bull trout migration (J. Dunham, U.S. Forest Service, written commun., 2004).

In 2003 and 2004, all sites had a temperature regime below the 19.0ºC MDAT and below the 22.0ºC MDMT IDEQ criteria, for protection of coldwater biota (applicable from June 22 through September 21). A summary of individual temperature metrics for 2003 and 2004 for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Beaver Creek

Beaver Creek is an easterly flowing tributary to the Salmon River and is about 10 mi downstream of the Salmon River headwaters (fig. 1). Beaver Creek originates in the Sawtooth Range on the west side of the Sawtooth Valley. The Beaver Creek Basin covers 15.2 mi^2, of which about 57 percent is forest. Mean elevation in the basin is about 8,240 ft above sea level and the basin receives an average of about 41 in/yr of precipitation. Grazing on lower Beaver Creek has significantly altered the stream channel and banks (Upper Salmon River Bull Trout Technical Advisory Team, 1998).

Hydrology

A short-term streamflow-gaging station (BCHWY75) was installed and operated on Beaver Creek from May 10 through September 30, 2004. This gaging station was at the Highway 75 bridge over Beaver Creek, about 0.5 mi upstream of the confluence with the Salmon River. Two diversions and one irrigation pump site are on Beaver Creek upstream of the streamflow-gaging station (fig. 4). The diversions and pump site were not in operation during WY04 (Bill Graham, Idaho Department of Water Resources, oral commun., 2004). A plot of the continuous daily mean discharge at BCHWY75 for WY04 is presented in figure 9, along with markers indicating when field data were collected at study site BC1, which was about 1,000 ft downstream. When discharges exceeded about 15 ft^3/s, an unknown volume of the streamflow bypassed the gaging station and was not accounted for (Mike Campbell, Idaho Power Company, oral commun., 2005.).

Additional analyses were completed to relate streamflows in Beaver Creek during WY04 to long-term mean streamflows. The same techniques used to estimate long-term streamflows for the upper Salmon River (long-term data comparisons from Valley Creek at Stanley; 13295000) also were used for Beaver Creek. The July, August, and September daily mean discharge hydrograph for Beaver Creek at BCHWY75 for WY04 and the estimated long-term daily mean discharge hydrograph are presented in figure 10. Estimated monthly streamflow exceedance statistics for the streamflow-gaging station based on regional regression equations developed by Hortness and Berenbrock (2001) also are presented in figure 10. Again, the median estimate gives an indication of long-term average streamflow conditions, and the other estimates provide an indication of the probable variation in streamflows at this location.

The 80-, 50-, and 20-percent monthly exceedance discharge values estimated on the basis of WY04 daily mean discharge values and estimated long-term daily mean discharge values for BCHWY75 are presented in table 5. Exceedance estimates, along with the confidence limits, derived from the regional regression equations (Hortness and Berenbrock, 2001) for this location also are presented in the table. Comparison between estimated long-term daily mean discharge values and values calculated on the basis of the regression equations can provide some insight as to the applicability of the regression equations for Beaver Creek. As shown in figure 10, the regression equation estimates tend to be higher than the estimated long-term values, indicating that the equations could overestimate streamflow conditions in Beaver Creek.

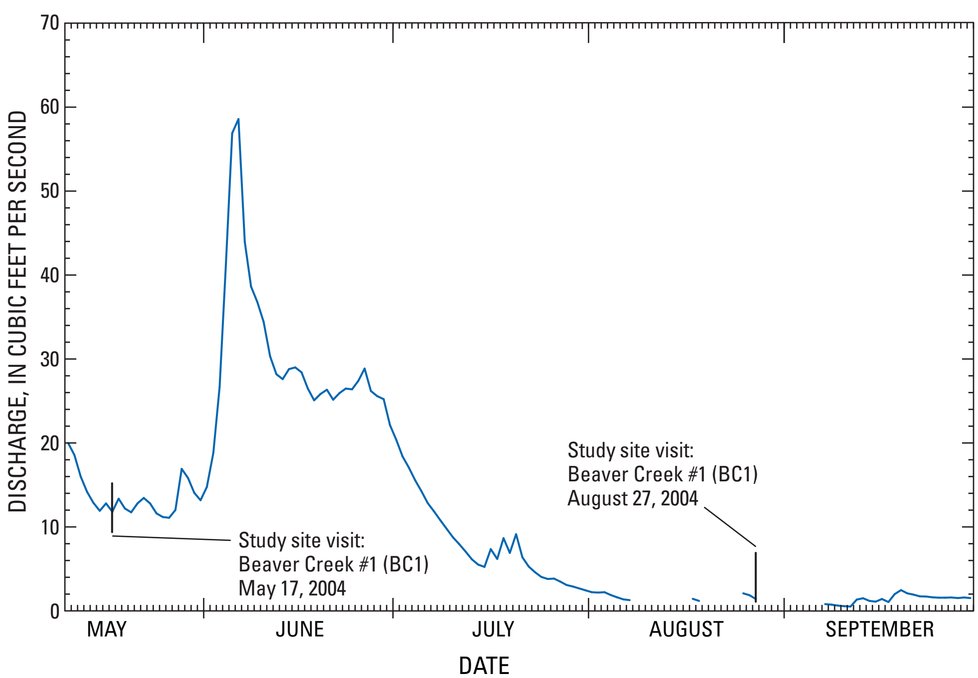

Figure 9. Daily mean discharge at Beaver Creek at Highway 75 Bridge, near Stanley (BCHWY75), upper Salmon River Basin, Idaho, May 10 through September 30, 2004 (streamflow-gaging station operated by Idaho Power Company).

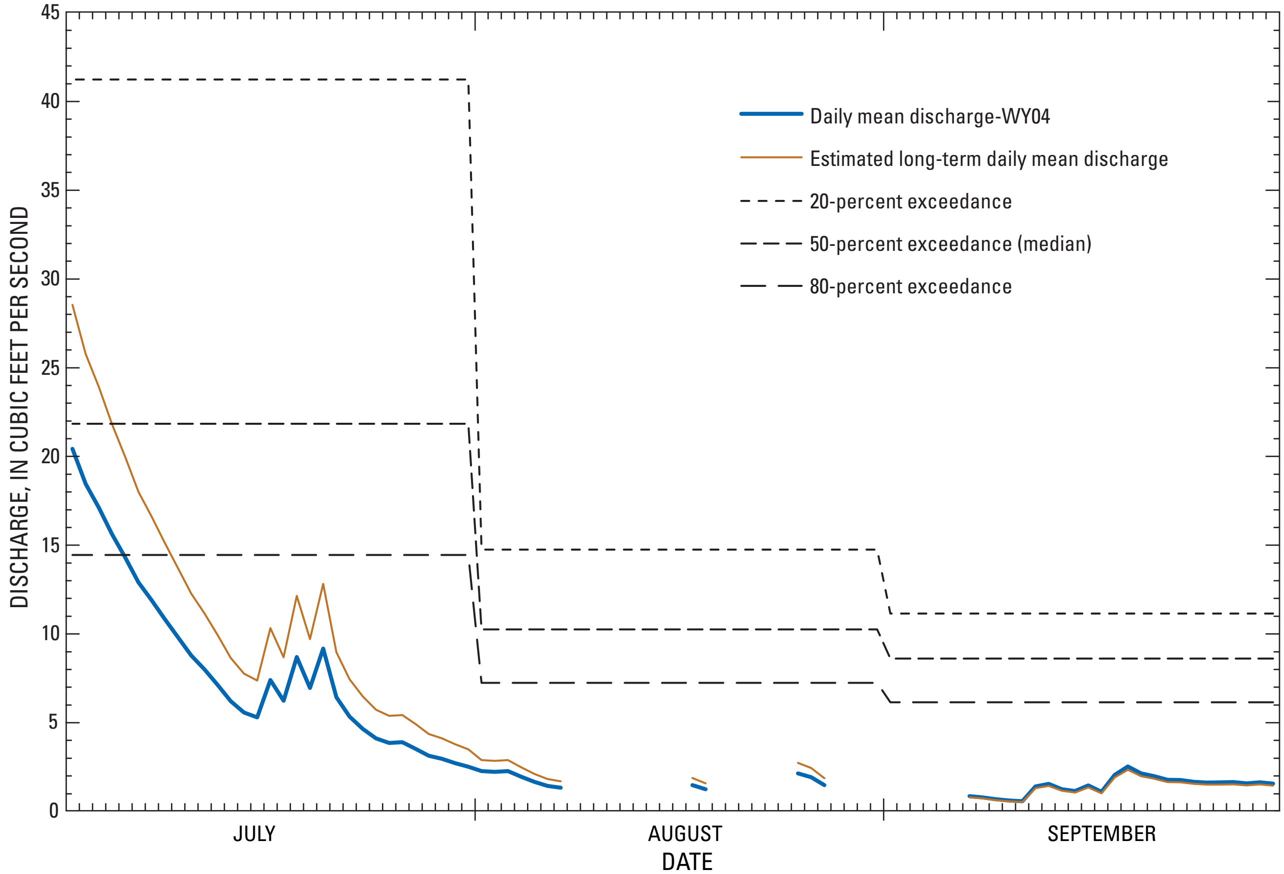

Figure 10. Daily mean discharge for water year 2004, estimated long-term daily mean discharge, and estimated 80-, 50-, and 20-percent exceedance statistics at Beaver Creek at Highway 75 bridge, near Stanley, upper Salmon River Basin, Idaho, July 1 through September 30 (streamflow-gaging station operated by Idaho Power Company).

Table 5. Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Beaver Creek at Highway 75 bridge (BCHWY75), near Stanley, upper Salmon River Basin, 2004.

[Values presented in cubic feet per second. **Water year 2004:** A small portion of the streamflow is not accounted for at discharges above about 15 cubic feet per second. **Estimated long term:** Based on comparisons between water year 2004 and long-term monthly mean discharge at Valley Creek at Stanley (13295000)]

	July			August			September		
	Q.80	**Q.50**	**Q.20**	**Q.80**	**Q.50**	**Q.20**	**Q.80**	**Q.50**	**Q.20**
Water year 2004	3.85	6.91	11.9	1.39	1.74	2.16	0.95	1.53	1.72
Estimated long term	5.38	9.66	16.6	1.78	2.23	2.77	.88	1.41	1.59
Regional regression equations									
Upper confidence limit	22.3	31.5	57.5	12.3	16.2	22.0	10.7	12.4	15.7
Estimate	14.4	21.8	41.2	7.19	10.2	14.7	6.10	8.56	11.1
Lower confidence limit	9.32	15.1	29.5	4.21	6.44	9.82	3.49	5.89	7.87

Habitat Modeling and Passage Criteria

Lower Beaver Creek (BC1) discharges required for maximum WUA were greater than 30 ft^3/s for bull trout, Chinook salmon, and steelhead trout adult and spawning life stages (table 6). The WUA curves showed a gradual increase for all species and life stages with discharge and never became asymptotic. Discharges required for adult passage over three shallow riffle habitat transects ranged from 10 to 22 ft^3/s and 4 to 20 ft^3/s for the 0.6 ft depth criterion greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively (see transects 1, 4, and 5 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix B provides more information summarizing these study results..

Summer (July through September) discharges for BC1 were estimated on the basis of regression equations and are listed in table 6. Median discharge (Q.50) estimates were 21.5 ft^3/s for July, 10.1 ft^3/s for August, and 11.1 ft^3/s for September. The mean annual discharge estimate was 29.0 ft^3/s.

Stream Temperature

Temperature recording data loggers were deployed at BC, BCHWY75, and BC1 in early June 2004 (fig. 4). Data loggers at BC and BCHWY75 were retrieved in late September 2004. The data logger at BC1 was found out of the water during a site visit on August 10, 2004, and was removed.

After downloading and reviewing the data, June 9 through September 30 (114 days) was selected as the period of record for calculating stream temperature metrics at BC and BCHWY75. Data from BC1 data logger were determined to be compromised by repeated exposure to air temperatures starting July 26 and no stream temperature metrics were calculated for this site.

Analysis of the stream temperature records for Beaver Creek indicated a strong warming trend downstream of BC to BC1 (fig. 11). Individual metric calculation results showed the MDAT was 13.8ºC at BC and 15.2ºC at BCHWY75. These temperatures are well below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

The MDMT was 17.7ºC at BC and 24.0ºC at BCHWY75. The difference in MDMT between BC and BCHWY75 on any given day was greater than 3.0ºC, 60 percent (68 of 114 days) of the time; the maximum difference in MDMT was 7.8ºC occurring on August 15, 2004.

The MDMT at BC is well below, while the MDMT at BCHWY75 is well above, the MDMT threshold of 21.0ºC that, according to Poole and others (2001), can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. The MDMT at all sites also exceeded the 18.0ºC threshold that may block bull trout migration (J. Dunham, U.S. Forest Service, written commun., 2004).

Comparing the temperature regime at the two sites on Beaver Creek to the IDEQ criteria for protection of coldwater biota (applicable from June 22 through September 21) indicates the temperature regime at BC was below the 19.0ºC MDAT and 22.0ºC MDMT criteria. The MDAT at BCHWY75 was below the 19.0ºC criterion while the MDMT was above the 22.0ºC criterion. A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Table 6. Summary of habitat and hydrologic measurements for lower Beaver Creek (BC1), upper Salmon River Basin, Idaho, 2004.

[Values presented in cubic feet per second. **Discharge:** 30 cubic feet per second was thought to be a reasonable upper limit of model extrapolation based on the calibration discharges. **Discharge passage criteria:** Passage criteria taken from Thompson (1972) and Scott and others (1981); both width criteria must be met to ensure passage. **Statistical discharge:** Discharge statistics derived from regional regression equations using basin and climatic characteristics (Hortness and Berenbrock, 2001); Q.xx, daily discharge exceeded xx percent of the time during the specified month. Qa, mean annual discharge; **Abbreviations:** WUA, weighted usable area; WUA optimum discharge estimates were based on PHABSIM (Physical Habitat Simulation) model output; ND, not determined; >, greater than]

Lifestage	Discharge required for maximum WUA			Discharge required for adult salmonid passage 0.6-foot depth criterion: Channel width		Discharge estimates									
						July			August			September			
	Bull trout	Chinook salmon	Steelhead trout	Greater than 25 percent (total)	Greater than 10 percent (contiguous)	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Qa
Adult	>30	>30	>30	[1]10, 22, 22	[1]4, 4, 20	14.2	21.5	40.5	7.1	10.1	14.6	6.1	8.6	11.1	29.0
Spawning	>30	>30	>30	ND	ND										

[1]Represents measurements at three transects.

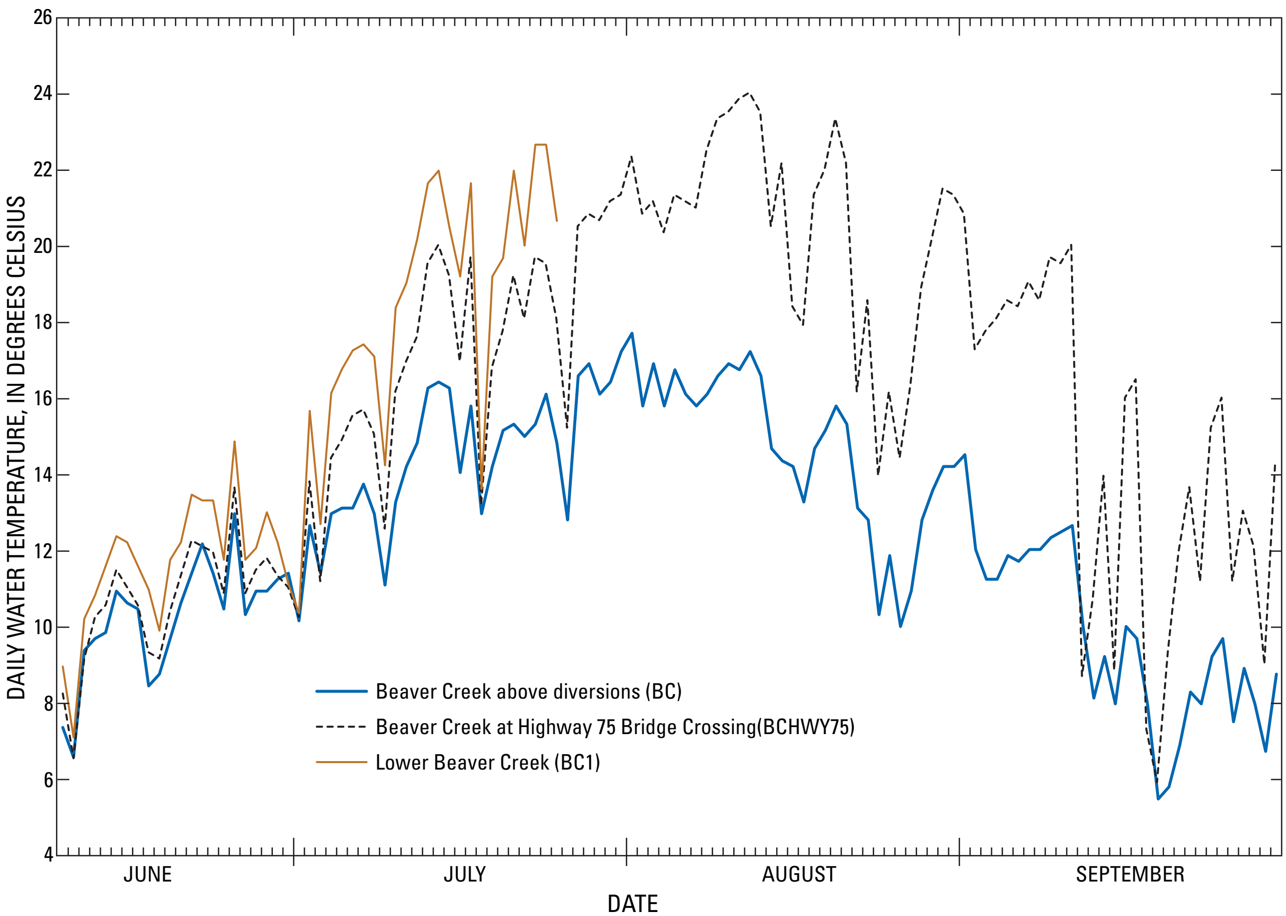

Figure 11. Maximum daily water temperature at Beaver Creek, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

Pole Creek

Pole Creek is a westerly flowing tributary to the Salmon River and is about 10 mi downstream of the Salmon River headwaters (fig. 1). Pole Creek originates in the White Cloud Peaks on the east side of the Sawtooth Valley. The Pole Creek Basin covers about 18.5 mi^2, of which about 74 percent is forest. Mean elevation in the basin is about 8,480 ft above sea level and the basin receives a mean of about 30 in/yr of precipitation.

Hydrology

A short-term streamflow-gaging station (13292380; PCG) was installed and operated on upper Pole Creek from June 1 through October 6, 2003, and again April 1 through September 30, 2004. This gaging station was upstream of all active diversions and about 3.5 mi upstream of the confluence with the Salmon River (fig. 4). A plot of the continuous daily mean discharge in upper Pole Creek upstream of the diversions during WY04 is presented in figure 12, along with markers indicating the times when field data were collected at the study site (PC1), which was located about 0.6 mi upstream of the mouth of Pole Creek.

Additional analyses were completed to relate streamflows in Pole Creek during WY04 to long-term mean streamflows. The same techniques used to estimate long-term streamflows for the upper Salmon River (long-term data comparisons from Valley Creek at Stanley; 13295000) also were used for Pole Creek. The July, August, and September daily mean discharge hydrograph for PCG for WY04 and the estimated long-term daily mean discharge hydrograph are presented in figure 13. Estimated monthly streamflow exceedance statistics for the streamflow-gaging station location based on regional regression equations developed by Hortness and Berenbrock (2001) also are presented in figure 13. Again, the median estimate gives an indication of long-term average streamflow conditions, and the other estimates provide an indication of the probable variation in streamflows at this location.

The 80-, 50-, and 20-percent monthly exceedance discharge values were estimated on the basis of WY04 daily mean discharge values and estimated long-term daily mean discharge values at the Pole Creek streamflow-gaging station (13292380) (table 7). Exceedance estimates, along with the confidence limits, also were derived from the regional regression equations (Hortness and Berenbrock, 2001) for this

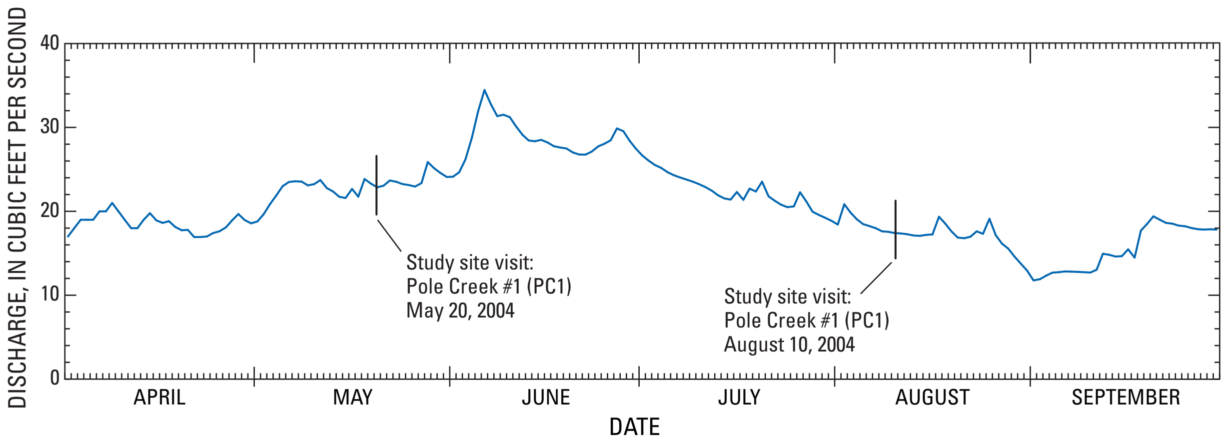

Figure 12. Daily mean discharge at Pole Creek below Pole Creek Ranger Station, near Obsidian (13292380), upper Salmon River Basin, Idaho, April 1 through September 30, 2004.

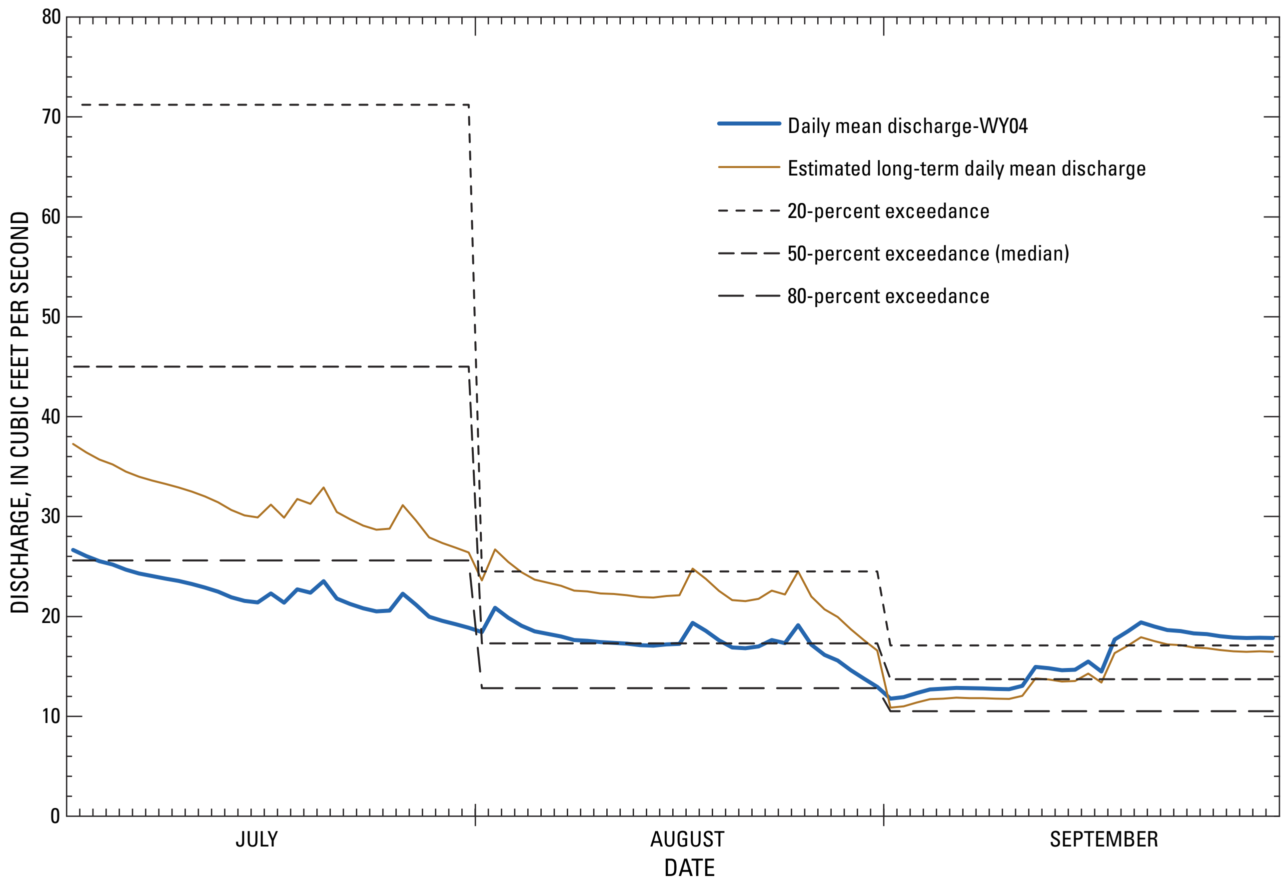

Figure 13. Daily mean discharge for water year 2004, estimated long-term daily mean discharge and estimated 80-, 50-, and 20-percent exceedance statistics at Pole Creek below Pole Creek Ranger Station, near Obsidian (13292380), upper Salmon River Basin, Idaho, July 1 through September 30.

Table 7. Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Pole Creek below Pole Creek Ranger Station, near Obsidian (13292380), Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Estimated long term:** Based on comparisons between water year 2004 and long-term monthly mean discharges at Valley Creek at Stanley (13295000)]

	July			August			September		
	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20
Water year 2004	20.8	22.3	24.0	16.9	17.4	18.5	12.7	14.9	18.2
Estimated long term	29.1	31.2	33.6	21.6	22.2	23.7	11.8	13.7	16.8
Regional regression equations									
Upper confidence limit	39.6	65.1	99.3	21.8	27.4	36.7	18.4	19.9	24.1
Estimate	25.6	45.0	71.2	12.8	17.3	24.5	10.5	13.7	17.1
Lower confidence limit	16.6	31.1	51.0	7.50	10.9	16.4	6.00	9.43	12.1

location (table 7). Comparison between estimated long-term daily mean discharge values and values calculated on the basis of the regression equations can provide some insight as to the applicability of the regression equations for Pole Creek.

Although seepage analyses were not within the scope of this project, instantaneous discharge measurements provide some indication of streamflow lost to ground water and diverted at specific times during the study period. A summary of all discharge measured in Pole Creek during the study period is presented in table 8.

Habitat Modeling and Passage Criteria

Lower Pole Creek (PC1) discharges required for maximum WUA were 9 to 19 ft^3/s for bull trout, 27 to 29 ft^3/s for Chinook salmon, and 27 to 29 ft^3/s for steelhead trout adult and spawning life stages (table 9). Discharges required for passage over three shallow riffle habitat transects ranged from 15 to 31 ft^3/s and 11 to 25 ft^3/s for the 0.6 ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively (see transects 1, 3, and 5 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix C provides more information summarizing these study results. Scott and others (1981), using a passage criteria similar to that used in this study, estimated that a discharge of 23 ft^3/s would provide passage for Chinook salmon in Pole Creek.

Pole Creek no longer sustains runs of anadromous fish. According to Munther (1974), the lack of anadromous stocks in Pole Creek could be attributable to historical dewatering of the lower 2.5 mi of this stream. During his 1973 study, Munther noted that streamflows upstream of all diversions in Pole Creek stabilized at about 20 ft^3/s; however, at the mouth downstream of all diversions, flow was reduced to less than 1 ft^3/s from June 15 through at least mid-September. According to Scott and others (1981), Pole Creek is considered the highest quality fishery habitat within the SNRA and has great potential to accommodate spawning of anadromous fish. However, this potential may be realized only if additional summer flows are provided to allow passage out of the Salmon River into spawning areas.

Median discharge (Q.50) estimates, based on regression equations, were 34.7 ft^3/s for July, 16.3 ft^3/s for August, and 13.4 ft^3/s for September. The mean annual discharge estimate was 42.9 ft^3/s (table 9).

Table 8. Summary of instantaneous and mean daily discharge for Pole Creek, upper Salmon River Basin, Idaho, water year 2004.

[Site locations shown in figure 1. **Discharge:** Values presented in cubic feet per second; mean daily discharge values are underlined]

Date	Discharge	
	PCG	PC1
05-20-04	<u>22.9</u>	17.8
05-26-04	<u>23.0</u>	15.7
06-23-04	<u>27.1</u>	11.6
07-14-04	<u>21.5</u>	6.55
08-10-04	<u>17.4</u>	4.98
08-16-04	<u>17.3</u>	5.65

Table 9. Summary of habitat and hydrologic measurements for lower Pole Creek (PC1), upper Salmon River Basin, Idaho, 2004.

[Values presented in cubic feet per second. **Discharge passage criteria:** Passage criteria taken from Thompson (1972) and Scott and others (1981); both width criteria must be met to ensure passage. **Discharge estimates:** Based on regional regression equations using basin and climatic characteristics (Hortness and Berenbrock, 2001); Q.xx, daily discharge exceeded xx percent of the time during the specified month; Qa, mean annual discharge. **Abbreviations:** WUA, weighted usable area; WUA optimum discharge estimates were based on PHABSIM (Physical Habitat Simulation) model output; ND, not determined]

Lifestage	Discharge required for maximum WUA			Discharge required for adult salmonid passage 0.6 foot depth criterion — Channel width		Discharge estimates									
						July			August			September			
	Bull trout	Chinook salmon	Steelhead trout	Greater than 25 percent (total)	Greater than 10 percent (contiguous)	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Qa
Adult	9	27	27	[1]18, 31, 15	[1]11, 25, 11	23.5	34.7	65.3	11.9	16.3	23.1	10.1	13.4	16.9	42.9
Spawning	19	29	29	ND	ND										

[1]Represents measurements at three transects.

Stream Temperature

Temperature recording data loggers were deployed at PCG and PC1 in early June 2004 (fig. 4). Data loggers were retrieved in late September 2004. After downloading and reviewing the data, June 9 through September 30 (114 days) was selected as the period of record for calculating stream temperature metrics.

Analysis of the stream temperature records for Pole Creek indicated an obvious warming trend downstream of PCG to PC1 (fig. 14). The difference in MDMT between PCG and PC1 on any given day was greater than 3.0ºC, 57 percent (65 of 114 days) of the time; the maximum difference in MDMT was 5.9ºC on June 22 and August 2, 2004. This warming trend likely is due to a combination of factors, including natural heat flux, lack of riparian shading along most of Pole Creek, and diversion of streamflow for irrigation.

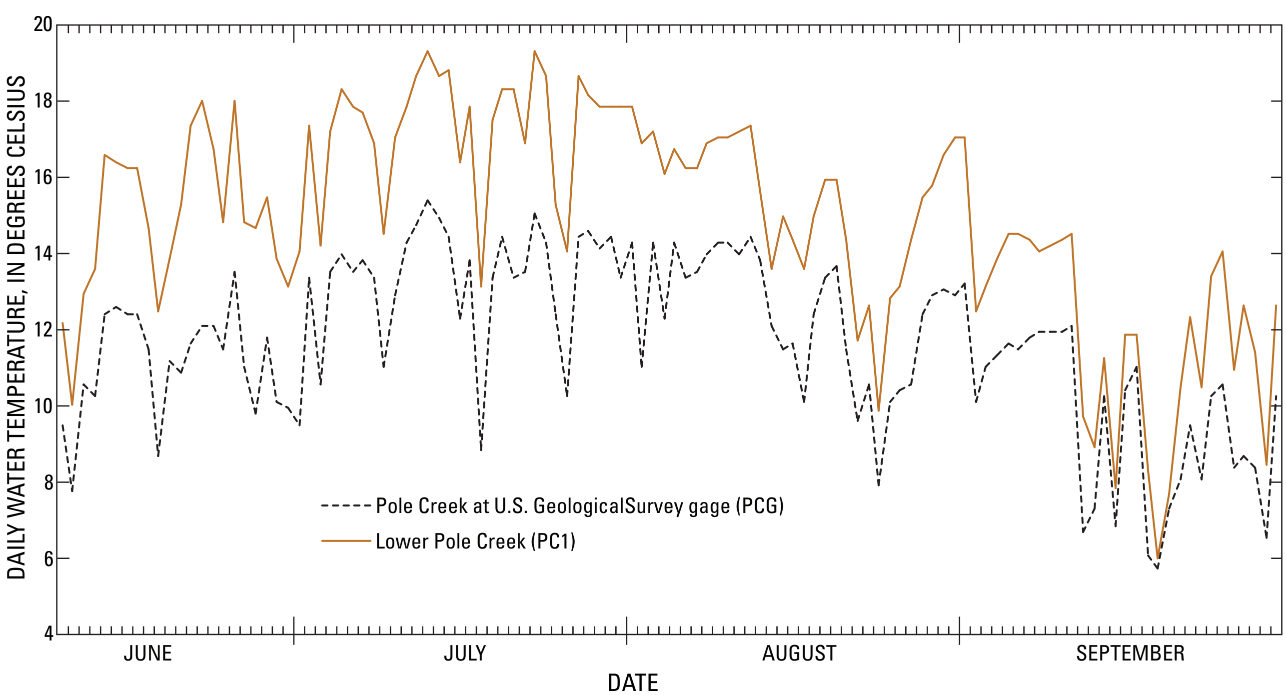

Figure 14. Maximum daily water temperature at Pole Creek, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

Individual metric calculation results showed that the MDAT was 10.2ºC at PCG and 14.0ºC at PC1, well below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

The MDMT was 15.4ºC at PCG and 19.3ºC at PC1; above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004). The MDMT at both sites was below the 21.0ºC threshold that, according to Poole and others (2001), can create a thermal barrier that can possibly block adult Chinook salmon from migrating to their spawning grounds.

Both Pole Creek sites had temperature regimes that were below the 19.0ºC MDAT and 22.0ºC MDMT IDEQ criteria for the protection of coldwater biota (applicable June 22 through September 21). A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Champion Creek

Champion Creek is a westerly flowing tributary to the Salmon River and is about 20 mi downstream of the Salmon River headwaters (fig. 1). Champion Creek originates in the White Cloud Peaks on the east side of the Sawtooth Valley. The Champion Creek Basin covers 17.1 mi^2, of which about 74 percent is forest. Mean elevation in the basin is about 8,580 ft above sea level and the basin receives an average of about 33 in/yr of precipitation.

Hydrology

No continuous record streamflow data were recorded on Champion Creek during the study period. Instantaneous discharge measurements were made at the lower Champion Creek study site (CC1) (fig. 15) several times during WY04. Data from these instantaneous discharge measurements are presented in table 10. Instantaneous discharges were affected by at least three irrigation diversions that were active upstream of CC1 during WY04 (Mark Moulton, U.S. Forest Service, written commun., 2004).

Because of the similarities in size and other characteristics of the Champion Creek and Fourth of July Creek basins (17.1 and 18.1 mi^2, respectively) and their proximity, it may be possible to make some inferences as to the characteristics of streamflow in Champion Creek based on information from Fourth of July Creek. For comparison, instantaneous measurement data from two sites on Fourth of July Creek (Fourth of July Creek above diversions, near Obsidian (13293350; JCG) and Fourth of July Creek at Highway 75 (13294880); JCHWY75) also are presented in table 10. However, since both CC1 and JCHWY75 were affected by irrigation withdrawals of unknown magnitudes, the usefulness of these data may be limited. JCG is above all diversions and may provide some information on natural flow conditions in the Champion Creek Basin.

Comparisons of estimated streamflow statistics based on regional regression equations (Hortness and Berenbrock, 2001) for August and September 2004, and the mean annual discharge show that Champion Creek may be expected to produce streamflows in the range of about 10 to 20 percent lower than those in Fourth of July Creek during base-flow conditions. This is a rough estimate, however, since actual comparison measurements of streamflow unaffected by irrigation diversions are not available.

Table 10. Comparisons of instantaneous and mean daily discharge for Champion and Fourth of July Creeks, upper Salmon River Basin, Idaho, water year 2004.

[Site locations shown in figure 1. **Discharge:** Values presented in cubic feet per second; daily mean discharge values are underlined]

Date	Discharge		
	CC1	JCG	JCHWY75
05-24-04	6.19	<u>15.0</u>	[1]<u>11.9</u>
05-26-04	5.98	14.5	8.89
06-23-04	3.66	26.4	13.8
07-14-04	2.53	12.5	3.48
08-09-04	1.89	<u>5.88</u>	[1]<u>2.50</u>
08-17-04	7.08	6.04	2.35
10-05-04	8.15	4.39	5.10

[1]Data from Idaho Power Company.

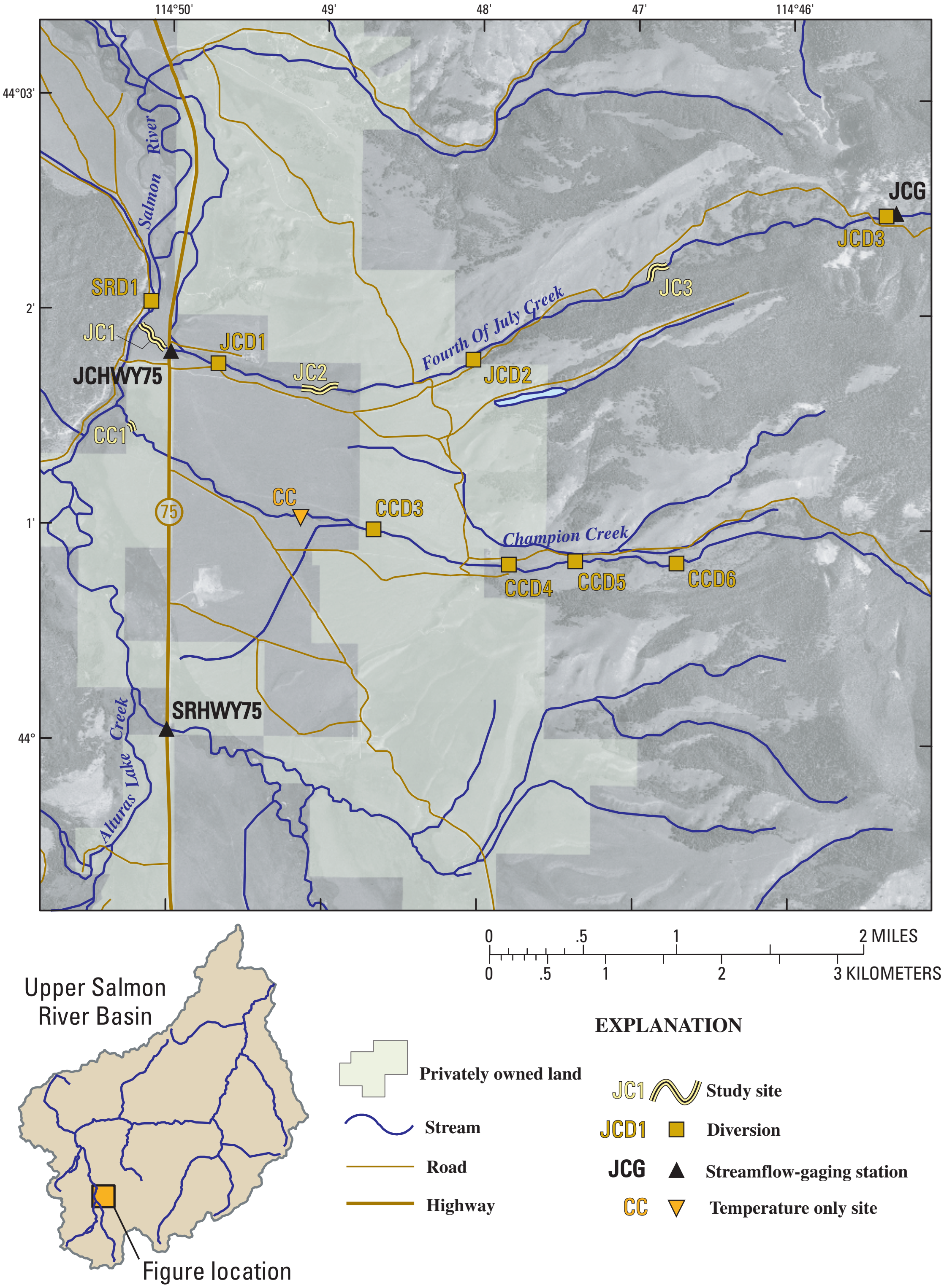

Figure 15. Location of study sites on Champion and Fourth of July Creeks and Salmon River, diversions, streamflow-gaging stations, and temperature monitoring locations, upper Salmon River Basin, Idaho, 2003-04.

Habitat Modeling and Passage Criteria

Lower Champion Creek (CC1) discharges required for maximum WUA were 3 ft^3/s for bull trout, 12 ft^3/s for Chinook salmon, 12 ft^3/s for steelhead trout adult life stages, and 12 ft^3/s for all spawning life stages (table 11). The unusually low WUA of 3 ft^3/s for adult bull trout likely is from difficulties calibrating velocities in the model. The combination of low calibration discharges (1.9 and 6.2 ft^3/s) and irregular channel bottoms resulted in unusually high and erratic calibration velocities, which proved to be difficult to model. Because the Champion Creek Basin is similar in size and proximity to Fourth of July Creek Basin, a more accurate measure of adult bull trout maximum WUA may be 12 ft^3/s determined by Maret and others (2004) on lower Fourth of July Creek. Discharges required for passage over three shallow riffle habitat transects ranged from 18 to 24 ft^3/s and 12 to 21 ft^3/s for the 0.6 ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively (see transects 3, 4, and 5 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Scott and others (1981) estimated 11 ft^3/s would provide marginal passage for anadromous adult fish in Champion Creek. Appendix D provides more information summarizing these study results.

Median discharge (Q.50) estimates, based on regression equations, were 36.8 ft^3/s for July, 16.7 ft^3/s for August, and 13.1 ft^3/s for September. The mean annual discharge estimate is 42.1 ft^3/s (table 11).

Stream Temperature

Temperature recording data loggers were deployed at CC and CC1 in early June 2004 (fig. 15). Study site CC is below at least three known diversions. Lack of permission to access private property prevented the deployment of a data logger upstream of all diversions. Both data loggers were retrieved in late September 2004. After downloading and reviewing the data, June 9 through September 30 (114 days) was selected as the period of record for calculating stream temperature metrics.

The difference in MDMT between CC and CC1 on any given day was greater than 3.0ºC, 83 percent (95 of 114 days) of the time with the maximum difference of 6.9ºC on June 21, 2004 (fig. 16). The obvious warming trend downstream of CC to CC1 likely is due to a combination of factors including the natural heat flux, lack of riparian shading along the stream banks, and streamflow diversions for irrigation.

Table 11. Summary of habitat and hydrologic measurements for lower Champion Creek (CC1), upper Salmon River Basin, Idaho, 2004.

[Values presented in cubic feet per second. **Discharge passage criteria:** Passage criteria taken from Thompson (1972) and Scott and others (1981); both width criteria must be met to ensure passage. **Statistical discharge:** Discharge statistics derived from regional regression equations using basin and climatic characteristics (Hortness and Berenbrock, 2001); Q.xx, daily discharge exceeded xx percent of the time during the specified month; Qa, mean annual discharge ;.**Abbreviations:** WUA, weighted usable area; WUA optimum discharge estimates were based on PHABSIM (Physical Habitat Simulation) model output; ND, not determined]

Lifestage	Discharge required for maximum WUA			Discharge required for adult salmonid passage using 0.6-foot depth criterion: Channel width		Discharge estimates									
						July			August			September			
	Bull trout	Chinook salmon	Steelhead trout	Greater than 25 percent (total)	Greater than 10 percent (contiguous)	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Qa
Adult	[1]3	12	12	[2]18, 18, 24	[2]12, 18, 21	25.0	36.8	69.9	12.3	16.7	23.7	10.1	13.1	16.5	42.1
Spawning	12	12	12	ND	ND										

[1]Not accurate due to problems with velocity calibration (see explanation in text).

[2]Represents measurements at three transects.

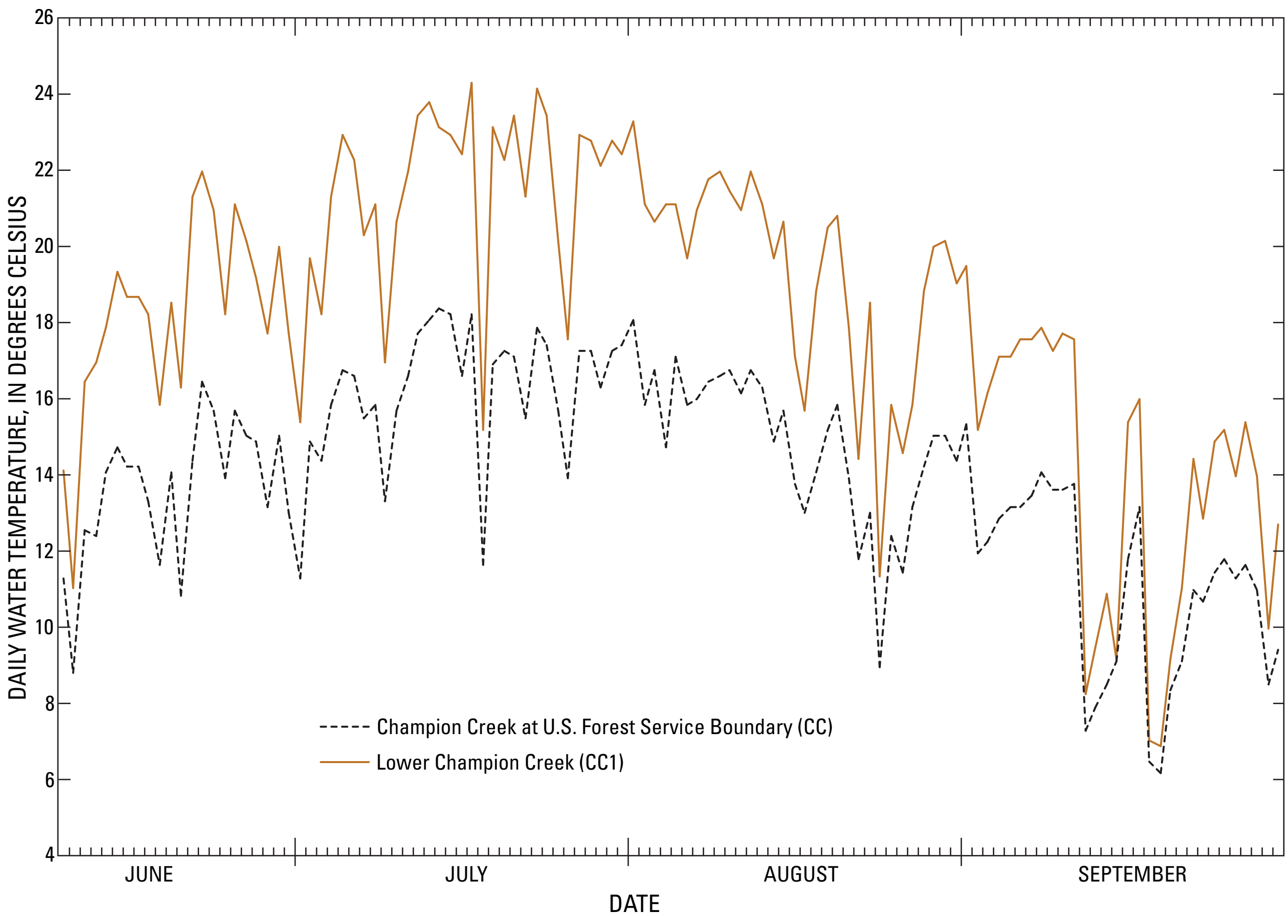

Figure 16. Maximum daily water temperature at Champion Creek, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

Individual metric calculation results showed that the MDAT was 12.2ºC at CC and 15.3ºC at CC1, well below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

The MDMT was 18.4ºC at CC and 24.3ºC at CC1, above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004). The MDMT exceeded 18.0ºC, 4 percent (5 of 114 days) of the time at CC, and 56 percent (64 of 114 days) of the time at CC1. The MDMT at CC1 also was above the 21.0ºC threshold that, according to Poole and others (2001), can create a thermal barrier that can possibly block adult Chinook salmon from migrating to their spawning grounds. The MDMT at CC1 exceeded 21.0ºC 30 percent (34 days of 114 days) of the time.

Comparison of temperature regimes at both CC and CC1 to the IDEQ criteria of 19.0ºC MDAT and 22.0ºC MDMT for the protection of coldwater biota (applicable from June 22 through September 21), indicates that the MDAT was below the 19.0ºC criterion at both sites and the MDMT at CC was below while the MDMT at CC1 was above the 22.0ºC MDMT criterion. A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Fourth of July Creek

Fourth of July Creek is a westerly flowing tributary to the Salmon River and is about 20 mi downstream of the Salmon River headwaters (fig. 1). Fourth of July Creek originates in the White Cloud Peaks on the east side of the Sawtooth Valley. The Fourth of July Creek Basin covers 18.1 mi^2, of which about 67 percent is forest. Mean elevation in the basin is about 8,730 ft above sea level and the basin receives an average of about 31 in/yr of precipitation.

Stream Temperature

Temperature recording data loggers were deployed at JCG and JCHWY75 in early June 2004 (fig. 15). Both data loggers were retrieved in late September 2004. After downloading and reviewing the data, June 9 through September 30 (114 days) was selected as the period of record for calculating stream temperature metrics.

Analysis of the stream temperature metrics for Fourth of July Creek shows an obvious warming trend downstream of JCG to JCHWY75 (fig. 17). The difference in MDMT between JCG and JCHWY75 was greater than 3.0ºC, 54 percent (62 of 114 days) of the time; the maximum difference in MDMT was 5.7ºC on August 25, 2004. This warming trend likely is due to a combination of factors, including the natural heating from increased exposure once the stream leaves the forested highlands and enters the valley floor and the streamflow diversion for irrigation. Figure 18 shows the daily mean discharges at JCG and JCHWY75. Each year, a large amount of streamflow is diverted for irrigation during the growing season likely resulting in increased water temperatures at the lower end of Fourth of July Creek.

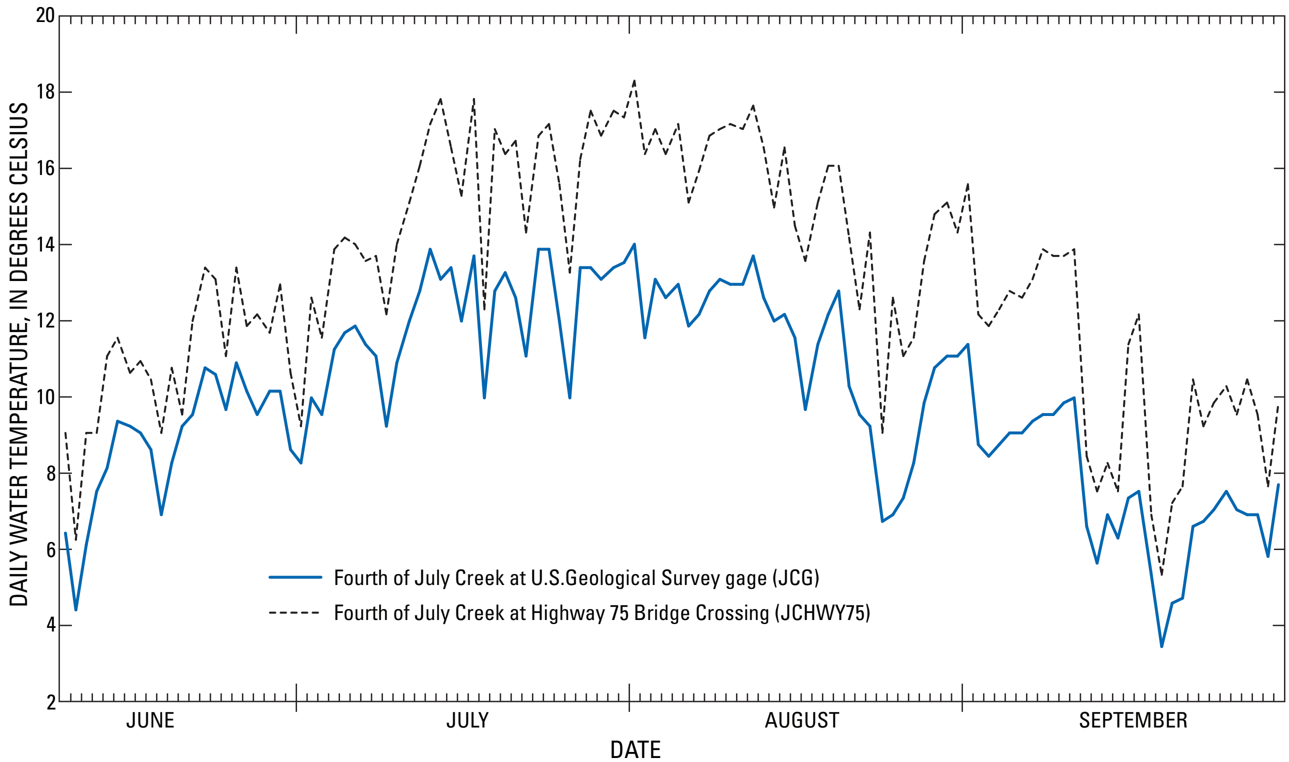

Figure 17. Maximum daily water temperature at Fourth of July Creek, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

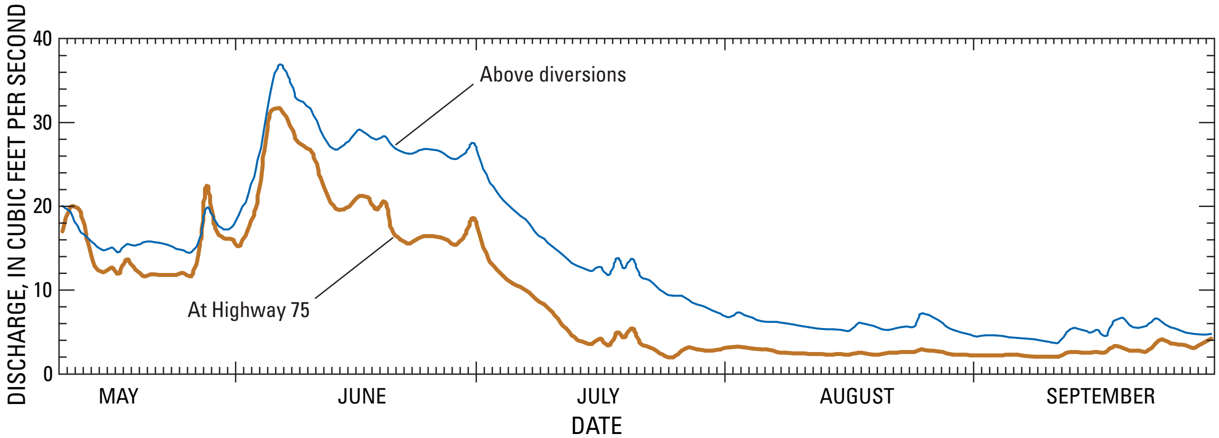

Figure 18. Daily mean discharges at Fourth of July Creek above diversions, near Obsidian (13293350), and Fourth of July Creek at Highway 75 bridge, near Obsidian (Idaho Power Company), upper Salmon River Basin, Idaho, May 10 through September 30, 2004.

Large increases in water temperature in the lower end of Fourth of July Creek are not uncommon. In 2001, the USFS measured stream temperatures increases of about 10ºC over about 1 mi, between the Forest Service boundary and the mouth of Fourth of July Creek (M. Moulton, U.S. Forest Service, written commun., 2003). In 2003, Maret and others (2004) measured stream temperature increases of about 9.0ºC (MDMT) in the same reach between the Forest Service boundary and the mouth of Fourth of July Creek.

Individual metric calculation results showed that the MDAT was 10.3ºC at JCG and 12.8ºC at JCHWY75, well below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

The MDMT was 14.0ºC at JCG and 18.3ºC at JCHWY75, slightly above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004). The MDMT at both sites were below the 21.0ºC threshold that, according to Poole and others (2001), can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds.

All Fourth of July Creek sites had temperature regimes that were below the 19.0ºC MDAT and 22.0ºC MDMT IDEQ criteria for the protection of coldwater biota (applicable June 22 through September 21). A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Description of Stream Temperature Model

To assess the effects of diversions on stream temperature in Fourth of July Creek, a SSTEMP model was developed using data collected on July 31, 2003 over about a 5-mi study reach extending from JCG to JCHWY75 (fig. 15). The model was calibrated to match measured stream temperatures in Fourth of July Creek and then used to evaluate the effects of diversions on stream temperature in the study reach.

Model Setup

Hydrologic data required by the model consist of discharge or flow data throughout the stream system, an initial stream temperature at the top of the stream segment, as well as accretion temperatures. Daily mean discharge at the USGS streamflow-gaging station (JCG) above the diversions on July 31, 2003, was 8.0 ft^3/s. Instantaneous streamflow measurements made on the same day at the three diversions on Fourth of July Creek were 4.1 ft^3/s at JCD3, 2.6 ft^3/s at JCD2, and 3.6 ft^3/s at JCD1. Streamflow at the study reach outlet was estimated at 4.0 ft^3/s based on an instantaneous measurement of 4.8 ft^3/s made July 16, 2003, an instantaneous measurement of 3.2 ft^3/s made August 27, 2003, and a receding hydrograph at JCG during this time. An approximate net gain of 6.3 ft^3/s was determined for the study reach.

Water temperature data were collected to characterize the surface and ground water temperature regimes in the study reach. Stream temperature data were necessary for input to the temperature model and also to assist with model calibration. Ground water temperature data were needed to characterize the thermal regime of lateral (ungaged) inflow to the study reach.

Stream temperatures were measured at four study sites on Fourth of July Creek from June 25 to September 28, 2003. These sites included JCG, and at the 2003 PHABSIM study sites JC3, JC2, and JC1 (fig. 15). Stream temperature at JCG was used for input to the model. Stream temperatures from JC3, JC2, and JC1 were used to calibrate the model.

As no appreciable surface water inputs are in the study reach, change in stream temperature due to lateral inflow was assumed to be caused by ground-water inputs. Accretion temperature was assumed to be the same as the ground water temperature in the area. Data from USGS monitoring wells near Stanley, Idaho indicate ground water temperature in July is about 7.5ºC (Brennan and others, 2003).

Meteorological data required by the model include air temperature, relative humidity, wind speed, ground temperature, thermal gradient, possible sun, a dust coefficient, and local ground reflectivity. Air temperature, relative humidity, and wind speed were derived from data collected at a meteorological station at the U.S. Forest Service Ranger Station (SRS) near Stanley, Idaho, downstream of the study reach (Western Regional Climate Center, 2005). Air temperatures were corrected for differences in elevation between the meteorological station at SRS and the study reach using the moist air lapse rate of 0.00656ºC per 1-m rise in elevation.

According to Bartholow (2002), ground temperatures approximate mean annual air temperatures. The mean annual air temperature at SRS is 1.8ºC (Western Regional Climate Center, 2005), so a ground temperature default value of 1.8ºC was used for input into the model. Values for thermal gradient, dust coefficient, and ground reflectivity all were derived from Bartholow (2002). A default value of 1.65 Joules/Meter^2/Second/ºC was used for thermal gradient, and a value of 5 (low dust) was used for the dust coefficient. Ground reflectivity input values varied from 5 (dark pine needle forest) in the upper section of the study reach to 10 (sand and sagebrush) in the lower section of the study reach. Possible sun, an indirect and inverse measure of cloud cover, was estimated at 95 percent based on field observations on July 31, 2003.

Stream geometry information needed for input into the model include stream latitude, stream elevation, the ratio of wetted stream-width to discharge, and channel roughness. Stream latitude and elevation were derived from USGS 1:24,000 scale topographic maps. The wetted stream-width to discharge ratio was derived through regression analysis from instantaneous discharge measurements made at various points throughout the study reach during 2003 (Maret and others, 2004). Width’s A term (the untransformed Y-intercept) values ranged 6.8 to 9.0. Width’s B term (the slope) values ranged from 0.32 to 0.34.

Manning’s *n*, or channel roughness, and total shade, or the amount of stream segment shaded by vegetation, cliffs, etc., were used as model calibration factors.

Model Structure

The study reach on Fourth of July Creek between JCG and JCHWY75 was divided into seven segments. Segment division was designed primarily to bracket the diversions and account for streamflow being withdrawn at these locations. One segment was used to define the part of Fourth of July Creek unaffected by diversions from JCG downstream to diversion JCD3. Three segments were used to bracket the diversions (JCD3, JCD2, and JCD1). The remaining three segments were used to define areas of the stream directly downstream of a diversion.

Although SSTEMP was designed to process a single stream segment in a single time step the model can be used to process multiple stream segments or multiple dates for the same stream segment. This is done by linking the segments together in an external file, which then is input to and processed by the model (Bartholow, 2002). This allows the user to bracket important hydrologic features such as tributaries or diversions and account for large changes in streamflow and to account for obvious changes in stream morphology.

Model Calibration

The SSTEMP model developed for Fourth of July Creek was calibrated to match the predicted stream temperatures with observed stream temperatures on July 31, 2003. The SSTEMP model typically is calibrated by adjusting one or more variables such as accretion temperature, wind speed, possible sun, Manning's *n*, or shade (Bartholow, 2002) until the predicted stream temperatures match, as closely as possible, the measured stream temperatures. The SSTEMP model for Fourth of July Creek was first calibrated by apportioning streamflow gains and then by adjusting total shade and Manning's *n*. Streamflow and diversion flow measurements made on July 31, 2003, indicated that the study reach had a net gain of about 6.3 ft^3/s. Measurements were not made at locations within the study reach that would define gaining segments. However, based on visual observations of spring inputs between JCD3 and JCD2, it was assumed that this was receiving ground-water input and was most likely a gaining segment.

Initial calibrations to the model were made by apportioning the 6.3 ft^3/s net gain across the segments below each diversion, with a larger part of the gain applied to the segment below JCD3, until stream temperatures were close to the measured temperatures. Through trial-and-error, a good match between predicted and measured stream temperatures was obtained by apportioning 5.3 ft^3/s of the gain to the segment below JCD3 and 1.0 ft^3/s to the segment below JCD2.

Next, calibrations to the model were made by slightly adjusting the shade variable for each of the segments until the predicted mean stream temperatures matched the measured mean stream temperatures to within 0.10ºC.

Final model calibrations were made by adjusting Manning's *n* until the predicted maximum stream temperatures matched the measured maximum stream temperatures to within 0.10ºC. Manning's *n* only affects simulations of maximum temperature in the SSTEMP model. Calibration results are shown in figure 19. There generally is good agreement between the measured daily mean and maximum stream temperatures and the simulated daily mean and maximum stream temperatures within the study reach.

Evaluating the Effects of Diversions on Stream Temperature

Once calibrated, the model then was used to evaluate the effects of diversions on stream temperature on July 31, 2003. This was done by negating the loss of streamflow in those segments bracketing diversions. At these segments, the streamflow that was actually being diverted for irrigation was allowed to enter the next downstream segment as if no diversion was present. All other variables remained the same. Results of the evaluation are shown in figure 19.

From the evaluation, two key observations can be made regarding the effect of diversions on stream temperatures in Fourth of July Creek on July 31, 2003. First, the cumulative effect of the three diversions on stream temperature at the lower end of the study reach (mile 5) appears to be an increase in the mean daily temperature of about 1.0ºC and an increase in the maximum daily temperature of about 3.0ºC (fig. 19). This does not appear to be much of an increase given that on this day the diversions were removing about 72 percent (10.3 of 14.3 ft^3/s) of the total streamflow. However, the less than expected increase in stream temperature is probably a result of the large influx of cold ground water in the upper part the study reach.

Second, ground-water accretion appears to play an important role in moderating the effects of diversions on stream temperatures in Fourth of July Creek. Ground-water accretion accounted for about 44 percent (6.3 of 14.3 ft^3/s) of the total flow measured at the lower end of the study reach on July 31, 2003. This cold ground water (7.5ºC), when mixed with the small volume of warmer surface water remaining in the stream channel, appears to result in cooler surface water and consequently lower stream temperatures throughout most of the study reach than expected. The inverse of this may explain why observed mean daily temperatures were lower than predicted mean daily temperatures at mile 2.8 (fig. 19). When the model was run allowing streamflow normally diverted for irrigation to enter the next downstream segment, the influx of ground water did not have as much effect on the larger volume of surface water in the channel, thus keeping stream temperatures from decreasing as much as those temperatures observed.

Future modeling efforts would likely be improved by additional discharge measurements to more accurately assess the locations and quantity of ground water input to Fourth of July Creek within the study reach. Model results may be different if developed for a different time with different hydrologic and climatologic conditions.

Iron Creek

Iron Creek is in the northwest part of the upper Salmon River Basin about 2 mi west of Stanley, Idaho. Iron Creek is a tributary to Valley Creek and its headwaters originate in the upper elevations of the Sawtooth Range (fig. 1). The Iron Creek Basin covers 7.7 mi^2, of which about 54 percent is forest. Mean elevation in the basin is about 7,820 ft above sea level and the basin receives an average of 30 in/yr of precipitation. The lower part of Iron Creek is split into two channels (fig. 20). A study site was selected on the larger north channel (IC1) to model fish habitat and passage requirements. Only miscellaneous discharge measurements were taken on the south channel (IC).

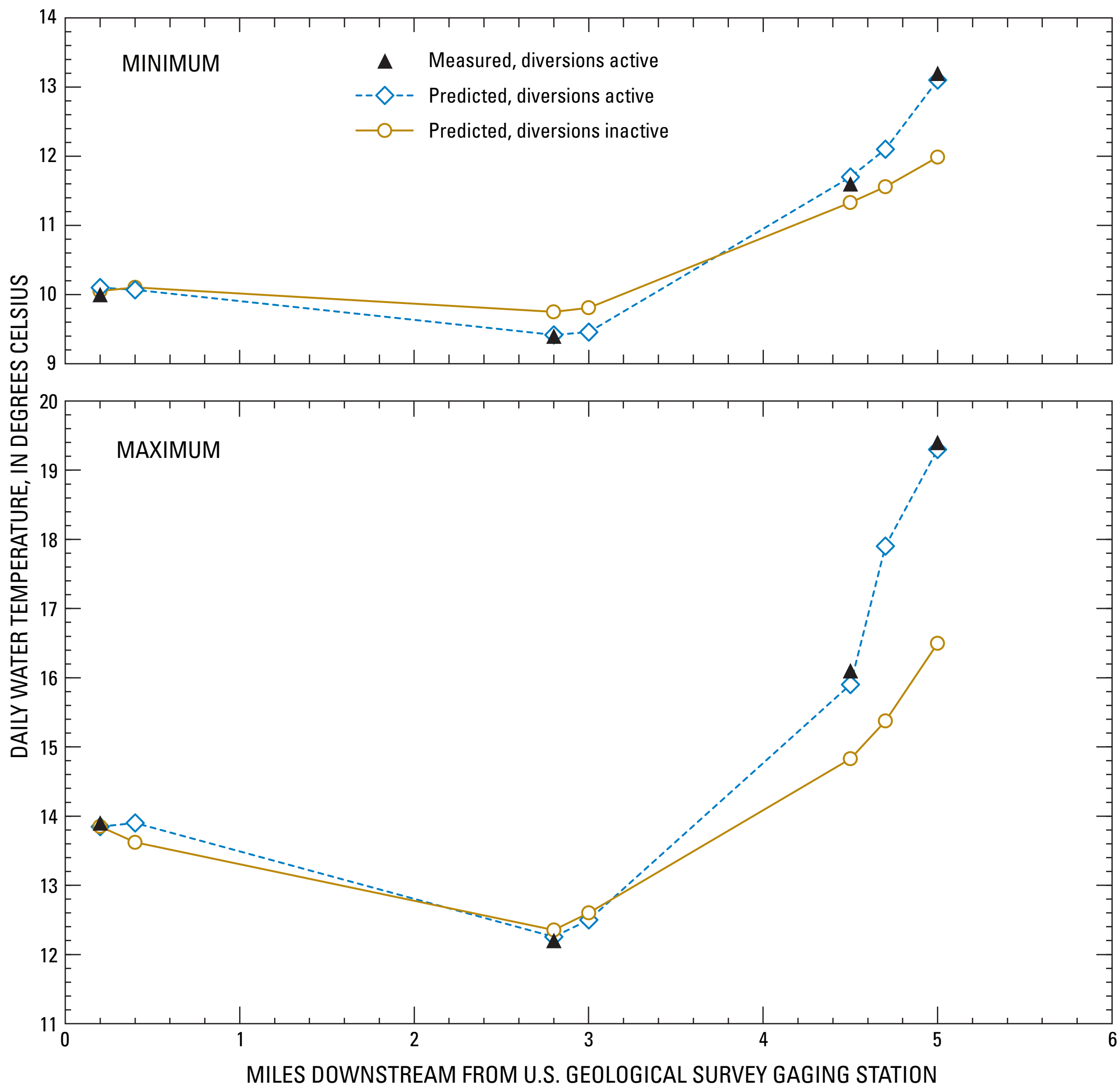

Figure 19. Comparison of measured stream temperatures with predicted stream temperatures at Fourth of July Creek, upper Salmon River Basin, Idaho, July 31, 2003.

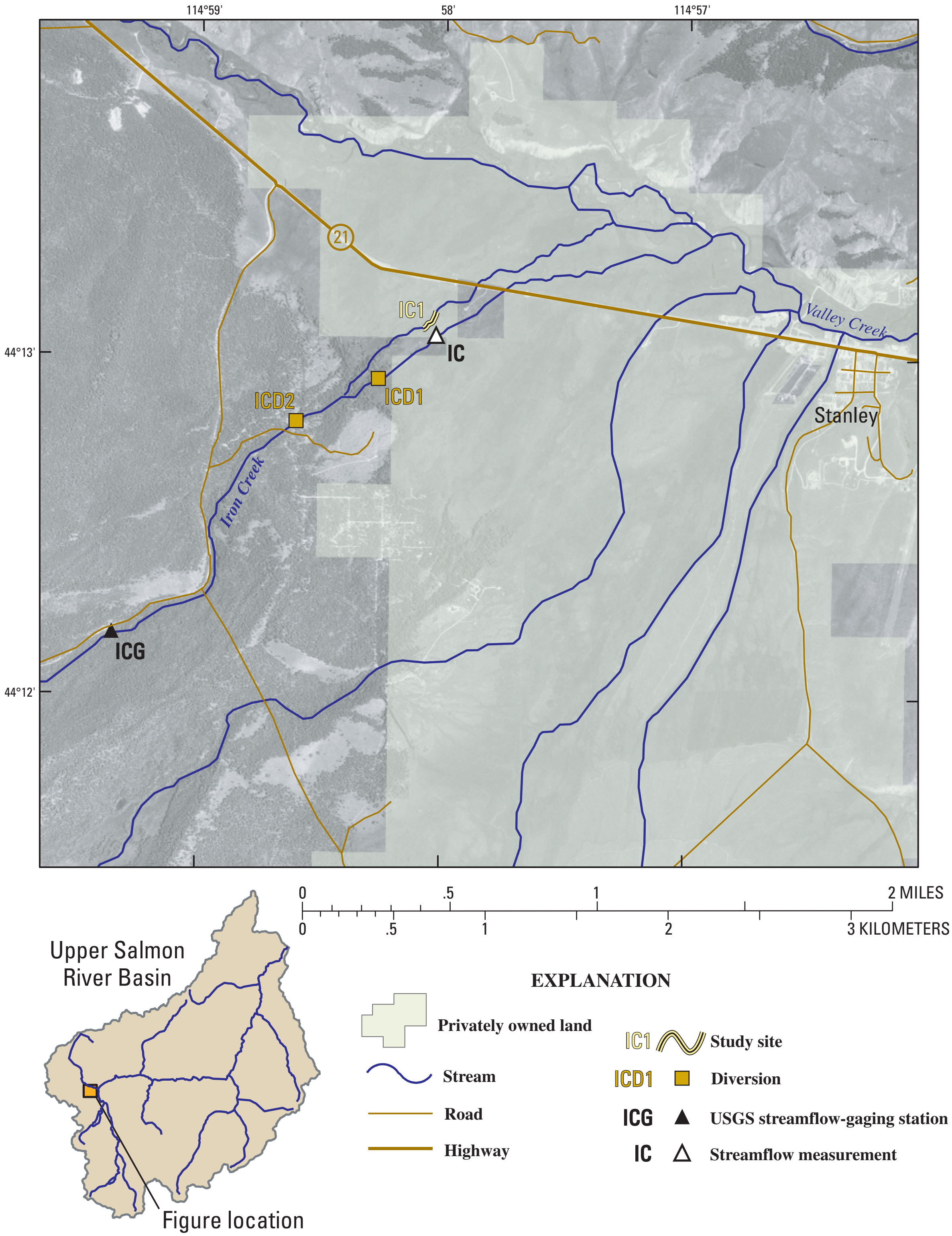

Figure 20. Location of study sites on Iron Creek, diversions, and streamflow-gaging stations, upper Salmon River Basin, Idaho, 2004.

Hydrology

A short-term streamflow-gaging station (13294880; ICG) was installed and operated on upper Iron Creek from April 1 through September 30, 2004. This gaging station was upstream of all active diversions and about 2.5 mi upstream of the confluence with Valley Creek (fig. 20). A plot of the continuous daily mean discharge in upper Iron Creek upstream of the diversions during WY04 is presented in figure 21, along with markers indicating when field data were collected at study site IC1, which was about 1 mi upstream of the mouth of Iron Creek.

Additional analyses were completed to relate streamflows in Iron Creek during WY04 to long-term mean streamfows. The same techniques used to estimate long-term streamflows for the upper Salmon River (long-term data comparisons from Valley Creek at Stanley; 13295000) also were used for Iron Creek. The July, August, and September daily mean discharge hydrograph for ICG for WY04 and the estimated long-term daily mean discharge hydrograph are presented in figure 22. Estimated monthly streamflow exceedance statistics for the streamflow-gaging station based on regional regression equations developed by Hortness and Berenbrock (2001) also are presented in figure 22. Again, the median estimate gives an indication of long-term average streamflow conditions, and the other estimates provide an indication of the probable variation in streamflows at this location.

The 80-, 50-, and 20-percent monthly exceedance discharge values were estimated on the basis of WY04 daily mean discharge values and estimated long-term daily mean discharge values at ICG (table 12). Exceedance estimates, along with the confidence limits, also were derived from the regional regression equations (Hortness and Berenbrock, 2001) for this location (table 12). Comparison between the estimated long-term daily mean discharge values and values calculated on the basis of the regression equations can provide some insight as to the applicability of the regression equations for Iron Creek. As shown in figure 22, the regression estimates tend to be higher than the estimated long-term values, indicating that the equations, to some degree, could overestimate streamflow conditions in Iron Creek.

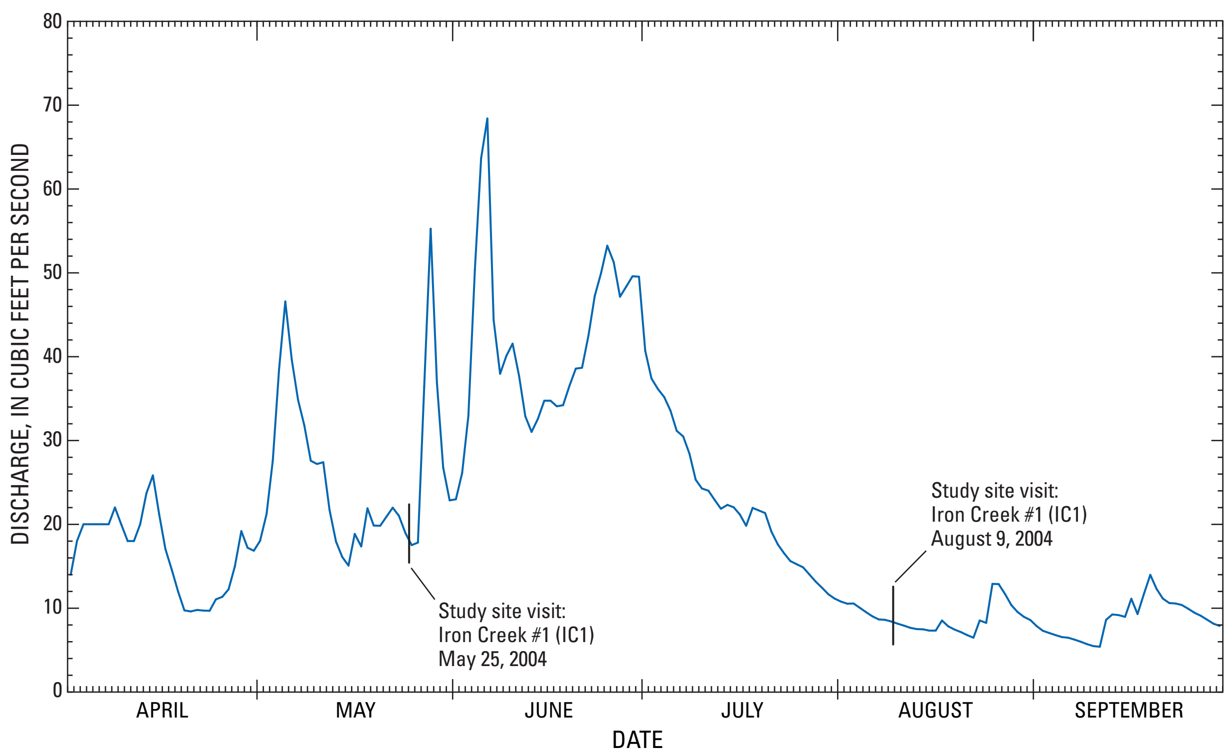

Figure 21. Daily mean discharge at Iron Creek above diversions, near Stanley (13294880), upper Salmon River Basin, Idaho, April 1 through September 30, 2004.

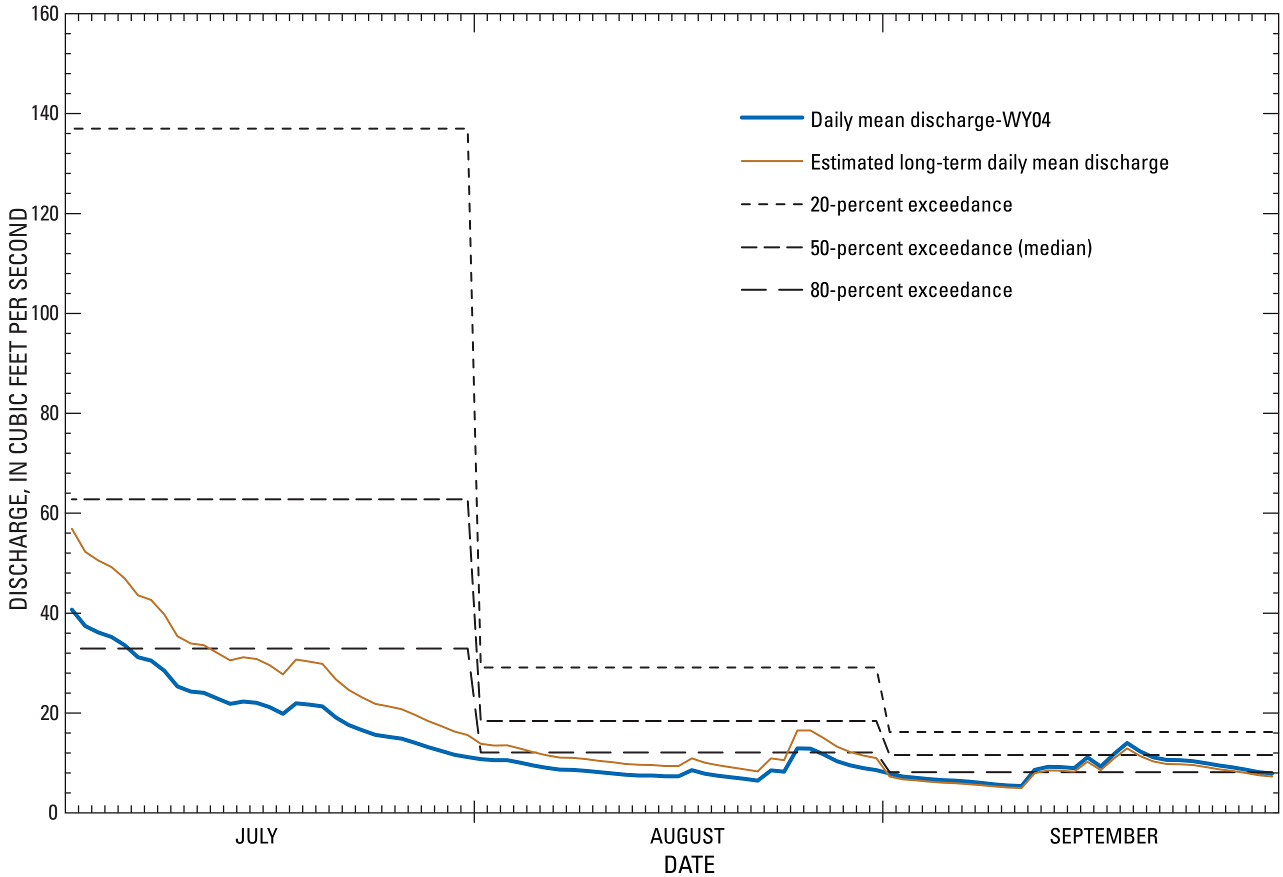

Figure 22. Daily mean discharge for water year 2004, estimated long-term daily mean discharge, and estimated 80-, 50-, and 20-percent exceedance statistics at Iron Creek above diversions, near Stanley (13294880), upper Salmon River Basin, Idaho, July 1 through September 30.

Table 12. Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Iron Creek above diversions, near Stanley (13294880), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Estimated long term:** Based on comparisons between water year 2004 and long-term monthly mean discharges at Valley Creek at Stanley (13295000)]

	July			August			September		
	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20
Water year 2004	15.2	21.9	30.5	7.5	8.5	10.4	6.5	8.8	10.6
Estimated long term	21.3	30.5	42.6	9.6	10.9	13.3	6.0	8.1	9.7
Regional regression equations									
Upper confidence limit	50.9	90.9	191.1	20.65	29.2	43.6	14.30	16.85	22.8
Estimate	32.9	62.8	137.0	12.1	18.4	29.1	8.2	11.6	16.2
Lower confidence limit	21.3	43.4	98.2	7.1	11.6	19.4	4.7	8.0	11.5

Although seepage analyses were not within the scope of this project, instantaneous discharge measurements provide some indication of streamflow lost to ground water and diverted at specific times during the study period. A summary of all discharge measured in Iron Creek during the study period is presented in table 13.

Table 13. Summary of instantaneous and mean daily discharge for Iron Creek, upper Salmon River Basin, Idaho, water year 2004.

[Site locations shown in figure 1. **Discharge:** Values presented in cubic feet per second; daily mean discharge values are underlined; **Abbreviations:** –, no data available]

Date	Discharge		
	ICG	IC1	IC
04-19-04	9.70	6.45	3.24
05-25-04	17.5	10.8	–
05-27-04	36.3	16.1	13.6
06-23-04	47.3	16.2	12.9
07-12-04	22.9	9.48	3.88
08-09-04	8.40	1.71	–
08-18-04	7.80	1.51	.73

Habitat Modeling and Passage Criteria

Lower Iron Creek, north channel (IC1) discharges required for maximum WUA were 4 to 16 ft^3/s for bull trout, 14 to 16 ft^3/s for Chinook salmon, and 14 to 16 ft^3/s for steelhead trout adult and spawning life stages (table 14). Discharges required for passage over three shallow riffle habitat transects ranged from 20 to >30 ft^3/s and 16 to >30 ft^3/s for the 0.6 ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively (see transects 2, 4, and 6 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix E provides more information summarizing these study results.

Median discharge (Q.50) estimates, based on regression equations, were 66.8 ft^3/s for July, 19.9 ft^3/s for August, 12.7 ft^3/s for September. The mean annual discharge estimate was 52.1 ft^3/s (table 14).

Stream Temperature

Temperature recording data loggers were deployed at ICG and IC1 in early June 2004 (fig. 20). Data loggers were retrieved in late September 2004. After the downloading and reviewing the data, June 9 through September 30 (114 days) was selected as the period of record for calculating stream temperature metrics.

Analysis of the stream temperature records for Iron Creek indicated that most of the time the difference in temperature between ICG to IC1 was only slightly higher than the measurement error associated with the temperature recording data logger (± 0.4) with no obvious trend in observed temperature (fig. 23). The difference in MDMT between ICG and IC1 on any given day was less than 0.5ºC, 93 percent (106 of 114 days) of the time; the maximum difference in MDMT was 1.7ºC on August 29, 2004.

Individual metric calculation results showed that the MDAT was 12.7ºC at ICG and 13.1ºC at IC1, well below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

The MDMT was 16.4ºC at ICG and 16.1ºC at IC1, below the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004) and well below the 21.0ºC threshold that, according to Poole and others (2001), can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds.

Both Iron Creek sites had temperature regimes that were below the 19.0ºC MDAT and 22.0ºC MDMT IDEQ criteria for the protection of coldwater biota (applicable June 22 through September 21). A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Table 14. Summary of habitat and hydrologic measurements for lower Iron Creek (IC1), upper Salmon River Basin, Idaho, 2004.

[Values presented in cubic feet per second. **Discharge passage criteria:** Passage criteria taken from Thompson (1972) and Scott and others (1981); both width criteria must be met to ensure passage; **Discharge estimates:** Based on regional regression equations using basin and climatic characteristics (Hortness and Berenbrock, 2001). Q.xx, daily discharge exceeded xx percent of the time during the specified month; Qa, mean annual discharge. **Abbreviations:** WUA, weighted usable area; WUA optimum discharge estimates were based on PHABSIM (Physical Habitat Simulation) model output; >, greater than; ND, not determined]

Lifestage	Discharge required for maximum WUA			Discharge required for adult salmonid passage 0.6-foot depth criterion: Channel width		Discharge estimates									
						July			August			September			
	Bull trout	Chinook salmon	Steelhead trout	Greater than 25 percent (total)	Greater than 10 percent (contiguous)	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Qa
Adult	4	14	14	[1]20, >30, 22	[1]16, >30, 22	35.4	66.8	144.0	13.2	19.9	31.2	19.1	12.7	17.6	52.1
Spawning	16	16	16	ND	ND										

[1]Represents measurements at three transects.

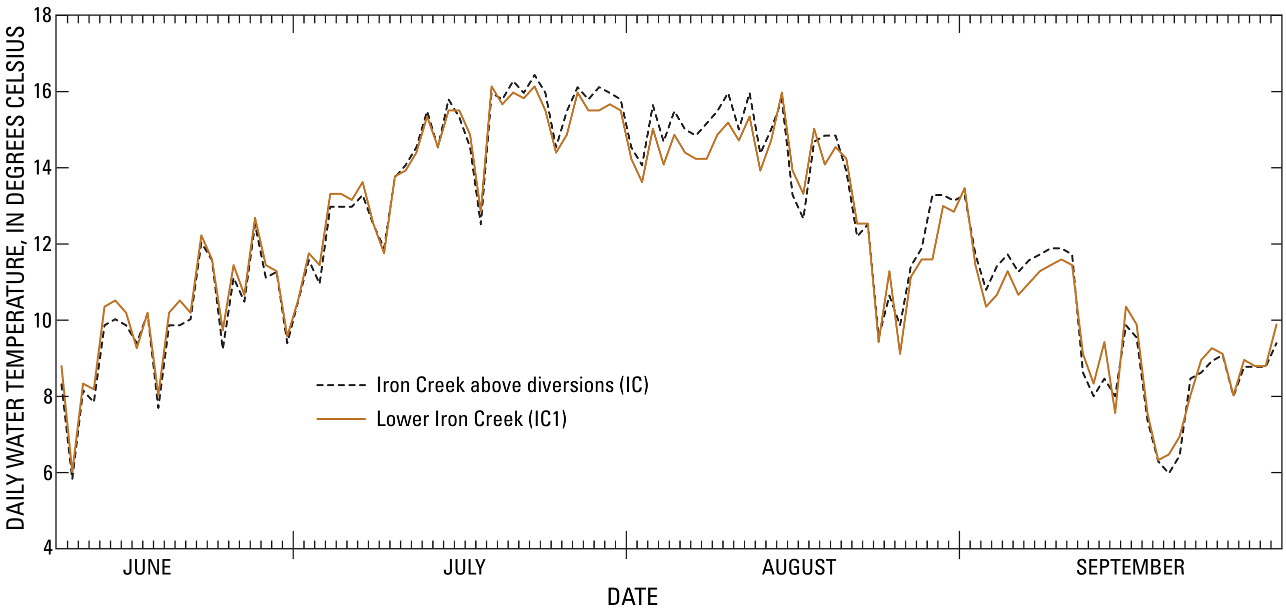

Figure 23. Maximum daily water temperature at Iron Creek, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

Thompson Creek

Thompson Creek is in the upper Salmon River Basin between Stanley and Challis, Idaho. Thompson Creek is a tributary to the Salmon River and its headwaters originate about 8 mi north of the Salmon River. (fig. 1). The Thompson Creek Basin covers 30.2 mi^2, of which about 69 percent is forest. Mean elevation in the basin is about 7,590 ft above sea level and the basin receives an average of 22.4 in/yr of precipitation. Recent biological sampling by Chadwick Ecological Consultants, Inc. (2004) indicated mining activities in the basin are having little or no effect on aquatic life in Thompson Creek. The data show water quality is suitable to support healthy invertebrate and fish populations.

Hydrology

The USGS has operated a long-term streamflow-gaging station (13297330; TCG) on Thompson Creek since November of 1972. This gaging station is upstream of the single active diversion on Thompson Creek, about 1.2 mi upstream of the confluence with the Salmon River (fig. 24). A plot of the continuous daily mean discharge at TCG during WY04 is presented in fig. 25, along with markers indicating when field data were collected at study site TC1, which was about 1 mi upstream of the mouth of Thompson Creek.

Additional analyses were completed to relate streamflows in Thompson Creek during WY04 to long-term mean streamflows. The July, August, and September daily mean discharge hydrograph at TCG for WY04 and the 80-, 50-, and 20-percent monthly exceedance statistics for the period of record (1972 through 2004) are presented in figure 26. The plot shows that WY04 streamflows in Thompson Creek were below the long-term median (50-percent exceedance) for July and much of August. Streamflows returned to near the long-term median conditions by the end of September. Analyses of WY04 and long-term monthly mean discharge data for Thompson Creek showed similar results (table 15). The July and August monthly means for WY04 were below the long-term monthly means, while the September monthly mean for WY04 was near the long-term mean. Table 15 also shows the 80-, 50-, and 20-percent monthly exceedance discharge estimates and confidence limits based on regional regression equations (Hortness and Berenbrock, 2001). Comparison between long-term statistic values and values calculated on the basis of the regression equations can provide some insight as to the applicability of the regression equations for Thompson Creek. In this case, the regression estimates tend to be higher than the long-term values, indicating that the equations, to some degree, could overestimate streamflow conditions in Thompson Creek.

Although seepage analyses were not within the scope of this project, instantaneous discharge measurements provide some indication of streamflow lost to ground water and being diverted at specific times during the study period. A summary of all discharge measured in Thompson Creek during the study period is presented in table 16.

Habitat Modeling and Passage Criteria

Lower Thompson Creek (TC1) discharges required for maximum WUA were 12 to 24 ft^3/s, for bull trout, 34 ft^3/s for Chinook salmon, and 34 ft^3/s for steelhead trout adult and spawning life stages (table 17). Discharges required for passage over two shallow riffle habitat transects were 8 and 10 ft^3/s and 3 and 6 ft^3/s for the 0.6 ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively (see transects 6 and 7 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix F provides more information summarizing these study results..

Median discharge (Q.50) estimates, based on regression equations, were for 18.1 ft^3/s for July, 10.2 ft^3/s for August, and 8.3 ft^3/s for September. The mean annual discharge estimate was 22.2 ft^3/s (table 17).

Stream Temperature

Temperature recording data loggers were deployed at TCG and TC1 in early June 2004 (fig. 24). Both data loggers were retrieved in late September 2004. After downloading and reviewing the data, June 9 through September 30 (114 days) was selected as the period of record for calculating stream temperature metrics.

The difference in MDMT between TCG and TC1 on any given day was less than 1.0ºC, 75 percent (85 of 114 days) of the time (fig. 27); the maximum difference in MDMT was 2.2ºC on July 5 and August 23, 2004. What little downstream warming from TCG to TC1 that may occur, likely is due to a combination of factors, including natural heat flux, lack of riparian shading along a few reaches of Thompson Creek, and the diversion of streamflow for irrigation.

Individual metric calculation results showed that the MDAT at was 14.1ºC TCG and 14.5ºC at TC1, well below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

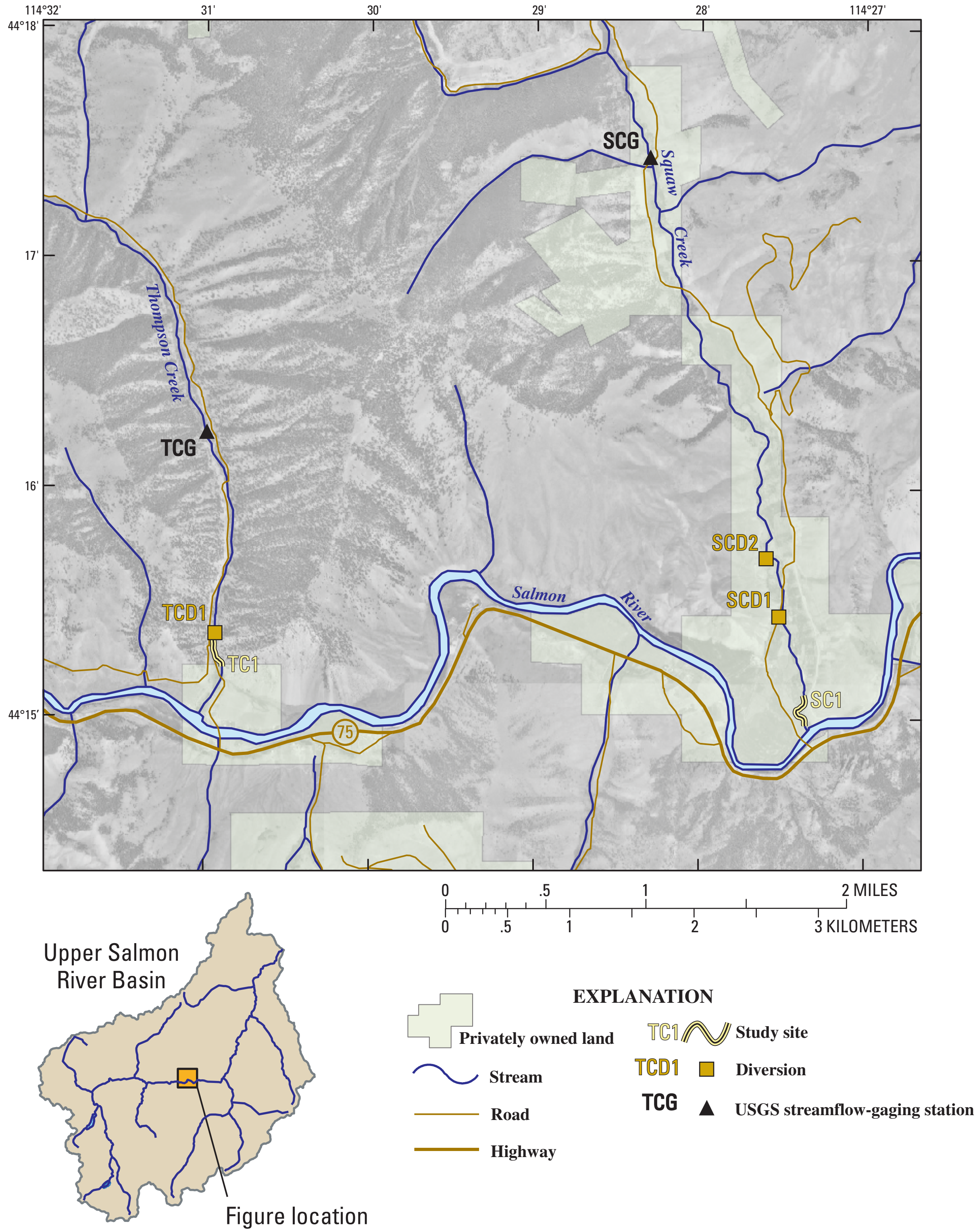

Figure 24. Location of study sites on Squaw and Thompson Creeks, diversions, and streamflow-gaging stations, upper Salmon River Basin, Idaho, 2004.

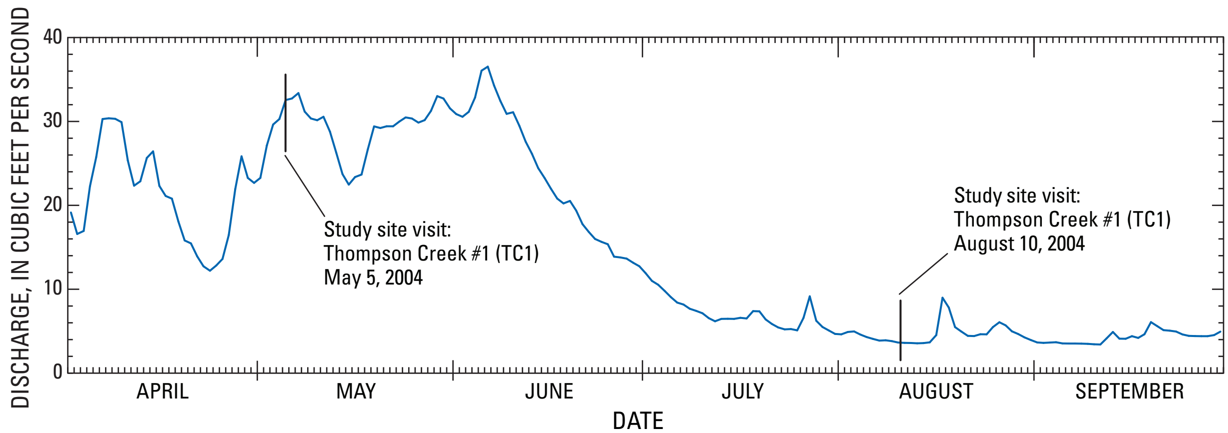

Figure 25. Daily mean discharge at Thompson Creek near Clayton (13297330; TCG), upper Salmon River Basin, Idaho, April 1 through September 30, 2004.

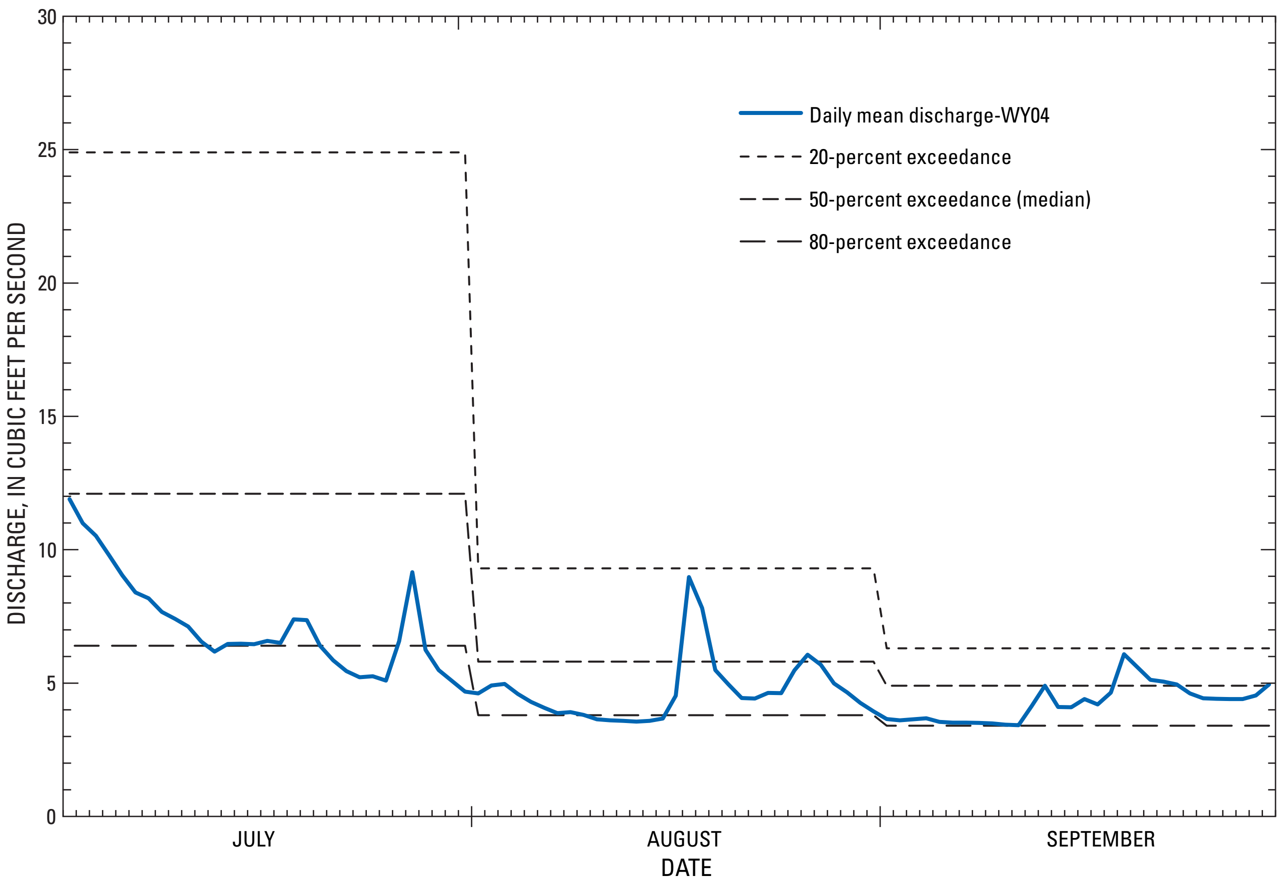

Figure 26. Daily mean discharge for water year 2004 and 80-, 50-, and 20-percent exceedance statistics for the period of record (1972-2004) at Thompson Creek near Clayton (13297330), upper Salmon River Basin, Idaho, July 1 through September 30.

Table 15. Calculated and estimated monthly mean and 80-, 50-, and 20-percent monthly exceedance discharge values for Thompson Creek near Clayton (13297330), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Long term:** Based on period of record (1972 through 2004). **Abbreviations:** –, not able to compute]

	July				August				September			
	Mean	Q.80	Q.50	Q.20	Mean	Q.80	Q.50	Q.20	Mean	Q.80	Q.50	Q.20
Water year 2004	7.17	5.49	6.55	8.40	4.70	3.80	4.52	4.99	4.26	3.54	4.30	4.91
Long term	16.7	6.40	12.1	24.9	6.60	3.80	5.80	9.30	4.91	3.40	4.90	6.30
Regional regression equations												
Upper confidence limit	–	26.8	33.2	48.2	–	15.0	22.2	20.9	–	12.7	17.3	15.4
Estimate	–	12.1	18.1	30.8	–	7.13	10.2	13.1	–	6.21	8.27	10.0
Lower confidence limit	–	5.46	9.88	19.7	–	3.39	4.68	8.19	–	3.05	3.95	6.45

Table 16. Summary of instantaneous and mean daily discharge for Thompson Creek, upper Salmon River Basin, Idaho, water year 2004.

[Site locations shown in figure 1. **Discharge:** Values presented in cubic feet per second; daily mean discharge values are underlined]

Date	Discharge	
	TCG	TC1
04-20-04	14.4	14.4
05-05-04	<u>32.5</u>	37.8
05-25-04	30.1	26.2
06-22-04	15.0	14.2
07-13-04	7.48	7.35
08-10-04	<u>3.60</u>	3.24
08-18-04	<u>7.80</u>	7.31

The MDMT was 19.4ºC at TCG and 20.3ºC at TC1, above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004) and below the 21.0ºC threshold that, according to Poole and others (2001), can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. The MDMT exceeded 18.0ºC, 15 percent (17 of 114 days) of the time at TCG, and 27 percent (31 of 114 days) of the time at TC1.

Both Thompson Creek sites had temperature regimes that were below the 19.0ºC MDAT and 22.0ºC MDMT IDEQ criteria for the protection of coldwater biota (applicable June 22 through September 21). A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Table 17. Summary of habitat and hydrologic measurements for lower Thompson Creek (TC1), upper Salmon River Basin, Idaho, 2004.

[Values presented in cubic feet per second. **Discharge passage criteria:** Passage criteria taken from Thompson (1972) and Scott and others (1981); both width criteria must be met to ensure passage. **Discharge estimates:** Based on regional regression equations using basin and climatic characteristics (Hortness and Berenbrock, 2001). Q.xx, daily discharge exceeded xx percent of the time during the specified month; Qa, mean annual discharge. **Abbreviations:** WUA, weighted usable area; WUA optimum discharge estimates were based on PHABSIM (Physical Habitat Simulation) model output; ND, not determined]

Lifestage	Discharge required for maximum WUA			Discharge required for adult salmonid passage 0.6 foot depth criterion		Discharge estimates									
				Channel width											
	Bull trout	Chinook salmon	Steelhead trout	Greater than 25 percent (total)	Greater than 10 percent (contiguous)	July			August			September			
						Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Qa
Adult	12	34	34	[1]8, 10	[1]3, 6	12.1	18.1	30.8	7.1	10.2	13.1	6.2	8.3	10.0	22.2
Spawning	24	34	34	ND	ND										

[1]Represents measurements at two transects.

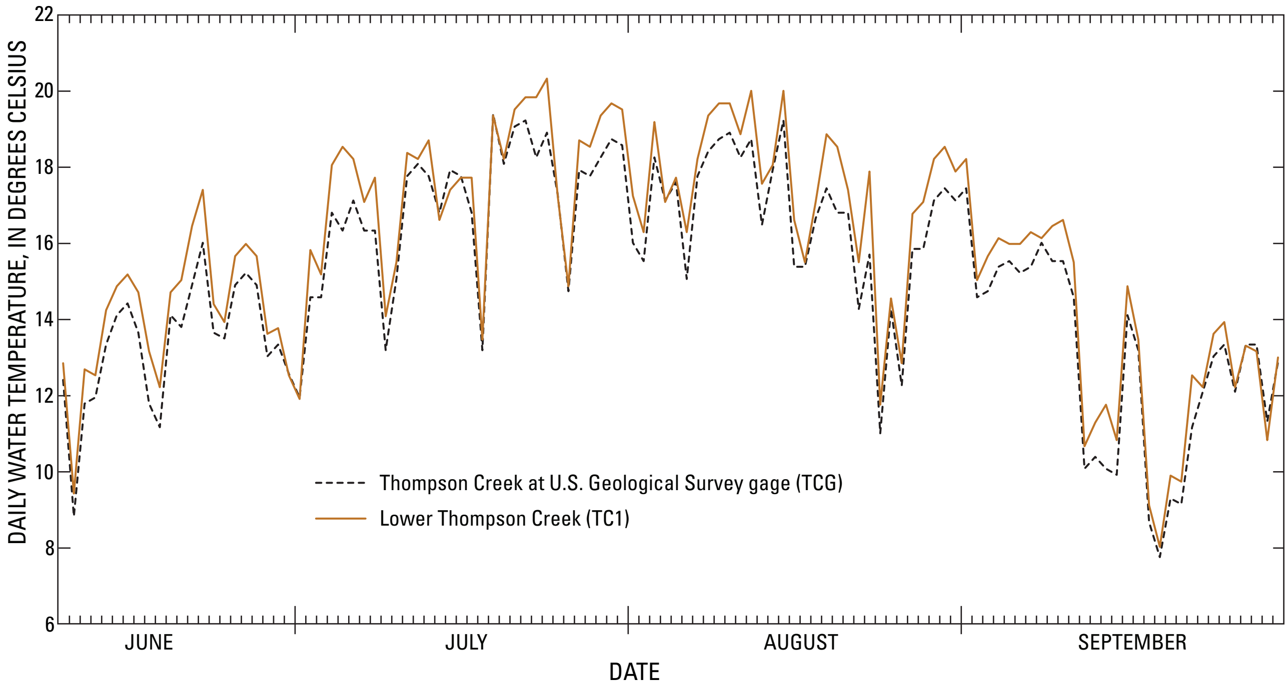

Figure 27. Maximum daily water temperature, at Thompson Creek, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

Squaw Creek

Squaw Creek is in the upper Salmon River Basin between Stanley and Challis, Idaho. Squaw Creek is a tributary to the Salmon River and its headwaters originate near Mill Creek Summit about 14 mi north of the Salmon River (fig. 1). The Squaw Creek Basin covers 71.6 mi^2, of which about 73 percent is forest. Mean elevation in the basin is about 7,730 ft above sea level and the basin receives an average of 25.2 in/yr of precipitation. Recent biological sampling by Chadwick Ecological Consultants, Inc. (2004), have indicated mining activities in the basin are having little or no effect on aquatic life in Squaw Creek. The data show water quality is suitable to support healthy invertebrate and fish populations. The IDFG, in cooperation with the Thompson Creek Mine, built a steelhead trout juvenile rearing facility in 1997 near the mouth of Squaw Creek. About 200,000 juveniles potentially could be released annually from this facility into Squaw Creek (Upper Salmon River Bull Trout Technical Advisory Team, 1998).

Hydrology

The USGS has operated a long-term streamflow-gaging station (13297355; SCG) on Squaw Creek since October of 1972. This gaging station is upstream of the two active diversions on Squaw Creek, about 3 mi upstream of the confluence with the Salmon River (fig. 24). A plot of the continuous daily mean discharge at SCG during WY04 is presented in figure 28, along with markers indicating when field data were collected at study site SC1, which was just upstream of the confluence with the Salmon River.

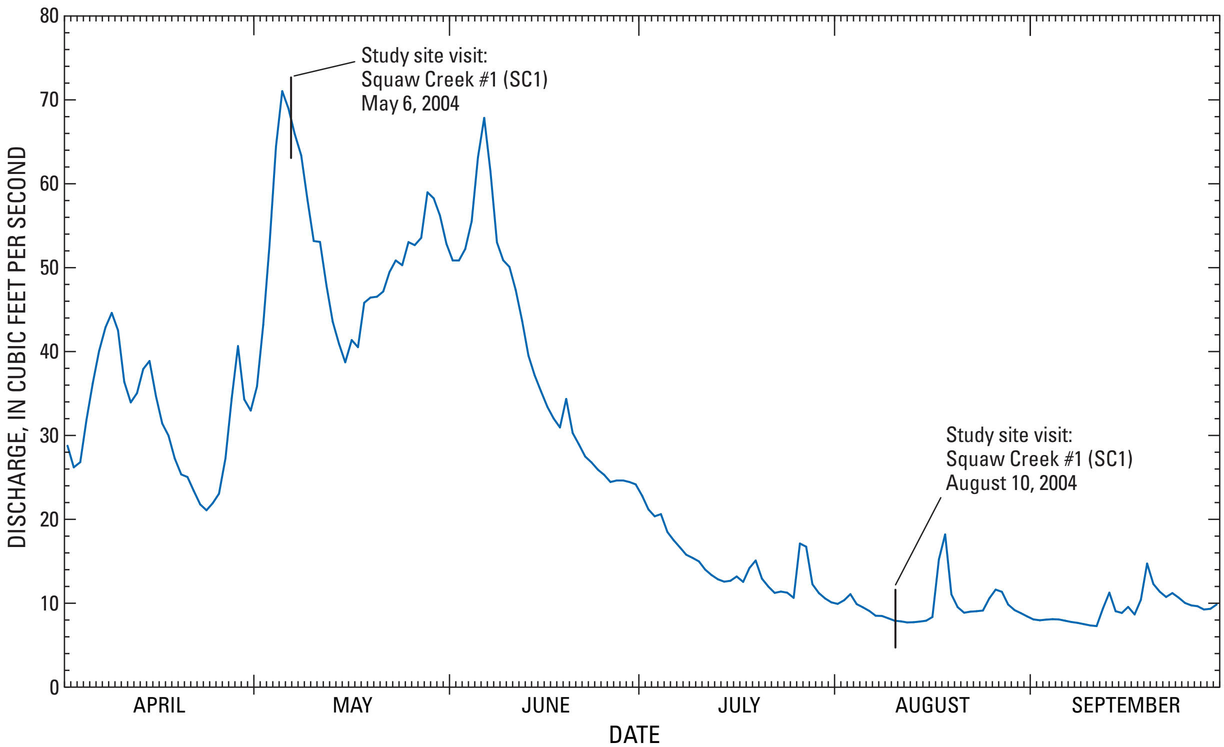

Figure 28. Daily mean discharge at Squaw Creek below Bruno Creek, near Clayton (13297355), upper Salmon River Basin, Idaho, April 1 through September 30, 2004.

Additional analyses were completed to relate streamflows in Squaw Creek during WY04 to long-term streamflow statistics. The July, August, and September daily mean discharge hydrograph at SCG for WY04 and the 80-, 50-, and 20-percent monthly exceedance statistics for the period of record (1972 through 2004) are presented in figure 29. The plot shows that WY04 streamflows in Squaw Creek were below the long-term median (50-percent exceedance) for July and much of August. Streamflows returned to near the long-term median conditions by the end of September. Analyses of WY04 and long-term monthly mean data for Squaw Creek showed similar results (table 18). The July and August monthly mean dishcarges for WY04 were below the long-term monthly means, while the September monthly mean for WY04 was near the long-term mean. Also included in table 18 are the 80-, 50-, and 20-percent monthly exceedance discharge estimates and confidence limits derived from the regional regression equations (Hortness and Berenbrock, 2001). Comparison between the long-term statistic values and values calculated on the basis of the regression equations can provide some insight as to the applicability of the regression equations for Squaw Creek. In this case, the regression estimates tend to be higher than the long-term values, indicating that the equations, to some degree, could overestimate streamflow conditions in Squaw Creek.

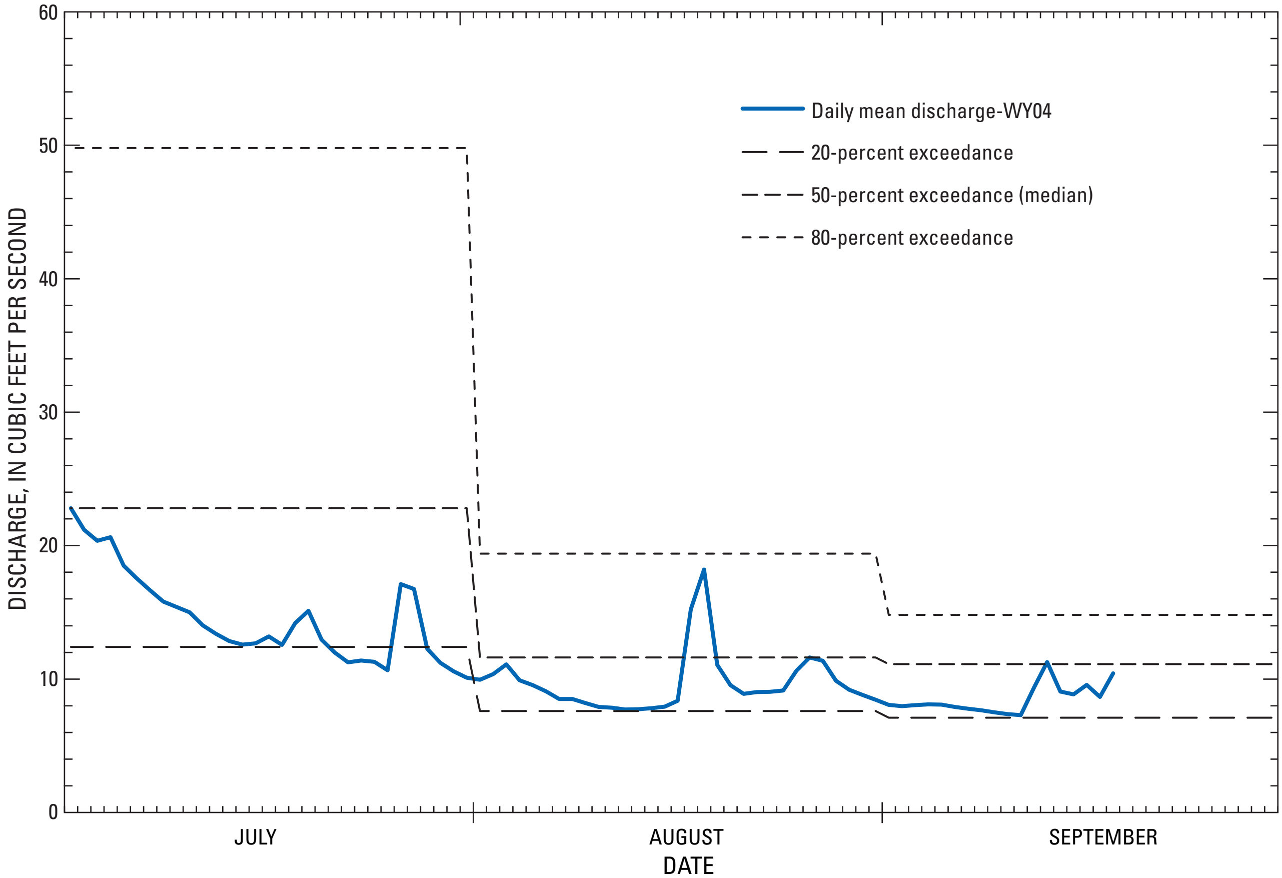

Figure 29. Daily mean discharge for water year 2004 and 80-, 50-, and 20-percent exceedance statistics for the period of record (1972-2004) at Squaw Creek below Bruno Creek, near Clayton (13297355), upper Salmon River Basin, Idaho, July 1 through September 30.

Table 18. Calculated and estimated monthly mean and 80-, 50-, and 20-percent monthly exceedance discharge values for Squaw Creek below Bruno Creek, near Clayton (13297355), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Long term:** Based on period of record (1972 through 2004). **Abbreviations:** –, not able to compute]

	July				August				September			
	Mean	**Q.80**	**Q.50**	**Q.20**	**Mean**	**Q.80**	**Q.50**	**Q.20**	**Mean**	**Q.80**	**Q.50**	**Q.20**
Water year 2004	14.6	11.4	13.4	17.1	9.66	8.20	9.08	10.6	9.37	7.95	9.29	10.7
Long term	33.3	12.4	22.8	49.8	13.2	7.60	11.6	19.4	10.8	7.10	11.1	14.8
Regional regression equations												
Upper confidence limit	–	45.9	66.3	99.4	–	26.1	39.7	44.8	–	22.4	31.6	33.4
Estimate	–	20.7	36.2	63.5	–	12.4	18.2	28.0	–	11.0	15.1	21.6
Lower confidence limit	–	9.33	19.8	40.5	–	5.90	8.35	17.5	–	5.40	7.21	14.0

Although seepage analyses were not within the scope of this project, instantaneous discharge measurements provide some indication of streamflow lost to ground water and diverted at specific times during the study period. A summary of all discharge measured in Squaw Creek during the study period is presented in table 19.

Table 19. Summary of instantaneous and mean daily discharge for Squaw Creek, upper Salmon River Basin, Idaho, water year 2004.

[Site locations shown in figure 1. **Discharge:** Values presented in cubic feet per second; daily mean discharge values are underlined]

Date	Discharge	
	SCG	SC1
04-20-04	26.6	25.3
05-06-04	<u>69.0</u>	51.3
05-25-04	46.8	39.8
06-22-04	<u>27.5</u>	21.0
07-13-04	13.0	7.05
08-10-04	<u>7.91</u>	3.30
08-18-04	<u>18.2</u>	6.76

Habitat Modeling and Passage Criteria

Lower Squaw Creek (SC1) discharges required for maximum WUA were 14 to 50 ft^3/s, 42 to 48 ft^3/s, and 42 to 48 ft^3/s for bull trout, Chinook salmon, and steelhead trout adult and spawning life stages, respectively (table 20). Discharges required for passage over three shallow riffle habitat transects ranged from 14 to 20 ft^3/s and 7 to 16 ft^3/s for the 0.6 ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively (see transects 1, 4 and 8 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix G provides more information summarizing these study results.

Median discharge (Q.50) estimates, based on regression equations, were 36.2 ft^3/s for July, 18.2 ft^3/s August, and 15.1,ft^3/s for September. The mean annual discharge estimate was 38.3 ft^3/s (table 20).

Stream Temperature

Temperature recording data loggers were deployed at SCG and SC1 in early June 2004 (fig. 24). Both data loggers were retrieved in late September. After downloading and reviewing the data, June 9 through September 30 (114 days) was selected as the period of record for calculating stream temperature metrics.

Analysis of the stream temperature records for Squaw Creek indicated that, most of the time, there is a slight warming trend downstream of SCG to SC1 (fig. 30). In 2004, the difference in MDMT between SCG and SC1 on any given day was less than 1.0ºC, 62 percent (71 of 114 days) of the time; the maximum difference in MDMT was 3.3ºC on August 23, 2004. This general warming trend most likely is due to a combination of factors, including natural heat flux, the lack of riparian shading along several stretches of Squaw Creek, and, possibly, the diversion of streamflow for irrigation.

Individual metric calculation results showed that the MDAT was 17.2ºC at SCG and 17.8ºC at SC1. These temperatures are at or below the 17.8ºC MDAT upper temperature threshold that according to McHugh and others (2004) can decrease the survival rate of summer Chinook salmon juveniles in natal streams.

The MDMT was 22.9ºC at SCG and 23.1ºC at SC1, above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004), and above the 21.0ºC threshold that, according to Poole and others (2001), can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. The MDMT exceeded 18.0ºC, 40 percent (46 of 114 days) of the time at SCG, and 46 percent (53 of 114 days) of the time at SC1. The MDMT exceeded 21.0ºC, 18 percent (21 of 114 days) of the time at SCG, and 17 percent (19 of 114 days) of the time at SC1.

Both Squaw Creek sites had temperature regimes that were below the 19.0ºC MDAT and 22.0ºC MDMT IDEQ criteria for the protection of coldwater biota (applicable June 22 through September 21). A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

Table 20. Summary of habitat and hydrologic measurements for lower Squaw Creek (SC1), upper Salmon River Basin, Idaho, 2004.

[Values presented in cubic feet per second. **Discharge passage criteria:** Passage criteria taken from Thompson (1972) and Scott and others (1981); both width criteria must be met to ensure passage. **Discharge estimates:** Based on regional regression equations using basin and climatic characteristics (Hortness and Berenbrock, 2001). Q.xx, daily discharge exceeded xx percent of the time during the specified month; Qa, mean annual discharge. **Abbreviations:** WUA, weighted usable area; WUA optimum discharge estimates were based on PHABSIM (Physical Habitat Simulation) model output; ND, not determined]

Lifestage	Discharge required for maximum WUA			Discharge required for adult salmonid passage 0.6 foot depth criterion: Channel width		Discharge estimates									
						July			August			September			
	Bull trout	Chinook salmon	Steelhead trout	Greater than 25 percent (total)	Greater than 10 percent (contiguous)	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Q.80	Q.50	Q.20	Qa
Adult	14	42	42	[1]20, 14, 16	[1]16, 7, 8	20.7	36.2	63.5	12.4	18.2	28.0	11.0	15.1	21.6	38.3
Spawning	50	48	48	ND	ND										

[1]Represents measurements at three transects.

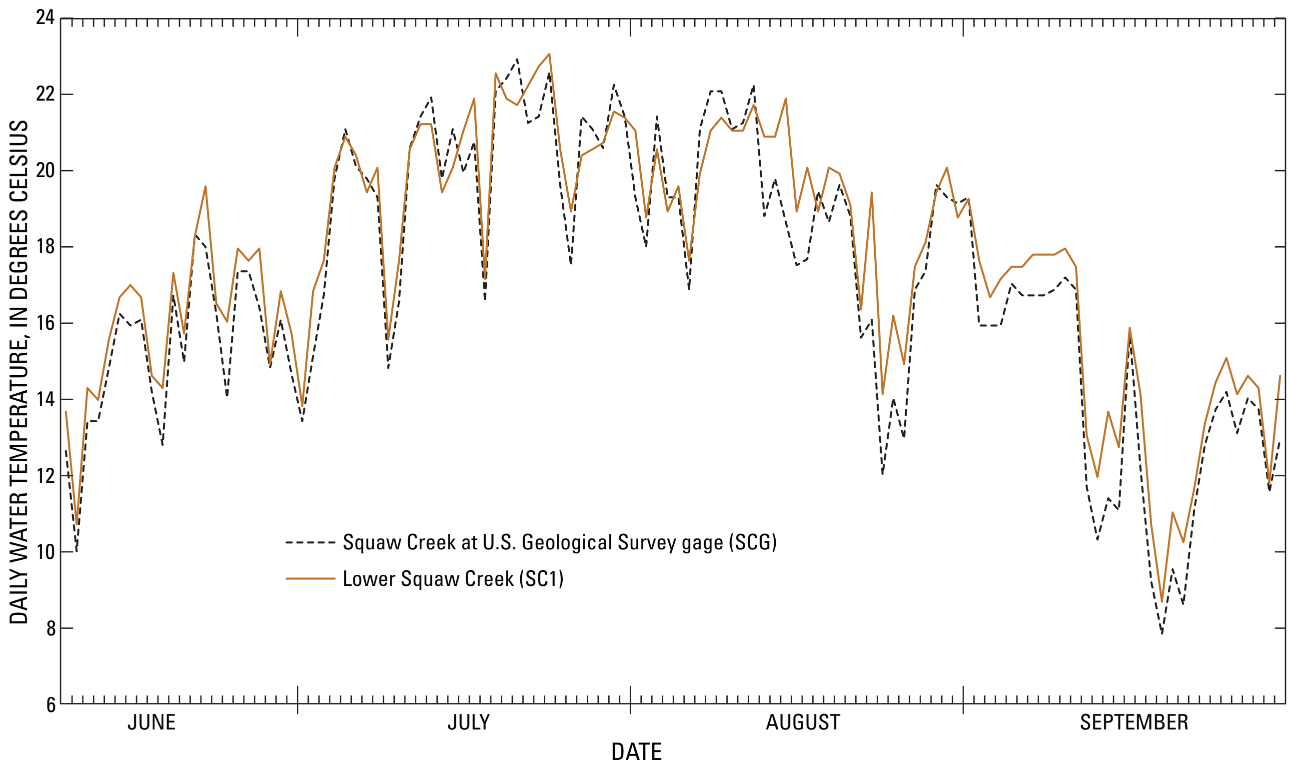

Figure 30. Maximum daily water temperature at Squaw Creek, upper Salmon River Basin, Idaho, June 9 through September 30, 2004.

Summary

Rivers, streams, and lakes in the upper Salmon River Basin historically provided migration corridors and significant habitat for anadromous Chinook salmon, sockeye salmon, and steelhead trout. Wild salmon and steelhead in the basin migrate nearly 900 miles between the mountain streams and the Pacific Ocean. Resident bull trout also inhabit many of the rivers and streams in the basin. High-altitude spawning and rearing and extensive migrations may be very important for the long-term survival of these species.

Anadromous fish populations in the Columbia River Basin have plummeted in the last 100 years; this severe decline led to listing Chinook salmon and steelhead trout stocks as endangered or threatened under the Federal Endangered Species Act (ESA) in the 1990s. Human development has modified the original flow conditions in many streams in the upper Salmon River Basin. Summer streamflow modifications, as a result of irrigation practices, have directly affected the quantity and quality of fish habitat and also have affected migration and (or) access to suitable spawning and rearing habitat for these fish. Reduced streamflows resulting from diversions may contribute to increased water temperatures that may be unsuitable for native salmonids.

As a result of these ESA listings and Action 149 of the Federal Columbia River Power System Biological Opinion of 2000, the Bureau of Reclamation was tasked to conduct streamflow characterization studies in the upper Salmon River Basin to clearly define habitat requirements for effective species management and habitat restoration. These studies were done to evaluate potential fish habitat improvements by increasing streamflows as called for by the NOAA Fisheries BiOp of 2000. These study results will be used to prioritize and direct cost-effective actions to improve fish habitat for ESA-listed anadromous and native fish species in the basin.

Hydraulic and habitat simulation models contained in PHABSIM were used to characterize the instream physical attributes (depth, velocity, substrate, and cover) over a range of expected summer (July through September) discharges. The final output is expressed as weighted usable area (WUA) for a representative stream segment. Continuous summer water temperature data for selected study sites also are summarized and compared with Idaho Water Quality Standards and various temperature requirements of targeted fish species. In addition to 2004 data, continuous summer water temperature and streamflow relations collected in 2003 were evaluated for Fourth of July Creek using the temperature model SSTEMP that predicts mean and maximum daily water temperatures with changes in streamflow.

Climatic and hydrologic conditions in the upper Salmon River Basin were below normal (30-year record, 1971–2000 for climatic conditions; long-term means for hydrologic conditions) during water year 2004. Monthly snowpack levels were significantly below normal between January 1 and June 1, 2004. Average monthly snowpack levels for the Salmon River basin upstream of Salmon, Idaho ranged from 25 to 97 percent of normal during January 1 to June 1.

The mean temperature at Stanley, Idaho during WY04 was about 2.17 degrees Celsius slightly higher than the 30-year (1971–2000) mean of 1.78 degrees Celsius (35.2 degrees Fahrenheit). Annual mean streamflows at the long-term USGS streamflow-gaging stations on Valley Creek at Stanley and on the Salmon River below Yankee Fork for water year 2004 were about 26.1 and 27.4 percent below the long-term means, respectively.

The Salmon River above Beaver Creek discharges required for maximum WUA ranged from 24 to 60 ft^3/s for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharges required for passage over two shallow riffle habitat transects ranged from 31 to 21 ft^3/s for the 0.6-ft depth criterion greater than 25 percent of the total channel width and 27 to 12 greater than 10 percent of the contiguous channel width, respectively. Median discharge estimates for were 44.4 ft^3/s for July, 23.3 ft^3/s for August, and 20.9 ft^3/s for September for Salmon River above Beaver Creek. The mean annual discharge estimate was 64.9 ft^3/s.

The Salmon River above Alturas Lake Creek discharges required for maximum WUA ranged from 35 to 100 ft^3/s for bull trout, 85 to 90 ft^3/s for Chinook salmon, and 85 to 90 ft^3/s, for steelhead trout adult and spawning life stages. Discharges required for passage over a shallow riffle habitat transect were 50 and 40 ft^3/s for the 0.6-ft depth criterion greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively.

Median discharge estimates were 74.8 ft^3/s for July, 40.2 ft^3/s for August, and 36.7 ft^3/s for September for Salmon River above Alturas Lake Creek. The mean annual discharge estimate was 112.0 ft^3/s.

Analysis of the 2003 stream temperature records for the Salmon River indicated a slight warming trend downstream of Salmon River at the USGS streamflow-gaging station at Pole Creek Road to the Salmon River above Alturas Lake Creek and then an obvious cooling trend downstream to Salmon River at Highway 75. The cooling trend probably is due to the inflow from several springs and subsurface inflow of cold ground water to the Salmon River just upstream of the Highway 75 Bridge as the Salmon River flood plain constricts in this area. The maximum daily-maximum temperature (MDMT) during 2003 and 2004 at all Salmon River sites was at or slightly below the MDMT threshold of 21.0ºC that can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. However, the MDMT during 2003 and 2004 at all sites exceeded the 18.0ºC threshold that may block bull trout migration.

Lower Beaver Creek discharges required for maximum WUA was greater than 30 ft^3/s for bull trout, Chinook salmon, and steelhead trout adult and spawning life stages. The WUA curves showed a gradual increase for all species and life stages with discharge and never becoming asymptotic. Discharges

required for passage over three shallow riffle habitat transects ranged from 10 to 22 ft^3/s and 4 to 20 ft^3/s for the 0.6-ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively.

Median discharge estimates were 21.5 ft^3/s for July, 10.1 ft^3/s for August, and 11.1 ft^3/s for September. The mean annual discharge estimate was 29.0 ft^3/s.

Analysis of the 2004 stream temperature metrics for Beaver Creek indicated a strong warming trend downstream of upper to lower Beaver Creek. The MDMT at upper Beaver Creek is well below, while the MDMT at lower Beaver Creek is well above, the MDMT threshold of 21.0ºC that can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. The MDMT at all Beaver Creek sites exceeded the 18.0ºC threshold that may block bull trout migration.

Lower Pole Creek discharges required for maximum WUA were 9 to 19 ft^3/s for bull trout, 27 to 29 ft^3/s for Chinook salmon, and 27 to 29 ft^3/s for steelhead trout adult and spawning life stages. Discharges required for passage over three shallow riffle habitat transects ranged from 15 to 31 ft^3/s and 11 to 25 ft^3/s for the 0.6-ft depth criterion greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively

Pole Creek is considered the highest quality fishery habitat within the SNRA and has great potential to accommodate spawning of anadromous fish. However, this potential may be realized only if additional summer flows are provided to allow passage out of the Salmon River into spawning areas. Median discharge estimates, based on regression equations, were 34.7 ft^3/s for July, 16.3 ft^3/s for August, and 13.4 ft^3/s for September. The mean annual discharge estimate was 42.9 ft^3/s.

Analysis of the 2004 stream temperature records for Pole Creek indicates an obvious warming trend downstream of upper Pole Creek to lower Pole Creek. This warming trend is most likely is due to a combination of factors, including the natural heat flux, the lack of riparian shading along most of Pole Creek, and the diversion of streamflow for irrigation. The MDMT at both Pole Creek sites were below the 21.0ºC threshold that can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. The MDMT at lower Pole Creek was above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures.

Lower Champion Creek discharges required for maximum WUA were 3 to 12 ft^3/s for bull trout, 12 ft^3/s for Chinook salmon, and 12 ft^3/s for steelhead trout and adult and spawning life stages. The unusually low WUA of 3 ft^3/s for adult bull trout likely results from difficulties with calibrating velocities in the model. The combination of low calibration discharges (1.9 ft^3/s and 6.2 ft^3/s) and irregular channel bottoms resulted in unusually high and very erratic velocities, which proved to be unsuitable for bull trout. Because the Champion Creek Basin is similar in size and proximity to Fourth of July Creek Basin, a more accurate measure of adult bull trout maximum WUA would be to use 12 ft^3/s determined by previous studies for Fourth of July Creek. Discharges required for passage over three shallow riffle habitat transects ranged from 18 to 24 ft^3/s and 12 to 21 ft^3/s for the 0.6-ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively.

Median discharge estimates, based on regression equations, were 36.8 ft^3/s for July, 16.7 ft^3/s for August, and 13.1 ft^3/s September. The mean annual discharge estimate was 42.1 ft^3/s.

Analysis of the 2004 stream temperature metrics for Champion Creek indicates an obvious warming trend downstream of upper to lower Champion Creek due to a combination of factors including the natural heat flux, lack of riparian shading along the stream banks, and, possibly, the diversion of streamflow for irrigation.

The MDMT at lower Champion Creek was above the 21.0ºC threshold that can create a thermal barrier that can possibly block adult Chinook salmon from migrating to their spawning grounds. The MDMT for both Champion Creek sites was above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures.

Analysis of the 2004 stream temperature metrics for Fourth of July Creek indicates an obvious warming trend downstream of upper to lower Fourth of July Creek. This warming trend likely is due to a combination of factors, including the natural heating from increased exposure once the stream leaves the forested highlands and enters the valley floor and the diversion of streamflow for irrigation. Each year, a large portion of streamflow is diverted for irrigation during the growing season causing increased water temperatures at the lower end of Fourth of July Creek. Large increases in water temperature in the lower end of Fourth of July Creek are not uncommon. In 2001, the U.S. Forest Service measured stream temperatures increases of about 10ºC over about 1 mile, between the Forest Service boundary and the mouth of Fourth of July Creek. The MDMT at both sites were below the 21.0ºC threshold that can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. Also, the MDMT at lower Fourth of July Creek was slightly above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures.

To assess the effects of diversions on stream temperature in Fourth of July Creek, a SSTEMP model was developed for July 31, 2003 over a 5-mile reach extending from USGS streamflow-gaging station above all diversion to just upstream of the confluence with the Salmon River. The model was calibrated to match measured stream temperatures in Fourth of July Creek and then used to predict stream temperatures in the study reach without the effects of diversions. The cumulative effect of the three diversions on stream temperature at the lower end of the study reach on July 31, 2003 is an increase in the mean daily temperature of about 1.0ºC. This does not appear to be much of an increase given that the diversions were removing about 72 percent (10.3 of 14.3 ft^3/s) of the total streamflow on this day. However, the less than expected increase in stream temperature is probably a result of the large influx of cold groundwater in the upper half of the study reach. Ground water accretion plays an important role in moderating the effects of diversions on stream temperatures in Fourth of July Creek. Ground water accretion accounted for about 44 percent (6.3 of 14.3 ft^3/s) of the total flow at the lower end of the study reach on July 31, 2003. This cold ground water (7.5ºC), when mixed with the small volume of warmer surface water remaining in the stream channel, resulted in cooler surface water and consequently lower stream temperatures throughout most of the study reach than perhaps one would expect.

Lower Iron Creek discharges required for maximum WUA were 4 to 16 ft^3/s for bull trout, 14 to 16 ft^3/s for Chinook salmon, and 14 to 16 ft^3/s for steelhead trout adult and spawning life stages. Discharges required for passage over shallow riffle habitat ranged from 20 to >30 ft^3/s and 16 to >30 ft^3/s for the 0.6-ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively.

Median discharge estimates, based on regression equations, were 66.8 for July, 19.9for August, and 12.7 for September. The mean annual discharge estimate was 52.1 ft^3/s.

Analysis of the 2004 stream temperature metrics for Iron Creek indicated that most of the time the difference in temperature between upper and lower Iron Creek was only slightly higher than the measurement error associated with the temperature recording data logger (+/- 0.4) with no obvious trend in temperature being observed. The MDMT for both Iron Creek sites were below the 21.0ºC threshold that can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. Also, the MDMT for both sites were below the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures.

Lower Thompson Creek discharges required for maximum WUA were 12 to 24 ft^3/s for bull trout, 34 ft^3/s for Chinook salmon, and 34 ft^3/s for steelhead trout adult and spawning life stages. Discharges required for passage over two shallow riffle habitat transects ranged from 8 to 10 ft^3/s and 3 to 6 ft^3/s for the 0.6-ft depth criterion of greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively. Median discharge estimates, based on regression equations, were 18.1 ft^3/s for July, 10.2 ft^3/s for August, and 8.3 ft^3/s for September. The mean annual discharge estimate was 22.2 ft^3/s.

Analysis of the 2004 stream temperature metrics for Squaw Creek indicated there was little downstream warming from upper to lower sites on Thompson Creek. The MDMT for both Thompson Creek sites were below the 21.0ºC threshold that can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. Also, the MDMT were above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures.

Lower Squaw Creek discharges required for maximum WUA were 14 to 50 ft^3/s for bull trout, 42 to 48 ft^3/s for Chinook salmon, and 42 to 48 ft^3/s for steelhead trout adult and spawning life stages. Discharges required for passage over three shallow riffle habitat transects ranged from 14 to 20 ft^3/s and 8 to 16 ft^3/s for the 0.6-ft depth criterion greater than 25 percent of the total channel width and greater than 10 percent of the contiguous channel width, respectively.

Median discharge estimates, based on regression equations, were 36.2 for July, 18.2 for August, and 15.1 ft^3/s for September. The mean annual discharge estimate was 38.3 ft^3/s.

Analysis of the 2004 stream temperature metrics for Squaw Creek indicated that most of the time, there is a slight warming trend downstream of upper to lower Squaw Creek. This general warming trend likely is due to a combination of factors, including natural heat flux, the lack of riparian shading along several stretches of Squaw Creek, and, possibly, the diversion of streamflow for irrigation.

The MDMT for both Squaw Creek sites are above the 21.0ºC threshold that can create a thermal barrier that would block adult Chinook salmon from migrating to their spawning grounds. Also, the MDMT for both sites exceeds the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures.

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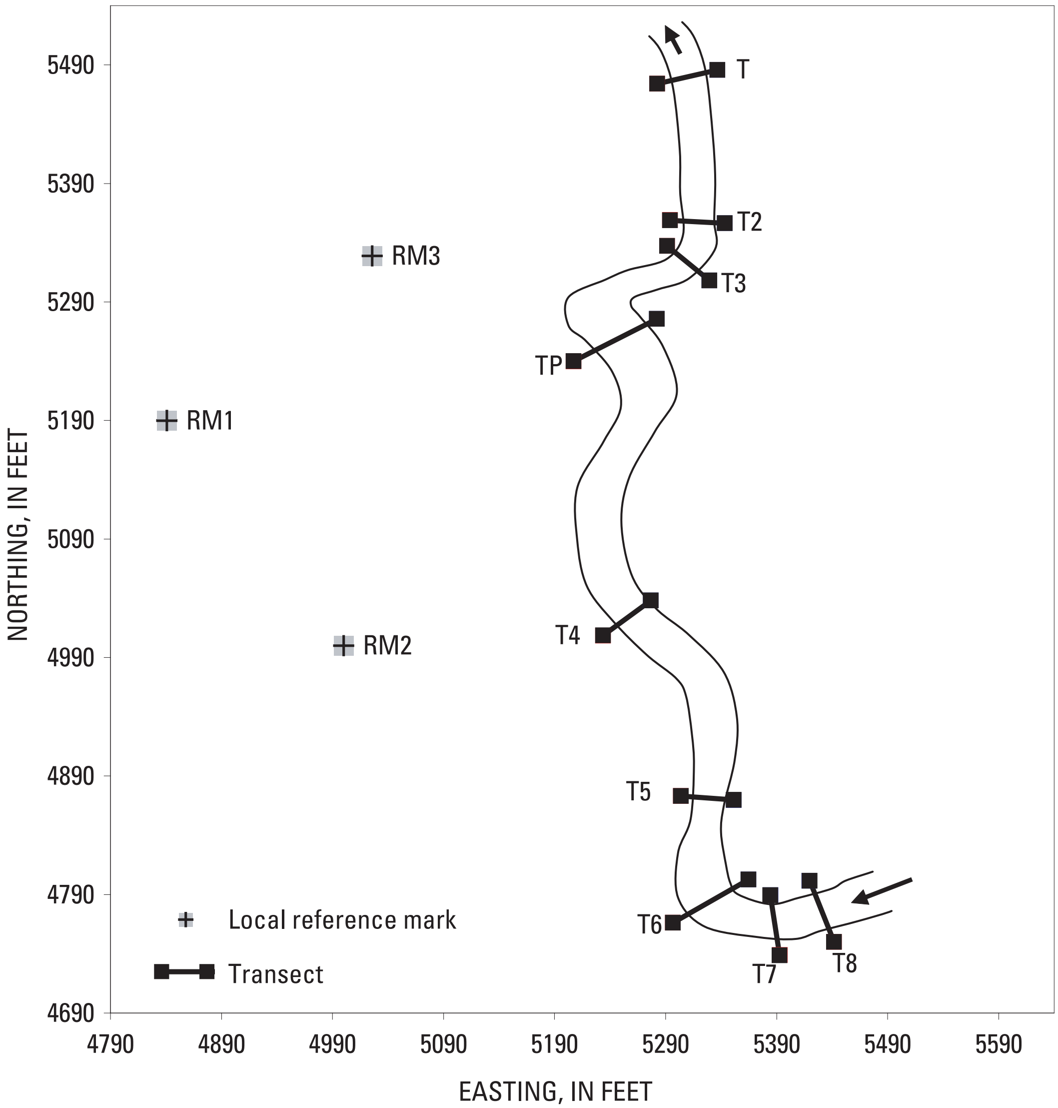
Appendix A. Plan view, weighted useable areas and passage criteria assessments for bull trout, Chinook salmon, and steelhead trout for Salmon River above Beaver Creek (SR2) and Salmon River above Alturas Lake Creek (SR1), upper Salmon River Basin, Idaho, 2004.



Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T1	43° 55' 28.32" N	114° 48' 32.54" W
RB T1	43° 55' 28.17" N	114° 48' 32.92" W
LB T2	43° 55' 27.06" N	114° 48' 32.50" W
RB T2	43° 55' 27.05" N	114° 48' 32.85" W
LB T3	43° 55' 26.57" N	114° 48' 32.60" W
RB T3	43° 55' 26.83" N	114° 48' 32.87" W
LB TP	43° 55' 26.22" N	114° 48' 32.93" W
RB TP	43° 55' 25.82" N	114° 48' 33.46" W
LB T4	43° 55' 23.88" N	114° 48' 32.99" W

Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
RB T4	43° 55' 23.56" N	114° 48' 33.29" W
LB T5	43° 55' 22.27" N	114° 48' 32.48" W
RB T5	43° 55' 22.27" N	114° 48' 32.81" W
LB T6	43° 55' 21.62" N	114° 48' 32.39" W
RB T6	43° 55' 21.21" N	114° 48' 32.87" W
LB T7	43° 55' 21.50" N	114° 48' 32.26" W
RB T7	43° 55' 21.01" N	114° 48' 32.20" W
LB T8	43° 55' 21.65" N	114° 48' 32.01" W
RB T8	43° 55' 21.15" N	114° 48' 31.86" W

For reference only; stream schematic not to scale.

Figure A1. Plan view of Salmon River above Beaver Creek (SR2), upper Salmon River Basin, Idaho, 2004.

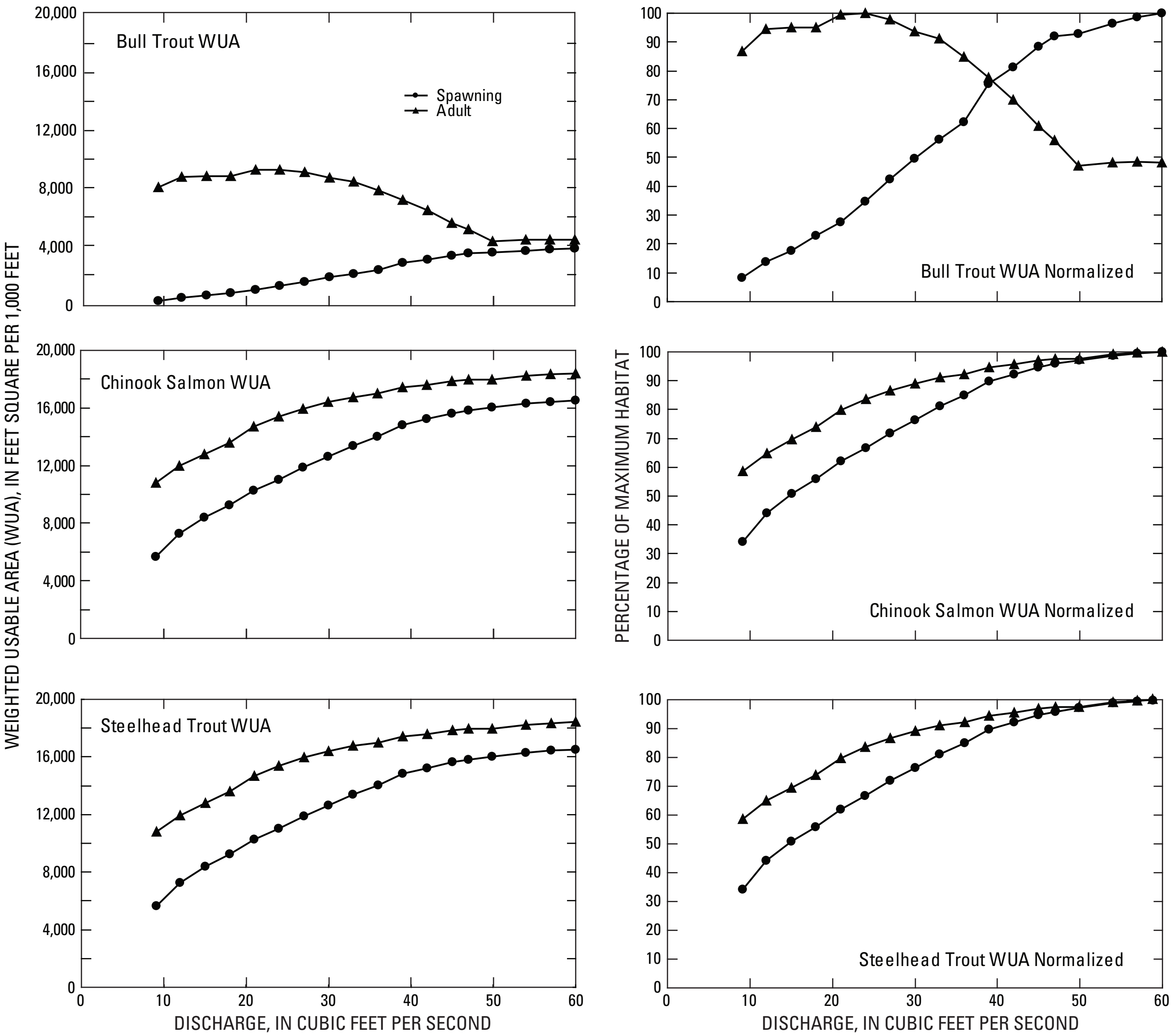


Figure A2. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, site SR2, Salmon River above Beaver Creek, upper Salmon River Basin, Idaho, 2004.

Table A1. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site SR2, Salmon River above Beaver Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; $ft^2/1,000$ ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1,000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
9.1	28,316	8,077	321	86.9	8.3
12	29,682	8,771	530	94.4	13.6
15	30,160	8,830	684	95.0	17.6
18	31,058	8,841	888	95.1	22.9
21	33,158	9,253	1,071	99.6	27.6
24	33,348	9,294	1,353	100.0	34.8
27	33,538	9,096	1,643	97.9	42.3
30	33,872	8,707	1,925	93.7	49.6
33	34,013	8,479	2,185	91.2	56.3
36	34,134	7,878	2,419	84.8	62.3
39	34,279	7,232	2,930	77.8	75.4
42	34,414	6,514	3,161	70.1	81.4
45	34,704	5,656	3,438	60.8	88.5
47	34,801	5,196	3,569	55.9	91.9
49.9	34,951	4,380	3,605	47.1	92.8
54	35,600	4,490	3,746	48.3	96.5
57	35,744	4,500	3,826	48.4	98.5
60	35,856	4,483	3,883	48.2	100.0
Chinook salmon					
9.1	28,315	10,796	5,649	58.6	34.2
12	29,682	11,954	7,274	64.9	44.1
15	30,160	12,802	8,401	69.5	50.9
18	31,058	13,609	9,227	73.9	55.9
21	33,158	14,693	10,248	79.8	62.1
24	33,348	15,397	11,030	83.6	66.8
27	33,538	15,951	11,866	86.6	71.9
30	33,872	16,400	12,624	89.1	76.4
33	34,013	16,762	13,394	91.0	81.1
36	34,134	16,979	14,023	92.2	84.9
39	34,279	17,409	14,837	94.5	89.8
42	34,414	17,601	15,223	95.6	92.2
45	34,704	17,869	15,623	97.0	94.6
47	34,801	17,952	15,830	97.5	95.9
49.9	34,951	17,979	16,038	97.6	97.1
54	35,600	18,245	16,308	99.1	98.8
57	35,744	18,351	16,430	99.7	99.5
60	35,856	18,414	16,513	100.0	100.0
Steelhead trout					
9.1	28,316	10,796	5,649	58.6	34.2
12	29,682	11,954	7,274	64.9	44.1
15	30,160	12,802	8,401	69.5	50.9
18	31,058	13,609	9,227	73.9	55.9
21	33,158	14,693	10,248	79.8	62.1
24	33,348	15,397	11,030	83.6	66.8
27	33,538	15,951	11,866	86.6	71.9
30	33,872	16,400	12,624	89.1	76.4
33	34,013	16,762	13,394	91.0	81.1
36	34,134	16,980	14,023	92.2	84.9
39	34,280	17,409	14,837	94.5	89.8
42	34,414	17,601	15,223	95.6	92.2
45	34,703	17,869	15,623	97.0	94.6
47	34,801	17,952	15,830	97.5	95.9
49.9	34,951	17,979	16,038	97.6	97.1
54	35,600	18,245	16,308	99.1	98.8
57	35,744	18,351	16,430	99.7	99.5
60	35,856	18,414	16,513	100.0	100.0

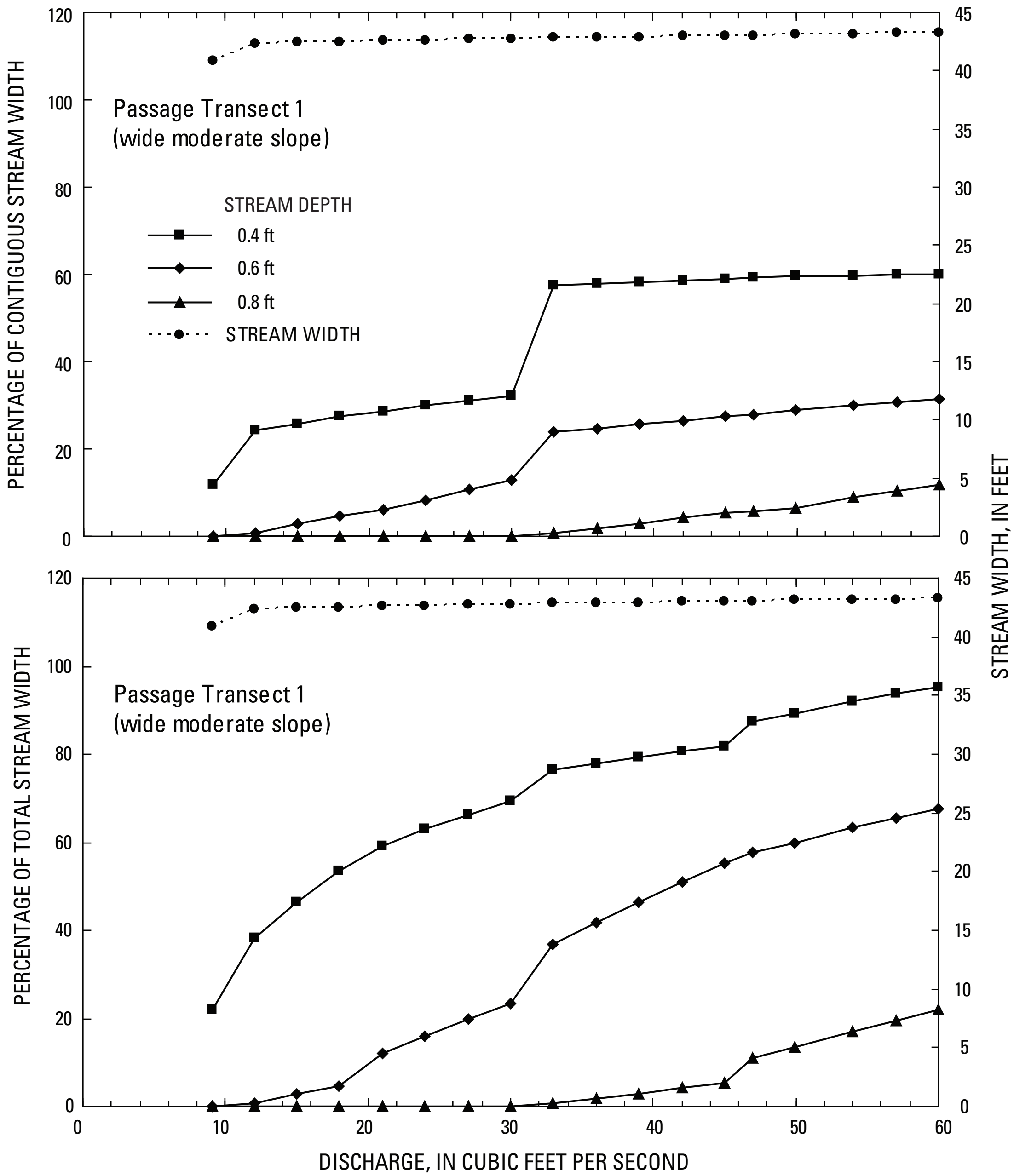


Figure A3. Percentages of contiguous and total stream width for passage transect 1, Salmon River above Beaver Creek (SR2), upper Salmon River Basin, Idaho, 2004.

Table A2. Passage criteria assessment for transect 1 (wide moderate slope), site SR2, Salmon River above Beaver Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
9.1	40.8	8.9	21.8	4.8	11.7
12	42.3	16.1	38.1	10.3	24.2
15	42.4	19.6	46.3	11.0	25.9
18	42.5	22.8	53.6	11.6	27.3
21	42.6	25.2	59.3	12.2	28.6
24	42.6	26.8	62.9	12.7	29.9
27	42.7	28.3	66.3	13.2	31.0
30	42.8	29.7	69.4	13.7	32.1
33	42.8	32.8	76.6	24.6	57.4
36	42.9	33.4	77.9	24.8	57.9
39	42.9	34.0	79.3	25.0	58.3
42	43.0	34.6	80.6	25.2	58.7
45	43.0	35.2	81.9	25.4	59.1
47	43.0	37.6	87.4	25.5	59.3
49.9	43.1	38.5	89.2	25.6	59.5
54	43.2	39.6	91.9	25.8	59.7
57	43.2	40.5	93.6	25.9	59.9
60	43.2	41.2	95.3	26.0	60.1
		Stream widths greater than 0.6-ft depth			
9.1	40.8	0.0	0.0	0.0	0.0
12	42.3	.3	.8	.3	.8
15	42.4	1.2	2.9	1.2	2.9
18	42.5	2.0	4.8	2.0	4.8
21	42.6	5.1	12.1	2.6	6.1
24	42.6	6.9	16.1	3.5	8.2
27	42.7	8.5	19.8	4.5	10.5
30	42.8	10.0	23.3	5.4	12.7
33	42.8	15.8	36.8	10.2	23.8
36	42.9	17.8	41.6	10.6	24.7
39	42.9	19.9	46.3	11.0	25.7
42	43.0	21.8	50.8	11.4	26.6
45	43.0	23.8	55.2	11.8	27.5
47	43.0	24.8	57.6	12.1	28.0
49.9	43.1	25.8	60.0	12.4	28.8
54	43.2	27.3	63.2	12.9	29.9
57	43.2	28.3	65.4	13.2	30.6
60	43.2	29.2	67.6	13.6	31.4
		Stream widths greater than 0.8-ft depth			
9.1	40.8	0.0	0.0	0.0	0.0
12	42.3	.0	.0	.0	.0
15	42.4	.0	.0	.0	.0
18	42.5	.0	.0	.0	.0
21	42.6	.0	.0	.0	.0
24	42.6	.0	.0	.0	.0
27	42.7	.0	.0	.0	.0
30	42.8	.0	.0	.0	.0
33	42.8	.2	.6	.2	.6
36	42.9	.8	1.8	.8	1.8
39	42.9	1.3	3.0	1.3	3.0
42	43.0	1.8	4.1	1.8	4.1
45	43.0	2.3	5.3	2.3	5.3
47	43.0	4.6	10.8	2.5	5.9
49.9	43.1	5.8	13.4	2.8	6.5
54	43.2	7.3	17.0	3.8	8.8
57	43.2	8.4	19.5	4.5	10.4
60	43.2	9.4	21.8	5.1	11.8

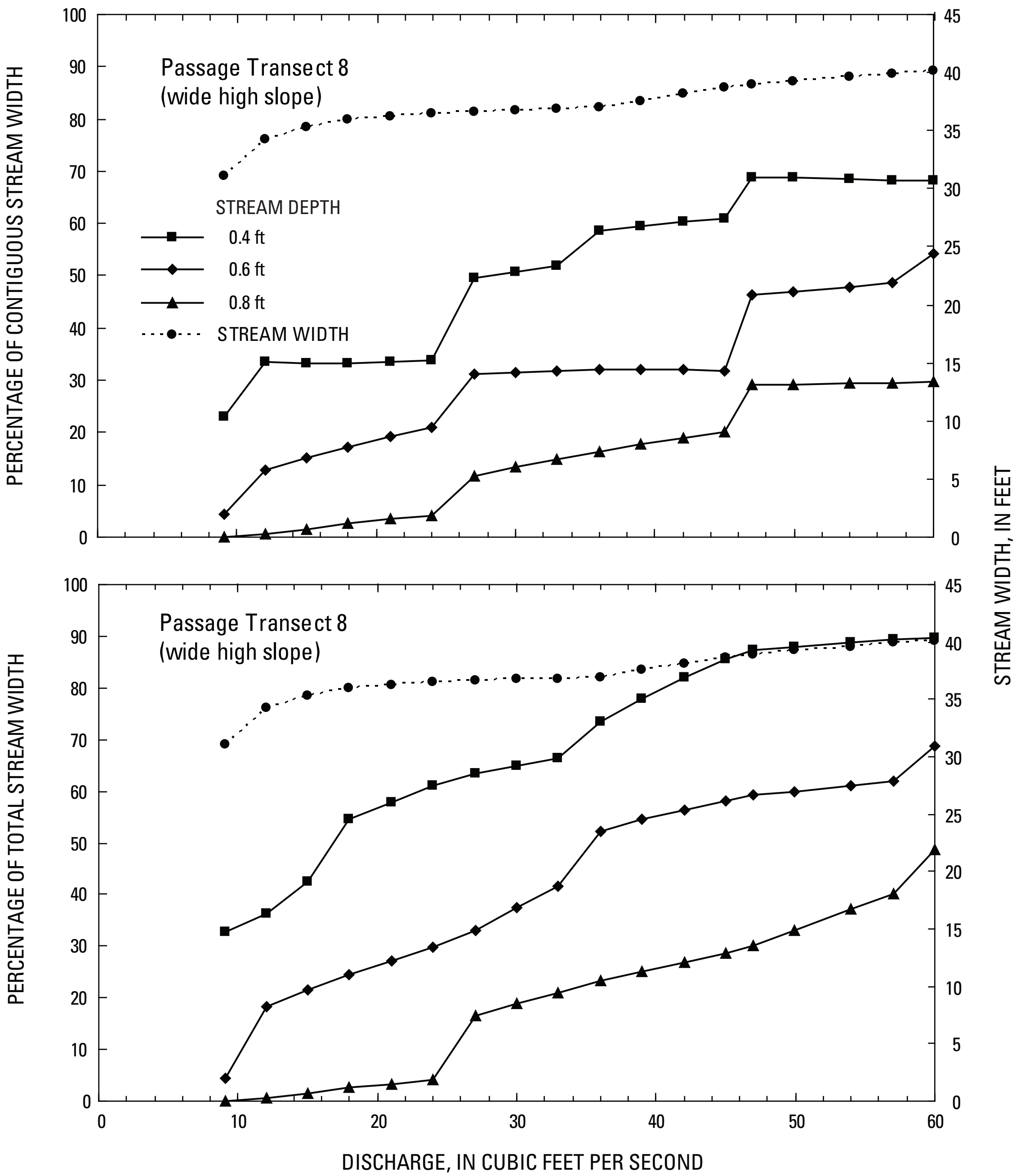
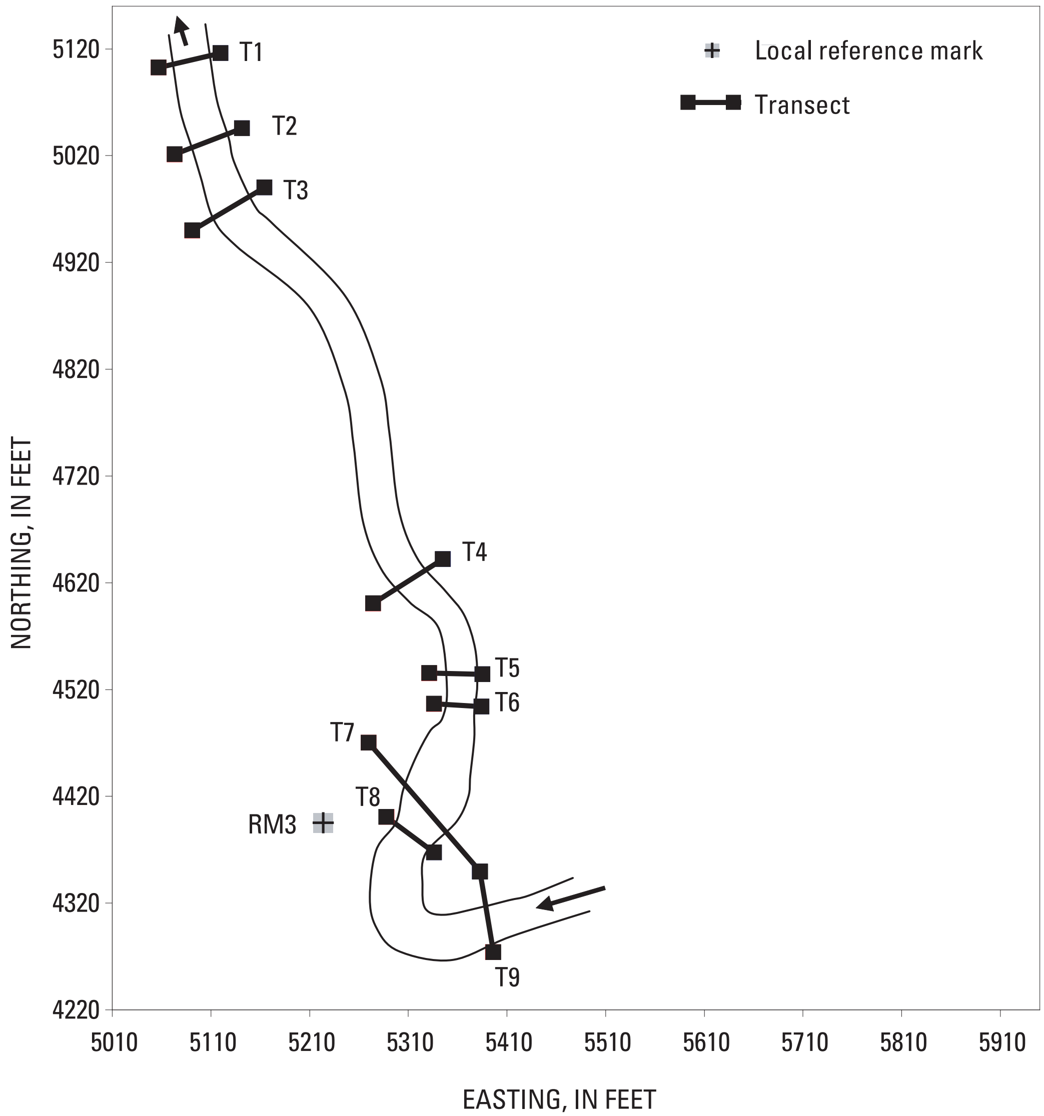


Figure A4. Percentages of contiguous and total stream width for passage transect 8, Salmon River above Beaver Creek (SR2), upper Salmon River Basin, Idaho, 2004.

Table A3. Passage criteria assessment for transect 8 (wide high slope), site SR2, Salmon River above Beaver Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
9.1	31.1	10.2	32.8	7.2	23.2
12	34.2	12.4	36.2	11.4	33.4
15	35.2	15.0	42.5	11.7	33.2
18	36.0	19.6	54.5	11.9	33.1
21	36.2	21.0	57.9	12.1	33.4
24	36.5	22.2	61.0	12.3	33.7
27	36.6	23.2	63.4	18.2	49.6
30	36.7	23.8	64.9	18.7	50.8
33	36.8	24.5	66.4	19.2	52.0
36	36.9	27.2	73.5	21.6	58.6
39	37.6	29.3	78.0	22.3	59.5
42	38.1	31.2	82.0	23.0	60.2
45	38.7	33.1	85.6	23.6	60.9
47	39.0	34.0	87.2	26.8	68.9
49.9	39.2	34.5	87.8	26.9	68.7
54	39.6	35.2	88.8	27.1	68.4
57	39.9	35.6	89.4	27.2	68.2
60	40.1	36.0	89.8	27.3	68.1
		Stream widths greater than 0.6-ft depth			
9.1	31.1	1.3	4.3	1.3	4.3
12	34.2	6.2	18.2	4.4	12.8
15	35.2	7.6	21.5	5.4	15.2
18	36.0	8.8	24.4	6.2	17.3
21	36.2	9.8	27.1	6.9	19.1
24	36.5	10.8	29.6	7.6	20.9
27	36.6	12.2	33.2	11.4	31.2
30	36.7	13.8	37.4	11.6	31.5
33	36.8	15.3	41.6	11.7	31.9
36	36.9	19.3	52.3	11.9	32.2
39	37.6	20.5	54.5	12.0	32.1
42	38.1	21.5	56.5	12.2	32.0
45	38.7	22.5	58.2	12.3	31.9
47	39.0	23.1	59.2	18.0	46.2
49.9	39.2	23.5	60.0	18.4	46.9
54	39.6	24.2	61.2	19.0	47.9
57	39.9	24.7	62.0	19.4	48.5
60	40.1	27.6	68.8	21.8	54.3
		Stream widths greater than 0.8-ft depth			
9.1	31.1	0.0	0.0	0.0	0.0
12	34.2	.2	.5	.2	.5
15	35.2	.6	1.6	.6	1.6
18	36.0	.9	2.6	.9	2.6
21	36.2	1.2	3.4	1.2	3.4
24	36.5	1.5	4.2	1.5	4.2
27	36.6	6.1	16.6	4.3	11.7
30	36.7	6.9	18.9	4.9	13.3
33	36.8	7.8	21.1	5.5	14.9
36	36.9	8.6	23.2	6.0	16.4
39	37.6	9.4	25.2	6.7	17.8
42	38.1	10.3	26.9	7.2	19.0
45	38.7	11.0	28.5	7.8	20.1
47	39.0	11.7	30.0	11.4	29.2
49.9	39.2	13.0	33.0	11.5	29.3
54	39.6	14.8	37.3	11.7	29.5
57	39.9	16.0	40.1	11.8	29.6
60	40.1	19.6	48.8	11.9	29.7



Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T1	43° 58' 32.65" N	114° 48' 25.86" W
RB T1	43° 58' 32.50" N	114° 48' 26.71" W
LB T2	43° 58' 31.96" N	114° 48' 25.52" W
RB T2	43° 58' 31.70" N	114° 48' 26.44" W
LB T3	43° 58' 31.42" N	114° 48' 25.19" W
RB T3	43° 58' 31.00" N	114° 48' 26.16" W
LB T4	43° 58' 28.05" N	114° 48' 22.55" W
RB T4	43° 58' 27.62" N	114° 48' 23.50" W
LB T5	43° 58' 27.00" N	114° 48' 21.95" W

Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
RB T5	43° 58' 26.99" N	114° 48' 22.69" W
LB T6	43° 58' 26.70" N	114° 48' 21.95" W
RB T6	43° 58' 26.71" N	114° 48' 22.61" W
LB T7	43° 58' 25.18" N	114° 48' 21.90" W
RB T7	43° 58' 26.33" N	114° 48' 23.49" W
LB T8	43° 58' 25.34" N	114° 48' 22.54" W
RB T8	43° 58' 25.65" N	114° 48' 23.22" W
LB T9	43° 58' 25.18" N	114° 48' 21.90" W
RB T9	43° 58' 24.44" N	114° 48' 21.68" W

For reference only; stream schematic not to scale.

Figure A5. Plan view of Salmon River above Alturas Lake Creek (SR1), upper Salmon River Basin, Idaho, 2004.

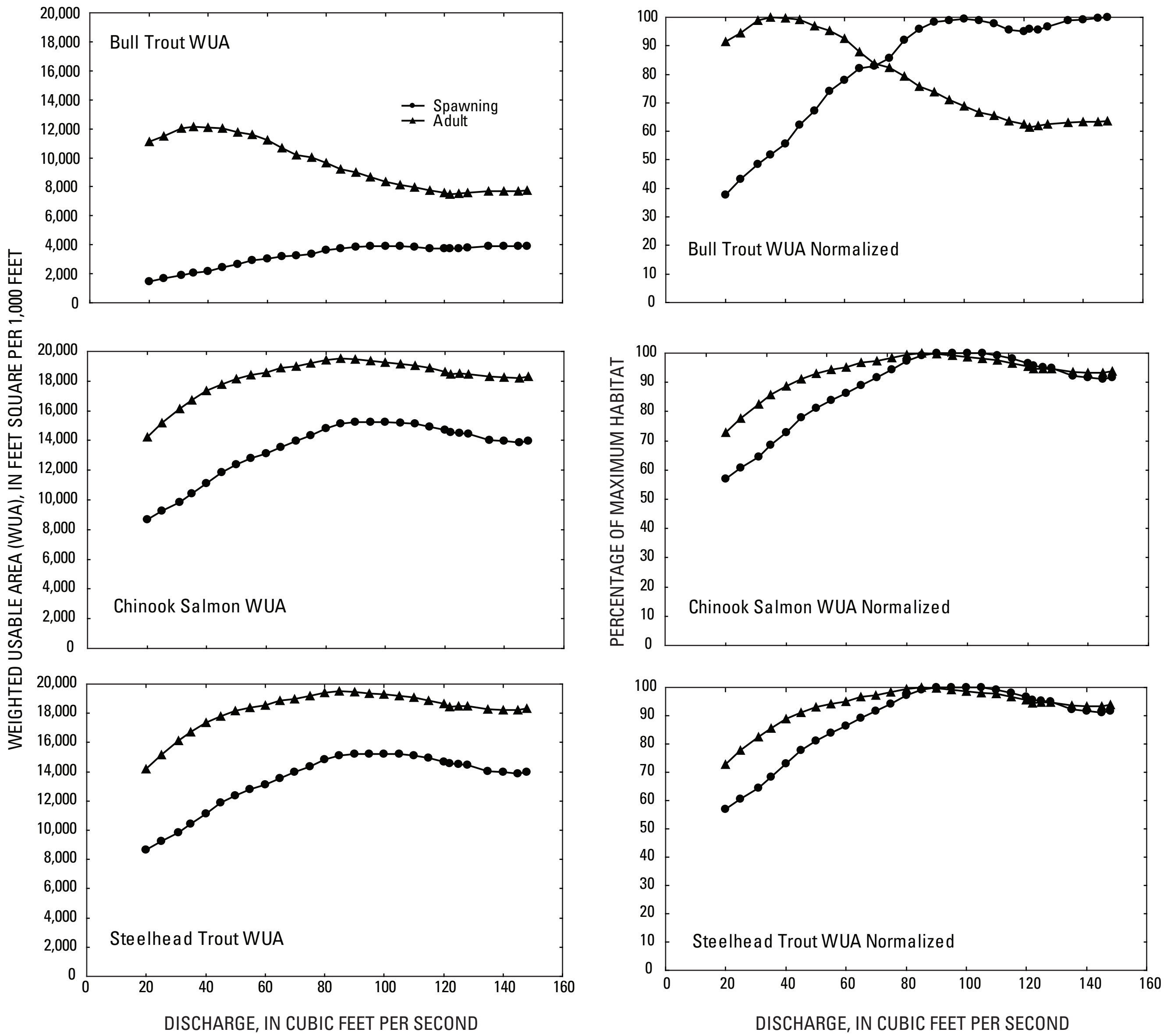


Figure A6. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, Salmon River above Alturas Lake Creek (SR1), upper Salmon River Basin, Idaho, 2004.

Table A4. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site SR1, Salmon River above Alturas Lake Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; $ft^2/1{,}000$ ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1{,}000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
20	27,413	11,095	1,482	91.3	37.8
25	28,987	11,489	1,692	94.6	43.1
30.9	30,112	12,012	1,904	98.9	48.5
35	30,644	12,148	2,035	100.0	51.9
40	31,228	12,098	2,181	99.6	55.6
45	31,858	12,059	2,439	99.3	62.1
50	32,406	11,781	2,643	97.0	67.3
55	32,764	11,582	2,910	95.3	74.1
60	33,091	11,243	3,060	92.6	78.0
65	33,358	10,664	3,219	87.8	82.0
70	33,603	10,169	3,260	83.7	83.1
75	33,810	10,012	3,361	82.4	85.6
80	34,005	9,631	3,608	79.3	91.9
85	34,195	9,206	3,760	75.8	95.8
90	34,382	8,977	3,864	73.9	98.4
95	34,560	8,651	3,884	71.2	99.0
100	34,732	8,361	3,899	68.8	99.3
105	34,896	8,115	3,884	66.8	99.0
110	35,058	7,955	3,836	65.5	97.8
115	35,211	7,744	3,751	63.8	95.6
120	35,363	7,603	3,729	62.6	95.0
122	35,342	7,478	3,766	61.6	96.0
125	35,501	7,536	3,751	62.0	95.6
128	35,583	7,604	3,794	62.6	96.7
135	36,175	7,670	3,883	63.1	98.9
140	36,390	7,702	3,894	63.4	99.2
145	36,958	7,704	3,913	63.4	99.7
148	37,145	7,724	3,925	63.6	100.0

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1{,}000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Chinook salmon					
20	27,413.	14,214	8,669	72.8	56.9
25	28,987	15,176	9,238	77.7	60.7
30.9	30,112	16,138	9,821	82.6	64.5
35	30,644	16,729	10,423	85.7	68.4
40	31,228	17,343	11,112	88.8	73.0
45	31,858	17,792	11,858	91.1	77.9
50	32,406	18,162	12,356	93.0	81.2
55	32,764	18,406	12,780	94.2	83.9
60	33,091	18,571	13,134	95.1	86.3
65	33,358	18,883	13,565	96.7	89.1
70	33,603	19,004	13,952	97.3	91.6
75	33,810	19,204	14,358	98.3	94.3
80	34,005	19,420	14,818	99.4	97.3
85	34,195	19,530	15,111	100.0	99.2
90	34,382	19,489	15,226	99.8	100.0
95	34,560	19,371	15,221	99.2	100.0
100	34,732	19,284	15,220	98.7	100.0
105	34,896	19,168	15,209	98.2	100.0
110	35,058	19,071	15,117	97.6	99.3
115	35,211	18,868	14,931	96.6	98.1
120	35,363	18,644	14,700	95.5	96.5
122	35,342	18,467	14,553	94.6	95.6
125	35,501	18,504	14,503	94.8	95.2
128	35,583	18,483	14,445	94.6	94.9
135	36,175	18,283	14,034	93.6	92.1
140	36,390	18,243	13,956	93.4	91.7
145	36,958	18,207	13,882	93.2	91.2
148	37,145	18,312	13,952	93.8	91.6

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1{,}000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Steelhead trout					
20	27,413	14,214	8,669	72.8	56.9
25	28,987	15,175	9,238	77.7	60.7
30.9	30,112	16,138	9,821	82.6	64.5
35	30,644	16,729	10,423	85.7	68.4
40	31,228	17,343	11,112	88.8	73.0
45	31,858	17,792	11,858	91.1	77.9
50	32,406	18,162	12,356	93.0	81.2
55	32,764	18,406	12,780	94.2	83.9
60	33,091	18,572	13,134	95.1	86.3
65	33,358	18,883	13,565	96.7	89.1
70	33,603	19,004	13,952	97.3	91.6
75	33,810	19,205	14,358	98.3	94.3
80	34,005	19,420	14,818	99.4	97.3
85	34,195	19,530	15,111	100.0	99.2
Steelhead trout—Continued					
90	34,382	19,489	15,226	99.8	100.0
95	34,560	19,371	15,221	99.2	100.0
100	34,732	19,284	15,220	98.7	100.0
105	34,896	19,168	15,209	98.2	99.9
110	35,058	19,071	15,117	97.6	99.3
115	35,211	18,868	14,931	96.6	98.1
120	35,363	18,644	14,700	95.5	96.6
122	35,342	18,467	14,553	94.6	95.6
125	35,501	18,504	14,503	94.8	95.2
128	35,583	18,483	14,445	94.6	94.9
135	36,175	18,283	14,034	93.6	92.2
140	36,390	18,243	13,956	93.4	91.7
145	36,958	18,207	13,882	93.2	91.2
148	37,145	18,312	13,952	93.8	91.6

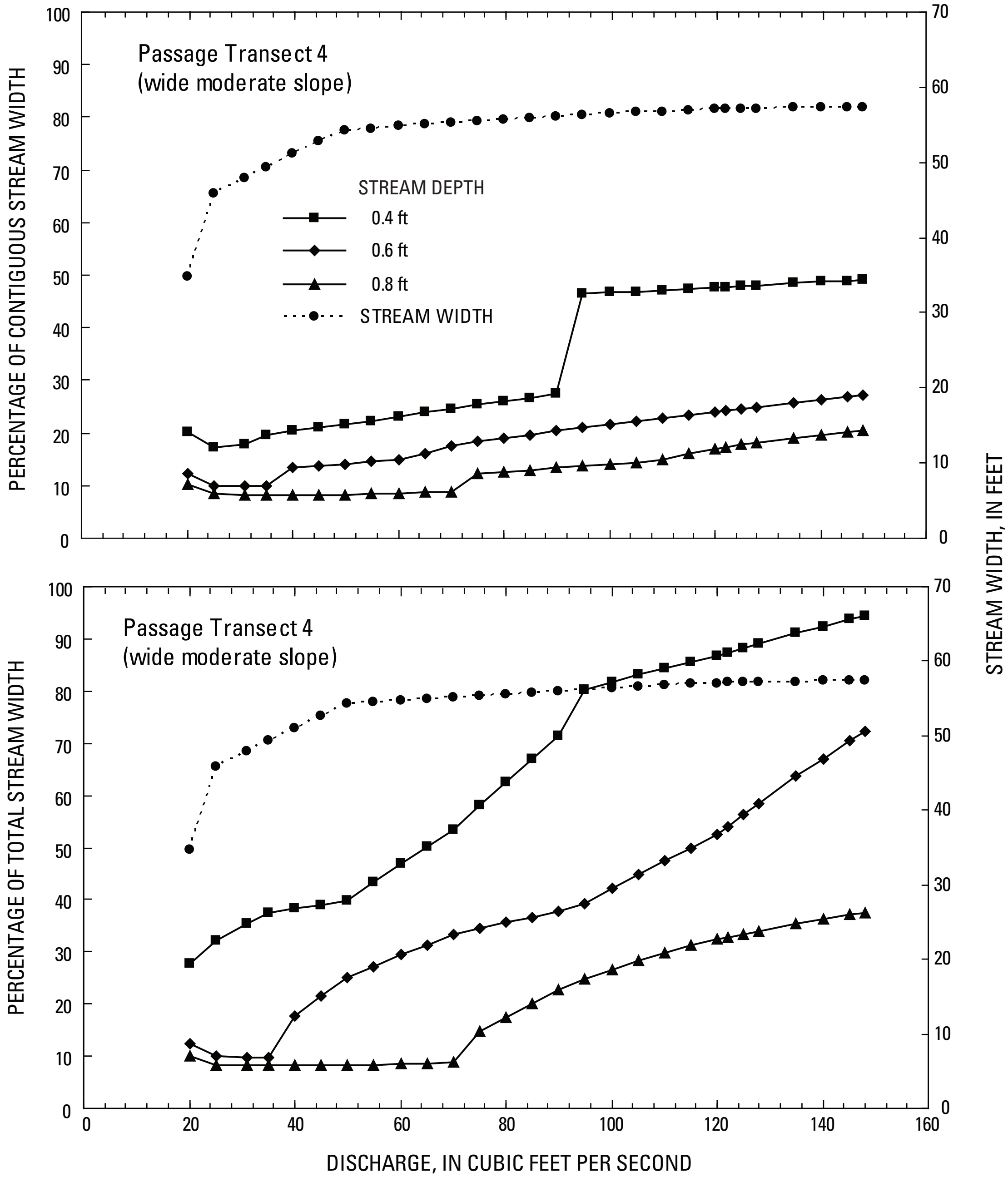


Figure A7. Percentages of contiguous and total stream width for passage transect 4, Salmon River above Alturas Lake Creek (SR1), upper Salmon River Basin, Idaho, 2004.

Table A5. Passage criteria assessment for transect 4 (wide moderate slope), site SR1, Salmon River above Alturas Lake Creek, upper Salmon River Basin, Idaho, 2004

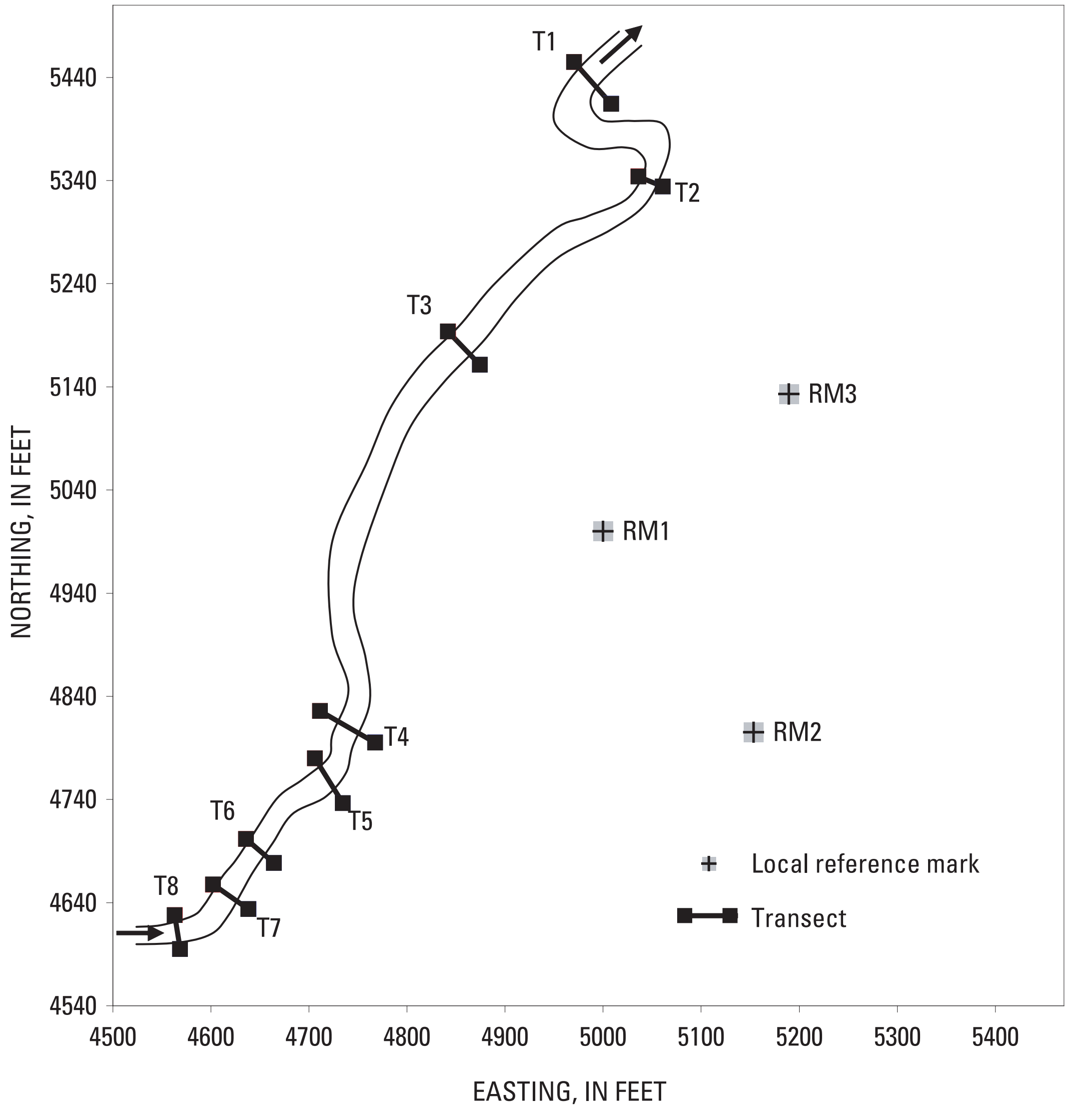
[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
20	34.8	9.6	27.6	7.0	20.2
25	45.8	14.7	32.0	7.9	17.2
31	47.9	17.0	35.4	8.5	17.8
35	49.3	18.4	37.4	9.7	19.6
40	51.1	19.6	38.3	10.4	20.4
45	52.7	20.6	39.0	11.1	21.0
50	54.3	21.6	39.7	11.7	21.5
55	54.5	23.6	43.3	12.2	22.4
60	54.8	25.6	46.8	12.7	23.2
65	55.0	27.6	50.1	13.2	23.9
70	55.2	29.4	53.3	13.6	24.7
75	55.4	32.2	58.2	14.1	25.4
80	55.6	34.8	62.5	14.5	26.1
85	55.8	37.4	66.9	14.9	26.7
90	56.0	40.0	71.4	15.3	27.4
95	56.2	45.1	80.3	26.1	46.4
100	56.4	46.1	81.7	26.3	46.7
105	56.6	47.0	83.1	26.6	46.9
110	56.8	47.9	84.3	26.8	47.1
115	56.9	48.7	85.5	27.0	47.4
120	57.1	49.5	86.7	27.2	47.6
122	57.1	49.9	87.3	27.2	47.7
125	57.2	50.4	88.2	27.4	47.9
128	57.2	51.0	89.1	27.5	48.0
135	57.3	52.2	91.1	27.7	48.4
140	57.3	53.0	92.5	27.9	48.7
145	57.4	53.8	93.8	28.1	49.0
148	57.4	54.3	94.5	28.2	49.1

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.6-ft depth			
20	34.8	4.3	12.3	4.3	12.3
25	45.8	4.6	9.9	4.6	9.9
31	47.9	4.7	9.9	4.7	9.9
35	49.3	4.8	9.8	4.8	9.8
40	51.1	9.0	17.6	6.9	13.6
45	52.7	11.4	21.6	7.3	13.8
50	54.3	13.6	25.1	7.6	14.1
55	54.5	14.9	27.3	7.9	14.6
60	54.8	16.1	29.4	8.2	15.0
65	55.0	17.2	31.4	8.8	15.9
70	55.2	18.4	33.3	9.6	17.4
75	55.4	19.2	34.6	10.1	18.3
80	55.6	19.8	35.6	10.6	19.0
85	55.8	20.5	36.7	11.0	19.7
90	56.0	21.2	37.8	11.4	20.4
95	56.2	22.1	39.3	11.8	21.0
100	56.4	23.8	42.2	12.2	21.7
105	56.6	25.4	44.9	12.6	22.3
110	56.8	26.9	47.4	13.0	22.9
115	56.9	28.4	49.8	13.4	23.5
120	57.1	29.9	52.4	13.7	24.0
122	57.1	30.8	53.9	13.8	24.2
125	57.2	32.1	56.2	14.1	24.6
128	57.2	33.4	58.5	14.3	25.0
135	57.3	36.4	63.6	14.8	25.8
140	57.3	38.4	67.1	15.1	26.3
145	57.4	40.4	70.4	15.4	26.8
148	57.4	41.5	72.4	15.6	27.2

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.8-ft depth			
20	34.8	3.5	10.2	3.5	10.2
25	45.8	3.8	8.3	3.8	8.3
31	47.9	4.0	8.3	4.0	8.3
35	49.3	4.1	8.3	4.1	8.3
40	51.1	4.2	8.3	4.2	8.3
45	52.7	4.4	8.3	4.4	8.3
50	54.3	4.5	8.2	4.5	8.2
55	54.5	4.6	8.4	4.6	8.4
60	54.8	4.7	8.5	4.7	8.5
65	55.0	4.8	8.6	4.8	8.6
70	55.2	4.8	8.8	4.8	8.8
75	55.4	8.1	14.6	6.8	12.2
80	55.6	9.6	17.3	7.0	12.6
85	55.8	11.1	20.0	7.3	13.0
		Stream widths greater than 0.8-ft depth—Continued			
90	56.0	12.7	22.7	7.5	13.4
95	56.2	14.0	24.8	7.7	13.8
100	56.4	15.0	26.6	8.0	14.1
105	56.6	16.0	28.2	8.2	14.5
110	56.8	16.9	29.7	8.5	14.9
115	56.9	17.8	31.2	9.2	16.1
120	57.1	18.6	32.5	9.8	17.1
122	57.1	18.8	32.9	9.9	17.3
125	57.2	19.1	33.5	10.1	17.7
128	57.2	19.5	34.0	10.3	18.1
135	57.3	20.2	35.3	10.8	18.9
140	57.3	20.8	36.2	11.2	19.5
145	57.4	21.2	37.1	11.5	20.0
148	57.4	21.6	37.6	11.7	20.4

Appendix B. Plan view, weighted useable areas and passage criteria assessments for bull trout, Chinook salmon, and steelhead trout for lower Beaver Creek (BC1), upper Salmon River Basin, Idaho, 2004.



Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T1	43° 55' 29.19" N	114° 48' 39.47" W
RB T1	43° 55' 29.56" N	114° 48' 40.03" W
LB T2	43° 55' 28.45" N	114° 48' 38.65" W
RB T2	43° 55' 28.53" N	114° 48' 39.00" W
LB T3	43° 55' 26.59" N	114° 48' 40.97" W
RB T3	43° 55' 26.87" N	114° 48' 41.45" W
LB T4	43° 55' 22.89" N	114° 48' 41.97" W
RB T4	43° 55' 23.14" N	114° 48' 42.77" W

Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T5	43° 55' 22.28" N	114° 48' 42.34" W
RB T5	43° 55' 22.68" N	114° 48' 42.78" W
LB T6	43° 55' 21.64" N	114° 48' 43.22" W
RB T6	43° 55' 21.85" N	114° 48' 43.64" W
LB T7	43° 55' 21.18" N	114° 48' 43.52" W
RB T7	43° 55' 21.38" N	114° 48' 44.04" W
LB T8	43° 55' 20.74" N	114° 48' 44.42" W
RB T8	43° 55' 21.05" N	114° 48' 44.53" W

For reference only; stream schematic not to scale.

Figure B1. Plan view of lower Beaver Creek (BC1), upper Salmon River Basin, Idaho, 2004.

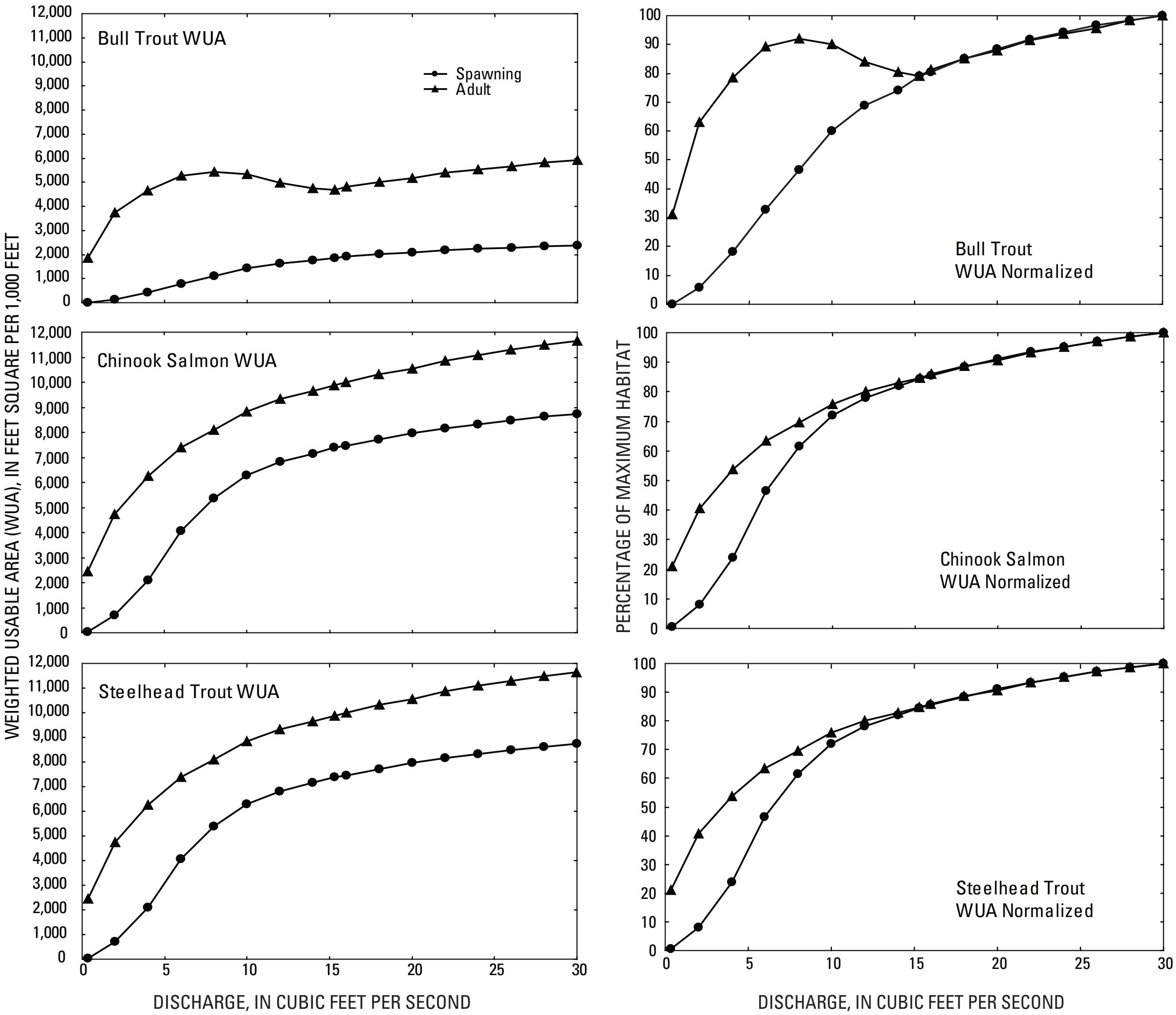


Figure B2. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, lower Beaver Creek (BC1), upper Salmon River Basin, Idaho, 2004.

Table B1. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site BC1, lower Beaver Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; $ft^2/1,000$ ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1,000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
0.34	13,137	1,839	0	31.1	0.0
2	18,339	3,728	135	63.1	5.7
4	19,352	4,634	433	78.5	18.3
6	20,174	5,275	774	89.3	32.7
8	21,033	5,430	1,105	91.9	46.7
10	21,524	5,328	1,422	90.2	60.1
12	21,833	4,970	1,628	84.2	68.8
14	22,099	4,743	1,757	80.3	74.2
15.3	22,265	4,674	1,869	79.1	79.0
16	22,355	4,798	1,903	81.2	80.4
18	22,587	5,022	2,013	85.0	85.0
20	22,798	5,186	2,093	87.8	88.4
22	22,991	5,405	2,169	91.5	91.6
24	23,158	5,529	2,228	93.6	94.1
26	23,320	5,653	2,287	95.7	96.6
28	23,470	5,809	2,330	98.4	98.4
30	23,613	5,906	2,367	100.0	100.0
Chinook salmon					
0.34	13,137	2,438	37	20.9	0.4
2	18,339	4,732	701	40.6	8.0
4	19,352	6,256	2,082	53.7	23.8
6	20,174	7,384	4,054	63.4	46.4
8	21,033	8,103	5,380	69.6	61.6
10	21,524	8,834	6,293	75.9	72.0
12	21,833	9,318	6,819	80.0	78.2
14	22,099	9,656	7,154	83.0	81.9
15.3	22,265	9,864	7,381	84.7	84.5
16	22,355	10,012	7,466	86.0	85.5
18	22,587	10,330	7,722	88.7	88.4
20	22,798	10,555	7,955	90.7	91.1
22	22,991	10,871	8,164	93.4	93.5
24	23,158	11,082	8,315	95.2	95.2
26	23,320	11,305	8,484	97.1	97.1
28	23,470	11,496	8,624	98.8	98.7
30	23,613	11,641	8,735	100.0	100.0
Steelhead trout					
0.34	13,137	2,438	36	20.9	0.4
2	18,339	4,732	701	40.6	8.0
4	19,352	6,256	2,082	53.7	23.8
6	20,174	7,384	4,054	63.4	46.4
8	21,033	8,103	5,380	69.6	61.6
10	21,524	8,834	6,293	75.9	72.0
12	21,833	9,318	6,819	80.0	78.1
14	22,099	9,656	7,154	83.0	81.9
15.3	22,265	9,864	7,381	84.7	84.5
16	22,355	10,012	7,466	86.0	85.5
18	22,587	10,330	7,722	88.7	88.4
20	22,798	10,555	7,955	90.7	91.1
22	22,991	10,871	8,164	93.4	93.5
24	23,158	11,082	8,315	95.2	95.2
26	23,320	11,305	8,484	97.1	97.1
28	23,470	11,496	8,624	98.8	98.7
30	23,613	11,641	8,735	100.0	100.0

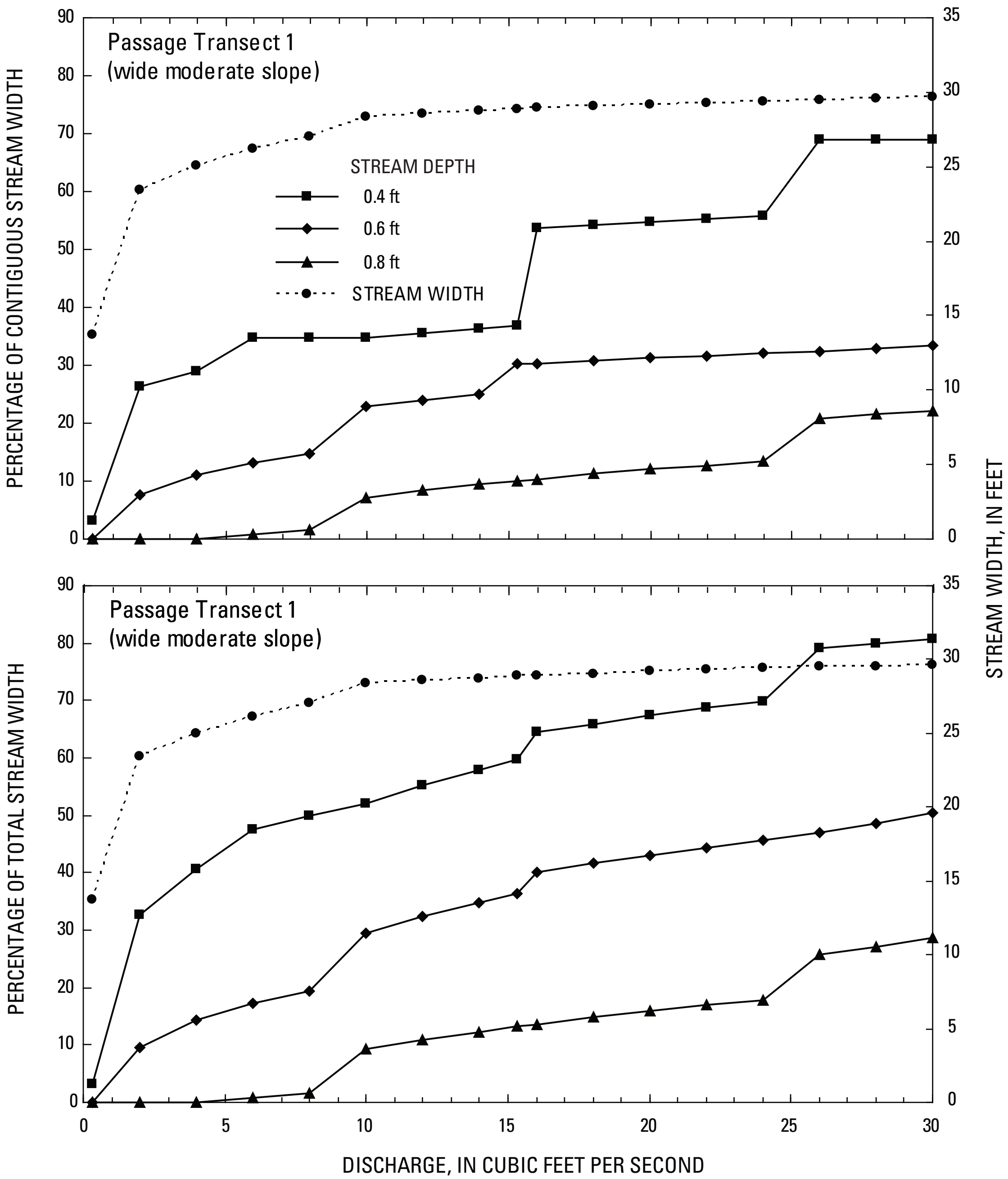


Figure B3. Percentages of contiguous and total stream width for passage transect 1, lower Beaver Creek (BC1), upper Salmon River Basin, Idaho, 2004.

Table B2. Passage criteria assessment for transect 1 (wide moderate slope), site BC1, lower Beaver Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
0.34	13.7	0.4	3.3	0.4	3.3
2	23.4	7.6	32.7	6.2	26.4
4	25.0	10.2	40.6	7.2	29.0
6	26.2	12.5	47.6	9.1	34.6
8	27.0	13.5	49.9	9.4	34.8
10	28.4	14.8	52.0	9.8	34.7
12	28.6	15.8	55.2	10.2	35.6
14	28.8	16.7	58.0	10.5	36.4
15.3	28.9	17.2	59.7	10.6	36.9
16	28.9	18.6	64.4	15.5	53.7
18	29.1	19.2	66.0	15.8	54.3
20	29.2	19.6	67.4	16.0	54.8
22	29.3	20.1	68.7	16.2	55.3
24	29.4	20.6	70.0	16.4	55.8
26	29.5	23.3	79.1	20.4	69.0
28	29.6	23.6	80.0	20.4	69.1
30	29.6	23.9	80.8	20.5	69.1
		Stream widths greater than 0.6-ft depth			
0.34	13.7	0.0	0.0	0.0	0.0
2	23.4	2.3	9.6	1.8	7.6
4	25.0	3.6	14.4	2.8	11.0
6	26.2	4.5	17.4	3.4	13.1
8	27.0	5.3	19.5	4.0	14.7
10	28.4	8.3	29.4	6.5	22.8
12	28.6	9.2	32.3	6.8	24.0
14	28.8	1.0	34.8	7.2	25.0
15.3	28.9	10.5	36.4	8.7	30.1
16	28.9	11.6	40.1	8.8	30.3
18	29.1	12.1	41.7	8.9	30.8
20	29.2	12.6	43.1	9.1	31.2
22	29.3	13.0	44.5	9.2	31.6
24	29.4	13.5	45.8	9.4	32.0
26	29.5	13.9	47.1	9.5	32.4
28	29.6	14.4	48.7	9.7	32.9
30	29.6	14.9	50.4	9.9	33.4

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.8-ft depth			
0.34	13.7	0.0	0.0	0.0	0.0
2	23.4	.0	.0	.0	.0
4	25.0	.0	.0	.0	.0
6	26.2	.2	.8	.2	.8
8	27.0	.4	1.5	.4	1.5
10	28.4	2.6	9.3	2.1	7.2
12	28.6	3.1	10.9	2.4	8.4
14	28.8	3.5	12.3	2.7	9.4
15.3	28.9	3.8	13.2	2.9	10.1
16	28.9	3.9	13.6	3.0	10.4
18	29.1	4.3	14.8	3.3	11.2
20	29.2	4.6	15.9	3.5	12.0
22	29.3	4.9	16.9	3.7	12.7
24	29.4	5.2	17.8	4.0	13.4
26	29.5	7.6	25.6	6.2	20.8
28	29.6	8.0	27.1	6.3	21.5
30	29.7	8.5	28.6	6.5	22.1

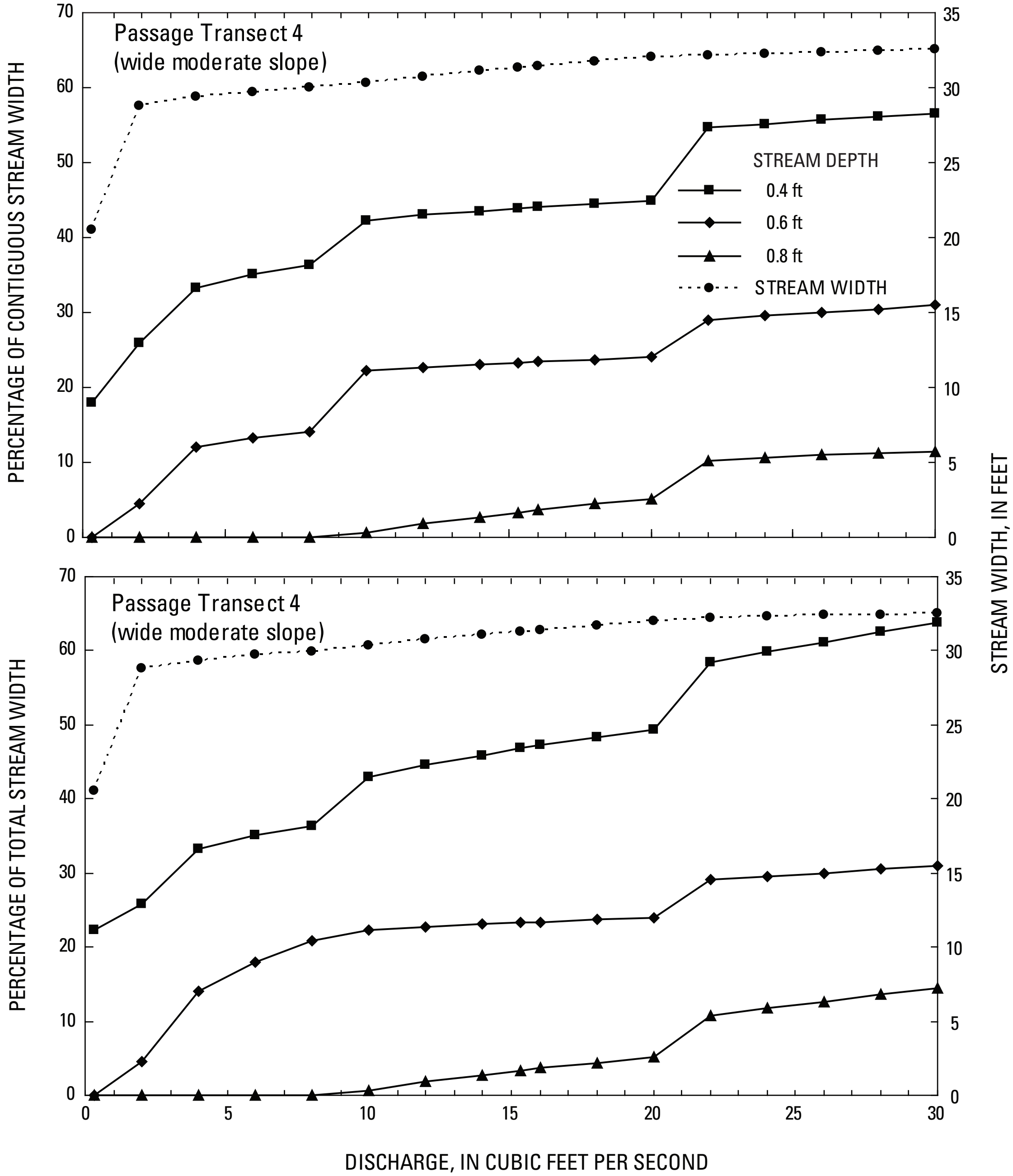


Figure B4. Percentages of contiguous and total stream width for passage transect 4, lower Beaver Creek (BC1), upper Salmon River Basin, Idaho, 2004.

Table B3. Passage criteria assessment for transect 4 (wide moderate slope), site BC1, lower Beaver Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
0.34	20.6	4.6	22.3	3.7	18.0
2	28.8	7.5	25.9	7.5	25.9
4	29.4	9.8	33.2	9.8	33.2
6	29.7	10.4	35.0	10.4	35.0
8	30.0	10.9	36.4	10.9	36.4
10	30.3	13.0	42.9	12.8	42.3
12	30.7	13.7	44.5	13.2	43.0
14	31.1	14.3	45.9	13.5	43.6
15.3	31.3	14.6	46.8	13.8	43.9
16	31.4	14.8	47.2	13.9	44.1
18	31.7	15.3	48.3	14.1	44.5
20	32.0	15.8	49.3	14.4	44.9
22	32.2	18.8	58.4	17.6	54.7
24	32.3	19.3	59.8	17.8	55.2
26	32.4	19.8	61.2	18.0	55.6
28	32.5	20.3	62.6	18.2	56.1
30	32.5	20.8	63.8	18.4	56.5
		Stream widths greater than 0.6-ft depth			
0.34	20.6	0.0	0.0	0.0	0.0
2	28.8	1.3	4.5	1.3	4.5
4	29.4	4.2	14.1	3.6	12.1
6	29.7	5.3	18.0	4.0	13.3
8	30.0	6.2	20.8	4.2	14.2
10	30.3	6.8	22.3	6.8	22.3
12	30.7	7.0	22.7	7.0	22.7
14	31.1	7.2	23.1	7.2	23.1
15.3	31.3	7.3	23.3	7.3	23.3
16	31.4	7.4	23.4	7.4	23.4
18	31.7	7.5	23.7	7.5	23.7
20	32.0	7.7	24.0	7.7	24.0
22	32.2	9.4	29.1	9.4	29.1
24	32.3	9.5	29.6	9.5	29.6
26	32.4	9.7	30.0	9.7	30.0
28	32.5	9.9	30.5	9.9	30.5
30	32.5	10.1	30.9	10.1	30.9
		Stream widths greater than 0.8-ft depth			
0.34	20.6	0.0	0.0	0.0	0.0
2	28.8	.0	.0	.0	.0
4	29.4	.0	.0	.0	.0
6	29.7	.0	.0	.0	.0
8	30.0	.0	.0	.0	.0
10	30.3	.2	.6	.2	.6
12	30.7	.6	1.8	.6	1.8
14	31.1	.9	2.8	.9	2.8
15.3	31.3	1.1	3.4	1.1	3.4
16	31.4	1.2	3.6	1.2	3.6
18	31.7	1.4	4.4	1.4	4.4
20	32.0	1.6	5.1	1.6	5.1
22	32.2	3.4	10.7	3.3	10.3
24	32.3	3.8	11.7	3.4	10.6
26	32.4	4.1	12.7	3.5	10.9
28	32.5	4.4	13.6	3.6	11.2
30	32.5	4.7	14.5	3.7	11.5

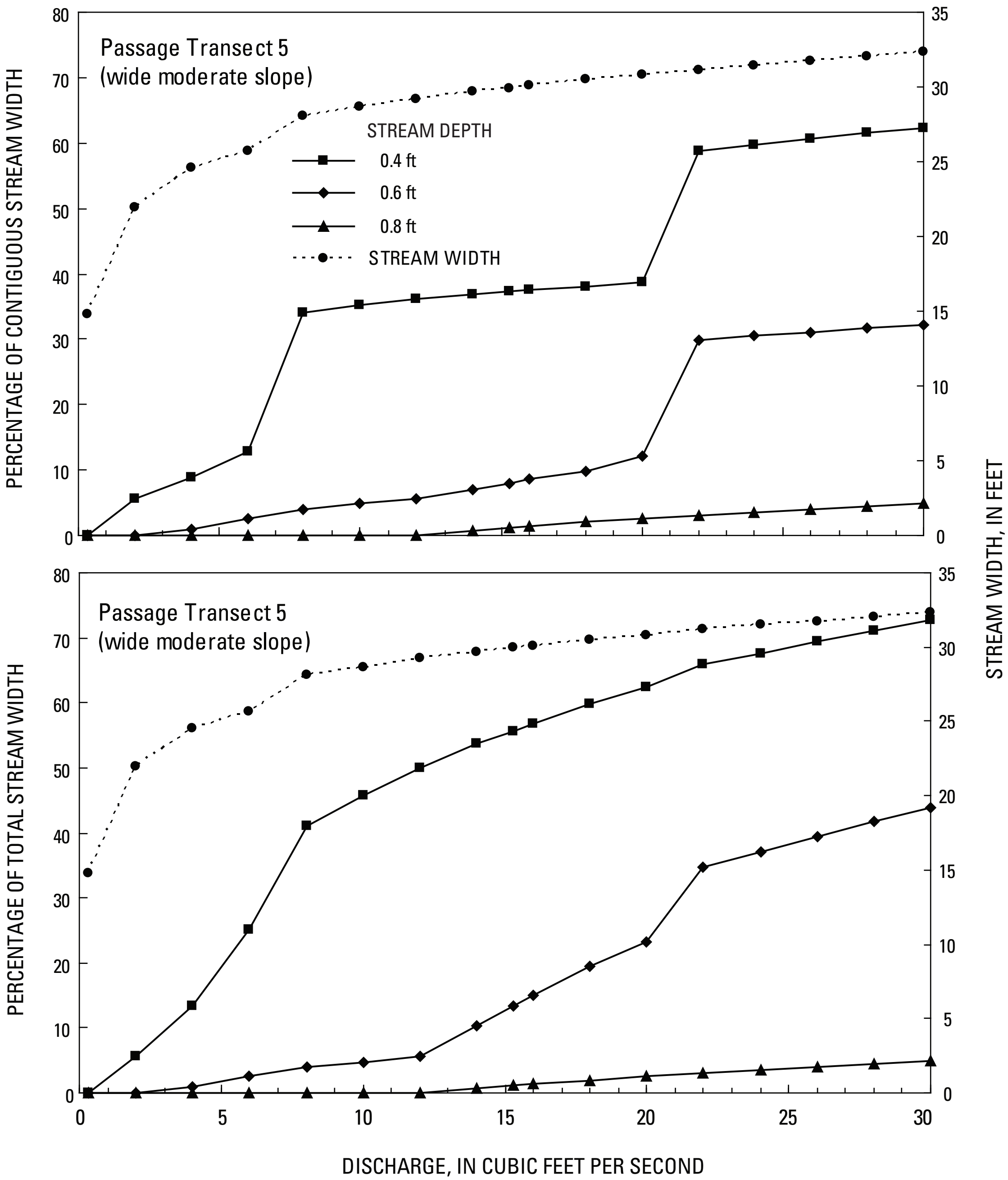


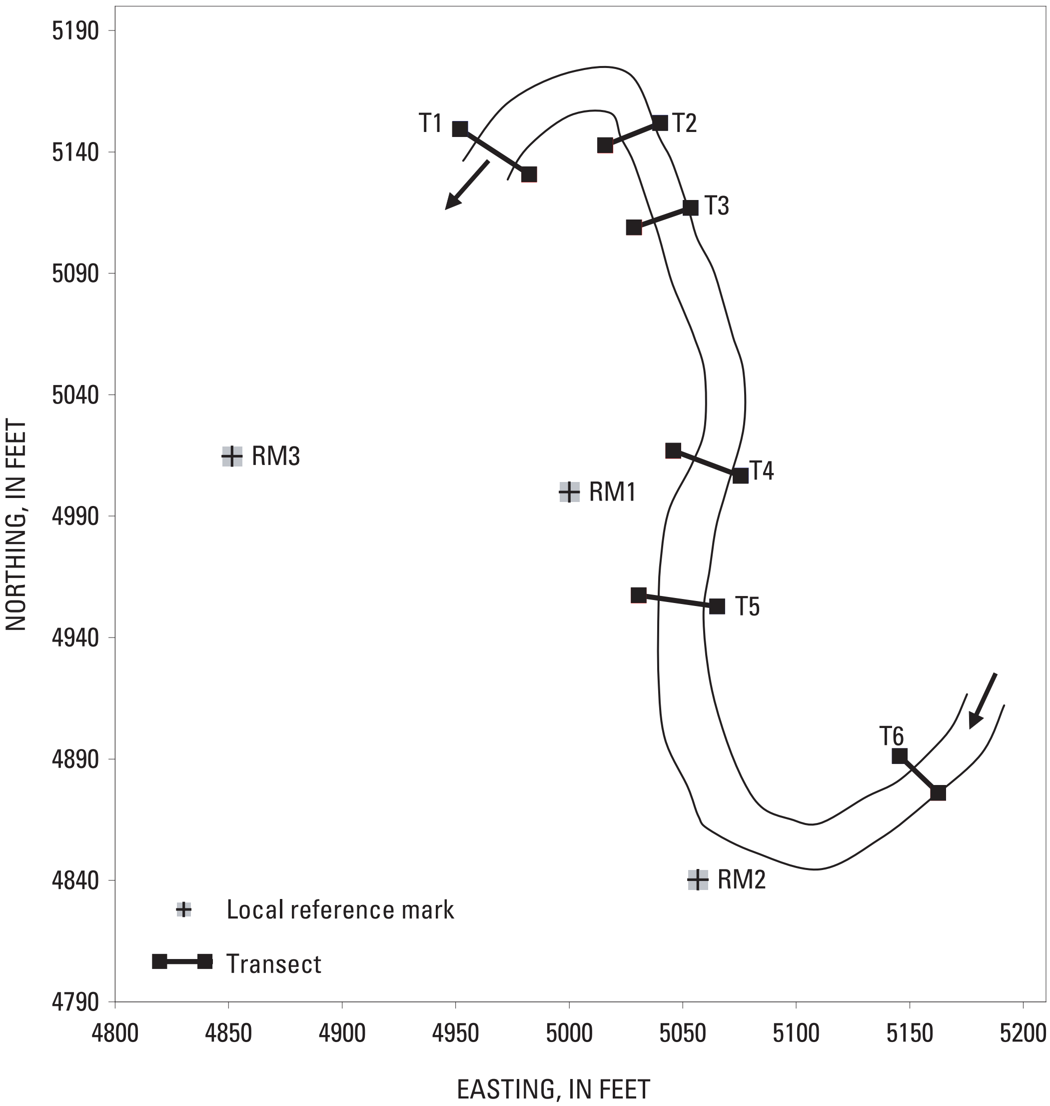
Figure B5. Percentages of contiguous and total stream width for passage lower Beaver Creek (BC1), upper Salmon River Basin, Idaho, 2004.

Table B4. Passage criteria assessment for transect 5 (wide moderate slope), site BC1, lower Beaver Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
0.34	14.8	0.0	0.0	0.0	0.0
2	21.9	1.2	5.7	1.2	5.7
4	24.6	3.3	13.5	2.2	8.9
6	25.7	6.4	25.0	3.3	12.7
8	28.1	11.5	41.1	9.6	34.0
10	28.7	13.1	45.8	10.1	35.1
12	29.2	14.6	50.0	10.5	36.1
14	29.7	15.9	53.6	10.9	36.8
15.3	30.0	16.7	55.7	11.2	37.3
16	30.1	17.1	56.8	11.3	37.5
18	30.5	18.2	59.8	11.6	38.1
20	30.8	19.2	62.4	11.9	38.7
22	31.2	20.5	65.9	18.3	58.7
24	31.5	21.3	67.6	18.8	59.7
26	31.8	22.0	69.4	19.2	60.6
28	32.0	22.8	71.0	19.7	61.5
30	32.3	23.5	72.6	20.2	62.4
		Stream widths greater than 0.6-ft depth			
0.34	14.8	0.0	0.0	0.0	0.0
2	21.9	.0	.0	.0	.0
4	24.6	.2	1.0	.2	1.0
6	25.7	.7	2.6	.7	2.6
8	28.1	1.1	3.9	1.1	3.9
10	28.7	1.4	4.8	1.4	4.8
12	29.2	1.6	5.6	1.6	5.6
14	29.7	3.1	10.3	2.1	7.1
15.3	30.0	4.0	13.4	2.4	8.0
16	30.1	4.5	15.0	2.6	8.5
18	30.5	5.9	19.4	3.0	9.8
20	30.8	7.2	23.2	3.8	12.2
22	31.2	10.8	34.7	9.3	29.9
24	31.5	11.7	37.1	9.6	30.5
26	31.8	12.6	39.5	9.9	31.1
28	32.0	13.4	41.7	10.1	31.7
30	32.3	14.2	43.9	10.4	32.2
		Stream widths greater than 0.8-ft depth			
0.34	14.8	0.0	0.0	0.0	0.0
2	21.9	.0	.0	.0	.0
4	24.6	.0	.0	.0	.0
6	25.7	.0	.0	.0	.0
8	28.1	.0	.0	.0	.0
10	28.7	.0	.0	.0	.0
12	29.2	.0	.0	.0	.0
14	29.7	.2	.7	.2	.7
15.3	30.0	.3	1.1	.3	1.1
16	30.1	.4	1.4	.4	1.4
18	30.5	.6	2.0	.6	2.0
20	30.8	.8	2.5	.8	2.5
22	31.2	1.0	3.1	1.0	3.1
24	31.5	1.1	3.5	1.1	3.5
26	31.8	1.3	4.0	1.3	4.0
28	32.0	1.4	4.4	1.4	4.4
30	32.3	1.6	4.8	1.6	4.8

Appendix C. Plan view, weighted useable areas and passage criteria assessments for bull trout, Chinook salmon, and steelhead trout for lower Pole Creek (PC1), upper Salmon River Basin, Idaho, 2004.



Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T1	43° 55' 29.73" N	114° 47' 44.48" W
RB T1	43° 55' 29.61" N	114° 47' 44.03" W
LB T2	43° 55' 29.93" N	114° 47' 43.31" W
RB T2	43° 55' 29.79" N	114° 47' 43.61" W
LB T3	43° 55' 29.61" N	114° 47' 43.04" W
RB T3	43° 55' 29.49" N	114° 47' 43.35" W

Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T4	43° 55' 28.59" N	114° 47' 42.44" W
RB T4	43° 55' 28.63" N	114° 47' 42.86" W
LB T5	43° 55' 28.05" N	114° 47' 42.43" W
RB T5	43° 55' 28.02" N	114° 47' 42.91" W
LB T6	43° 55' 27.61" N	114° 47' 41.19" W
RB T6	43° 55' 27.50" N	114° 47' 40.92" W

For reference only; stream schematic not to scale.

Figure C1. Plan view of lower Pole Creek (PC1), upper Salmon River Basin, Idaho, 2004.

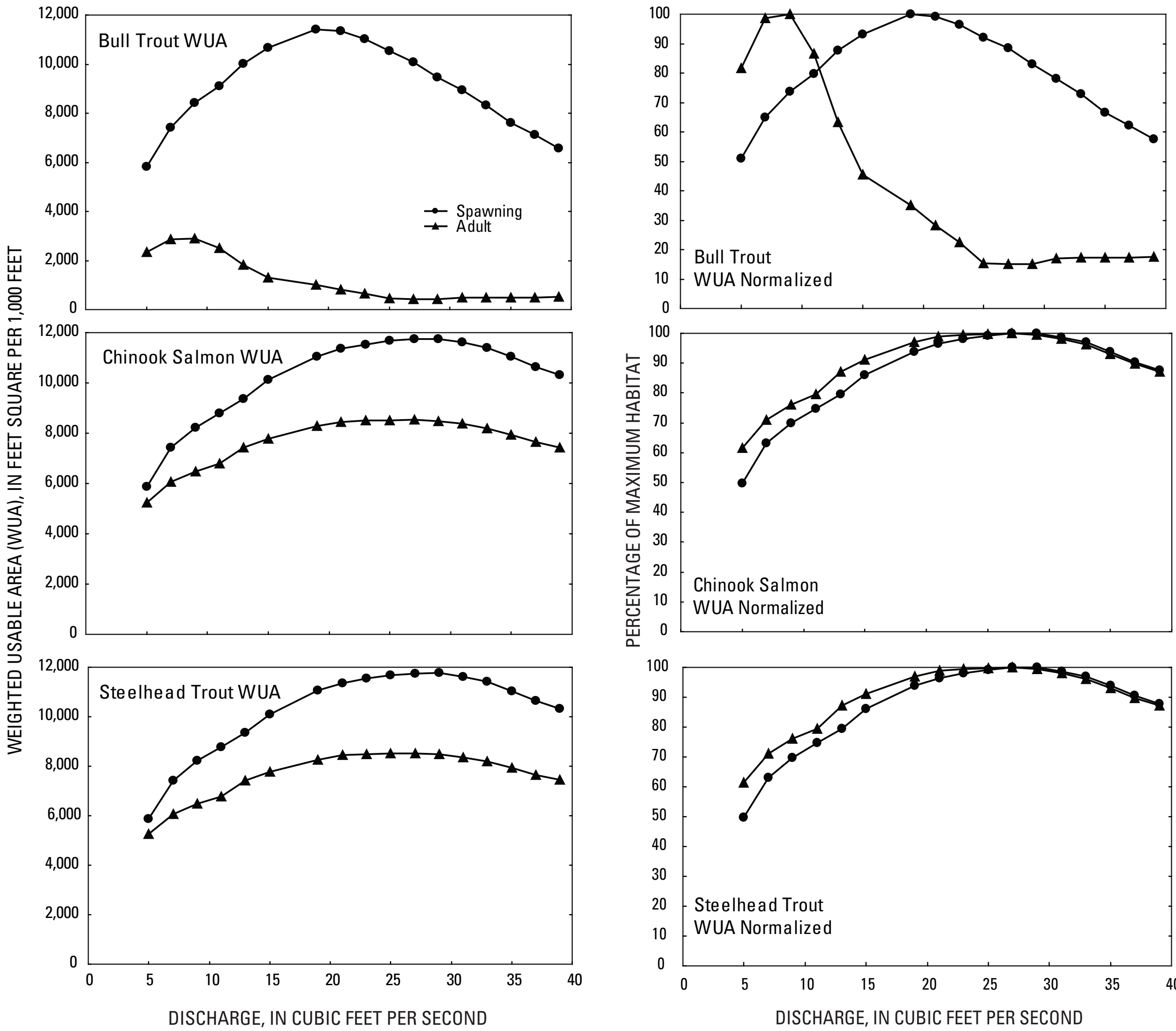


Figure C2. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, lower Pole Creek (PC1), upper Salmon River Basin, Idaho, 2004.

Table C1. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site PC1, lower Pole Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; ft^2/l,000 ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA (ft^2/1,000 ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
5	17,455	2,356	5,812	81.6	50.9
7	18,082	2,848	7,420	98.6	64.9
9	18,416	2,888	8,428	100.0	73.8
11	18,557	2,499	9,099	86.5	79.6
13	18,680	1,825	10,004	63.2	87.6
15	18,791	1,310	10,657	45.3	93.3
19	19,145	1,013	11,425	35.1	100.0
21	19,247	818	11,341	28.3	99.3
23	19,343	650	11,024	22.5	96.5
25	19,429	442	10,531	15.3	92.2
27	19,556	437	10,095	15.1	88.4
29	19,732	436	9,473	15.1	82.9
31	19,824	494	8,929	17.1	78.2
33	19,893	502	8,330	17.4	72.9
35	19,961	495	7,600	17.1	66.5
37	20,048	498	7,114	17.2	62.3
39	20,134	504	6,558	17.5	57.4
Chinook salmon					
5	17,454	5,247	5,860	61.5	49.8
7	18,082	6,061	7,422	71.1	63.1
9	18,416	6,488	8,212	76.1	69.8
11	18,557	6,781	8,787	79.5	74.7
13	18,680	7,431	9,355	87.1	79.6
15	18,791	7,762	10,112	91.0	86.0
19	19,145	8,270	11,049	97.0	94.0
21	19,247	8,438	11,350	98.9	96.5
23	19,343	8,493	11,539	99.6	98.1
25	19,429	8,514	11,674	99.8	99.3
27	19,556	8,529	11,751	100.0	99.9
29	19,732	8,473	11,761	99.4	100.0
31	19,824	8,368	11,605	98.1	98.7
33	19,893	8,198	11,412	96.1	97.0
35	19,961	7,938	11,046	93.1	93.9
37	20,048	7,652	10,636	89.7	90.4
39	20,134	7,439	10,322	87.2	87.8

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA (ft^2/1,000 ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Steelhead trout					
5	17,455	5,247	5,860	61.5	49.8
7	18,082	6,061	7,422	71.1	63.1
9	18,416	6,488	8,212	76.1	69.8
11	18,557	6,781	8,787	79.5	74.7
13	18,680	7,431	9,355	87.1	79.6
15	18,791	7,762	10,112	91.0	86.0
19	19,145	8,270	11,049	97.0	94.0
21	19,247	8,438	11,350	98.9	96.5
23	19,343	8,493	11,539	99.6	98.1
25	19,429	8,514	11,674	99.8	99.3
27	19,556	8,529	11,751	100.0	99.9
29	19,732	8,473	11,761	99.4	100.0
31	19,824	8,368	11,605	98.1	98.7
33	19,893	8,198	11,412	96.1	97.0
35	19,961	7,938	11,046	93.1	93.9
37	20,048	7,652	10,636	89.7	90.4
39	20,134	7,439	10,322	87.2	87.8

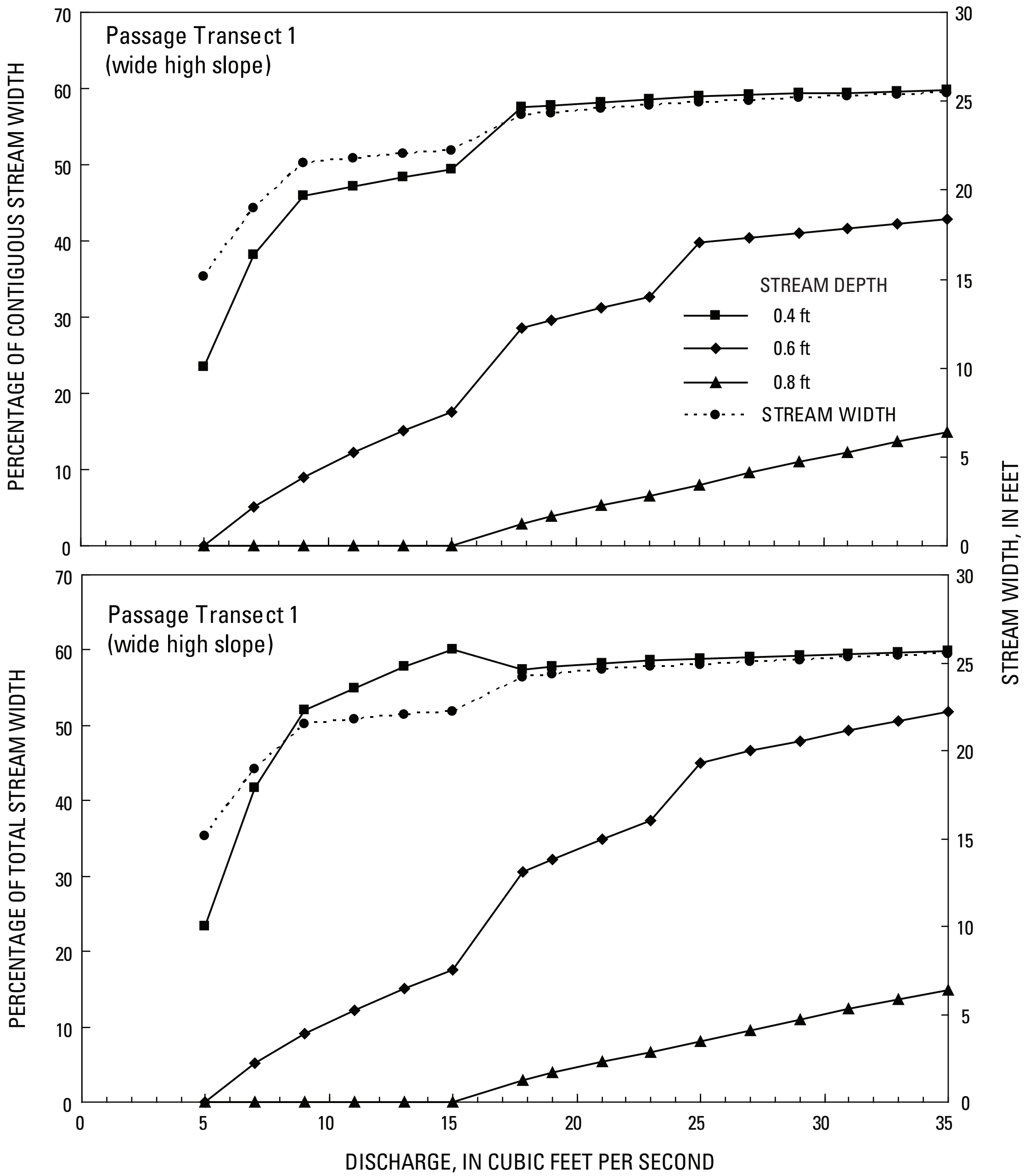


Figure C3. Percentages of contiguous and total stream width for passage transect 1, lower Pole Creek (PC1), upper Salmon River Basin, Idaho, 2004.

Table C2. Passage criteria assessment for transect 1 (wide high slope), site PC1, lower Pole Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
5	15.2	3.6	23.4	3.6	23.4
7	19.0	7.9	41.7	7.2	38.2
9	21.5	11.2	52.0	9.9	45.9
11	21.8	12.0	55.0	10.3	47.2
13	22.0	12.7	57.8	10.7	48.4
15	22.2	13.4	60.1	11.0	49.5
17.8	24.2	13.9	57.5	13.9	57.5
19	24.3	14.1	57.8	14.1	57.8
21	24.7	14.3	58.3	14.3	58.3
23	24.8	14.5	58.7	14.5	58.7
25	24.9	14.7	58.9	14.7	58.9
27	25.0	14.8	59.1	14.8	59.1
29	25.2	14.9	59.3	14.9	59.3
31	25.3	15.0	59.5	15.0	59.5
33	25.4	15.1	59.6	15.1	59.6
35	25.5	15.2	59.8	15.2	59.8
37	25.6	17.0	66.4	15.3	60.0
39	25.7	17.6	68.4	15.4	60.11
		Stream widths greater than 0.6-ft depth			
5	15.2	0.0	0.0	0.0	0.0
7	19.0	1.0	5.1	1.0	5.1
9	21.5	1.9	9.0	1.9	9.0
11	21.8	2.7	12.2	2.7	12.2
13	22.0	3.3	15.2	3.3	15.2
15	22.2	3.9	17.6	3.9	17.6
17.8	24.2	7.4	30.5	6.9	28.5
19	24.3	7.8	32.3	7.2	29.6
21	24.6	8.6	34.9	7.7	31.3
23	24.8	9.2	37.3	8.1	32.7
25	24.9	11.2	45.1	9.9	39.7
27	25.0	11.7	46.6	10.1	40.4
29	25.2	12.1	48.0	10.3	41.1
31	25.3	12.5	49.4	10.5	41.7
33	25.4	12.8	50.6	10.7	42.3
35	25.5	13.2	51.9	10.9	42.9
37	25.6	13.5	52.8	13.5	52.8
39	25.7	13.7	53.2	13.7	53.2
		Stream widths greater than 0.8-ft depth			
5	15.2	0.0	0.0	0.0	0.0
7	19.0	.0	.0	.0	.0
9	21.5	.0	.0	.0	.0
11	21.8	.0	.0	.0	.0
13	22.0	.0	.0	.0	.0
15	22.2	.0	.0	.0	.0
17.8	24.2	.7	2.9	.7	2.9
19	24.3	.9	3.9	.9	3.9
21	24.6	1.3	5.3	1.3	5.3
23	24.8	1.6	6.6	1.6	6.6
25	24.9	2.0	8.1	2.0	8.1
27	25.0	2.4	9.6	2.4	9.6
29	25.2	2.8	11.0	2.8	11.0
31	25.3	3.1	12.3	3.1	12.3
33	25.9	3.5	13.6	3.5	13.6
35	25.5	3.8	14.9	3.8	14.9
37	25.6	6.2	24.1	6.1	23.9
39	25.7	6.7	26.0	6.4	25.1

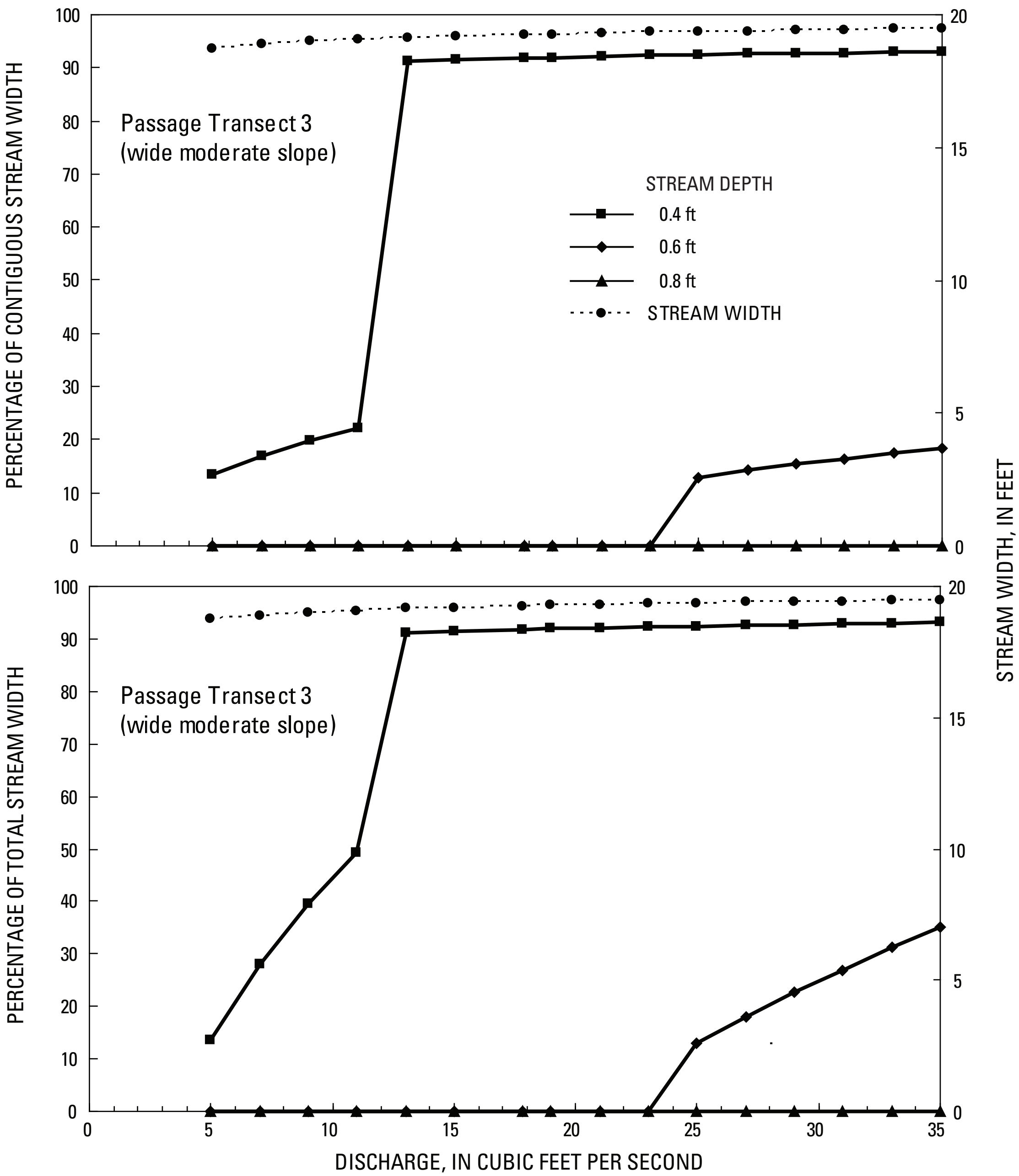


Figure C4. Percentages of contiguous and total stream width for passage transect 3, lower Pole Creek (PC1), upper Salmon River Basin, Idaho, 2004.

Table C3. Passage criteria assessment for transect 3 (wide moderate slope), site PC1, lower Pole Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
5	18.7	2.5	13.5	2.5	13.4
7	18.9	5.3	28.0	3.2	17.0
9	19.0	7.5	39.6	3.8	19.8
11	19.1	9.4	49.3	4.2	22.2
13	19.2	17.5	91.3	17.5	91.3
15	19.2	17.6	91.5	17.6	91.5
17.8	19.2	17.7	91.8	17.7	91.8
19	19.3	17.7	91.9	17.7	91.9
21	19.3	17.8	92.1	17.8	92.1
23	19.3	17.8	92.3	17.8	92.3
25	19.4	17.9	92.4	17.9	92.4
27	19.4	18.0	92.6	18.0	92.6
29	19.4	18.0	92.7	18.0	92.7
31	19.4	18.1	92.8	18.1	92.8
33	19.5	18.1	93.0	18.1	93.0
35	19.5	18.1	93.1	18.1	93.1
37	19.5	18.2	93.2	18.2	93.2
39	19.5	18.2	93.3	18.2	93.3
		Stream widths greater than 0.6-ft depth			
5	18.7	0.0	0.0	0.0	0.0
7	18.9	.0	.0	.0	.0
9	19.0	.0	.0	.0	.0
11	19.1	.0	.0	.0	.0
13	19.2	.0	.0	.0	.0
15	19.2	.0	.0	.0	.0
17.8	19.2	.0	.0	.0	.0
19	19.3	.0	.0	.0	.0
21	19.3	.0	.0	.0	.0
23	19.3	.0	.0	.0	.0
25	19.4	2.5	13.0	2.5	12.9
27	19.4	3.5	18.0	2.8	14.2
29	19.4	4.4	22.6	3.0	15.3
31	19.4	5.2	26.9	3.2	16.4
33	19.5	6.1	31.1	3.4	17.4
35	19.5	6.8	35.2	3.6	18.5
37	19.5	7.6	39.0	3.8	19.4
39	19.5	8.3	42.7	4.0	20.3
		Stream widths greater than 0.8-ft depth			
5	18.7	0.0	0.0	0.0	0.0
7	18.9	.0	.0	.0	.0
9	19.0	.0	.0	.0	.0
11	19.1	.0	.0	.0	.0
13	19.2	.0	.0	.0	.0
15	19.2	.0	.0	.0	.0
17.8	19.2	.0	.0	.0	.0
19	19.3	.0	.0	.0	.0
21	19.3	.0	.0	.0	.0
23	19.3	.0	.0	.0	.0
25	19.4	.0	.0	.0	.0
27	19.4	.0	.0	.0	.0
29	19.4	.0	.0	.0	.0
31	19.4	.0	.0	.0	.0
33	19.5	.0	.0	.0	.0
35	19.5	.0	.0	.0	.0
37	19.5	.0	.0	.0	.0
39	19.5	.0	.0	.0	.0

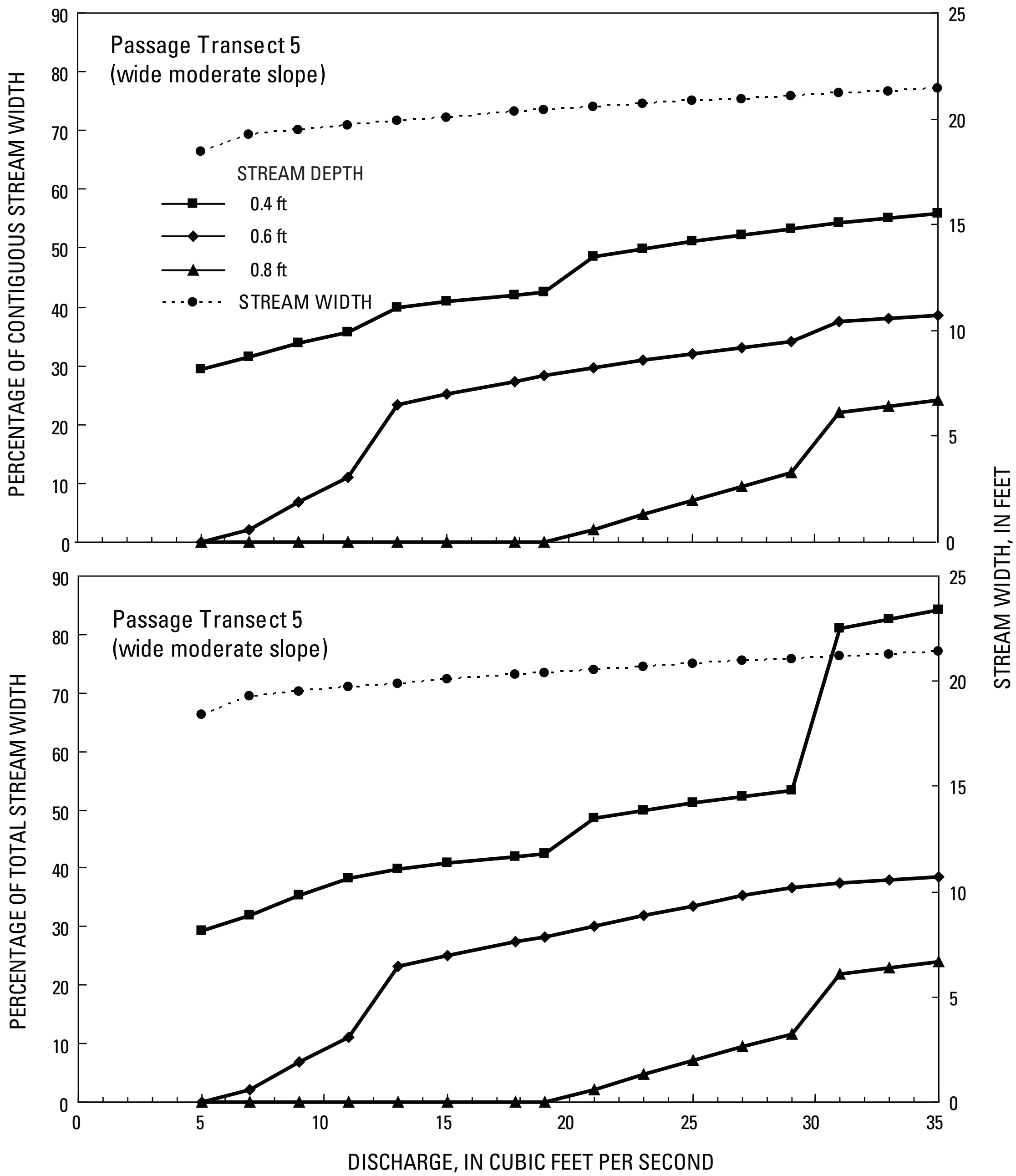


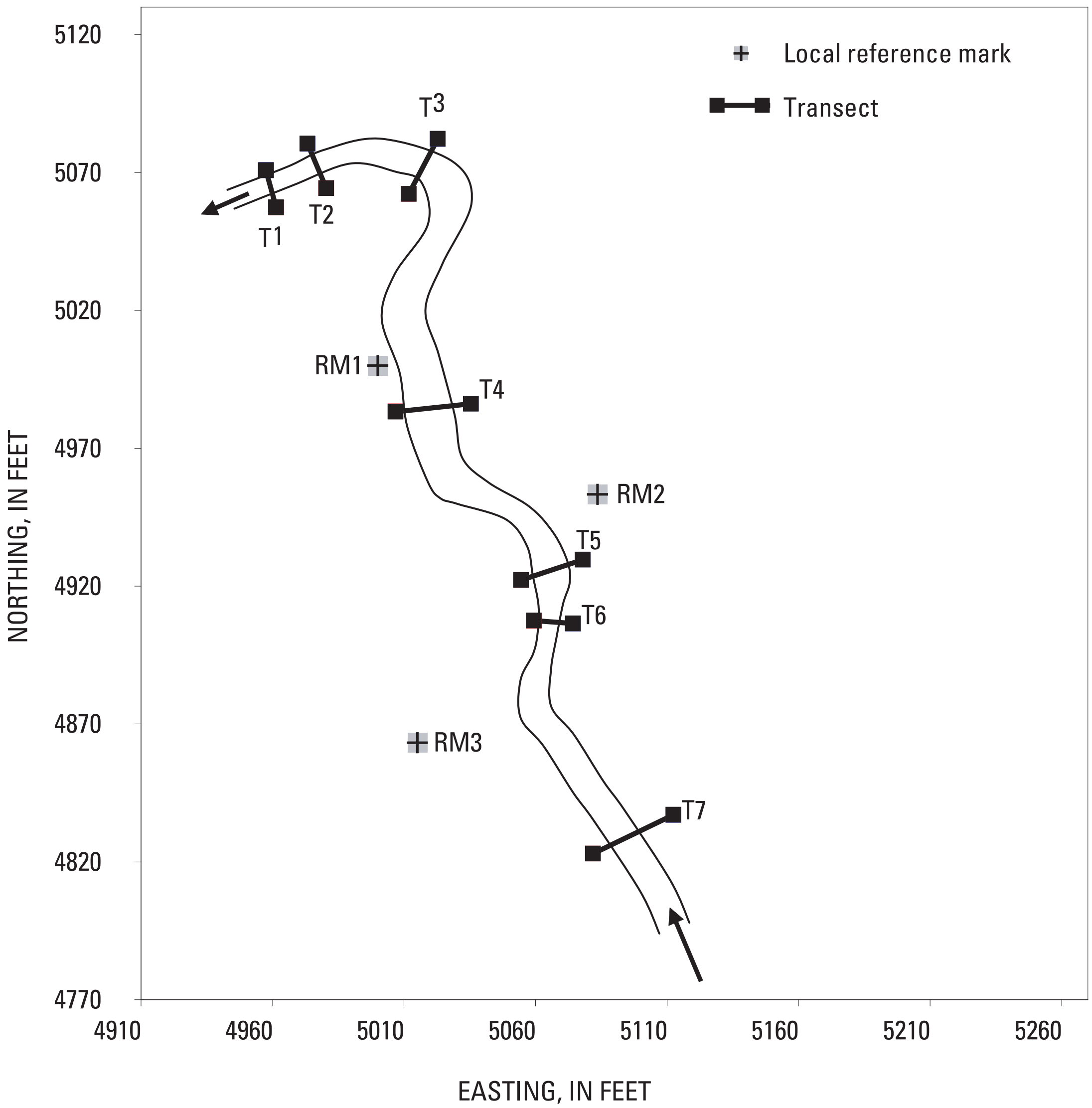
Figure C5. Percentages of contiguous and total stream width for passage transect 5, lower Pole Creek (PC1), upper Salmon River Basin, Idaho, 2004.

Table C4. Passage criteria assessment for transect 5 (wide moderate slope), site PC1, lower Pole Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment				Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous			Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth						Stream widths greater than 0.8-ft depth			
5	18.4	5.4	29.4	5.4	29.4	5	18.4	0.0	0.0	0.0	0.0
7	19.2	6.2	32.0	6.4	31.6	7	19.2	.0	.0	.0	.0
9	19.45	6.9	35.3	6.6	33.8	9	19.5	.0	.0	.0	.0
11	19.7	7.5	38.1	7.0	35.6	11	19.7	.0	.0	.0	.0
13	19.9	7.9	39.8	7.9	39.8	13	19.9	.0	.0	.0	.0
15	20.1	8.2	40.8	8.2	40.8	15	20.1	.0	.0	.0	.0
17.8	20.3	8.5	42.1	8.5	42.1	17.8	20.3	.0	.0	.0	.0
19	20.4	8.7	42.6	8.7	42.6	19	20.4	.0	.0	.0	.0
21	20.5	10.0	48.6	10.0	48.7	21	20.5	.4	2.1	.4	2.1
23	20.7	10.3	49.9	10.3	49.9	23	20.7	1.0	4.7	1.0	4.7
25	20.8	10.6	51.1	10.6	51.1	25	20.8	1.5	7.2	1.5	7.2
27	20.9	10.9	52.3	10.9	52.3	27	20.9	2.0	9.5	2.0	9.5
29	21.1	11.2	53.3	11.2	53.3	29	21.1	2.5	11.7	2.5	11.7
31	21.2	17.2	81.1	11.5	54.3	31	21.2	4.7	22.0	4.7	22.0
33	21.3	17.6	82.6	11.7	55.1	33	21.3	4.9	23.1	4.9	23.1
35	21.4	18.0	84.1	12.0	56.0	35	21.4	5.2	24.1	5.2	24.1
37	21.5	18.4	85.5	12.2	56.8	37	21.5	5.4	25.1	5.4	25.1
39	21.6	18.8	87.0	12.4	57.6	39	21.6	5.6	26.1	5.6	26.1
		Stream widths greater than 0.6-ft depth									
5	18.4	0.0	0.0	0.0	0.0						
7	19.2	.4	2.2	.4	2.1						
9	19.5	1.4	6.9	1.4	6.9						
11	19.7	2.2	11.0	2.2	11.0						
13	19.9	4.6	23.3	4.6	23.3						
15	20.1	5.0	25.1	5.0	25.1						
17.8	20.3	5.6	27.4	5.6	27.4						
19	20.4	5.8	28.3	5.8	28.3						
21	20.5	6.2	30.1	6.1	29.6						
23	20.7	6.6	31.9	6.4	30.8						
25	20.8	7.0	33.6	6.7	32.0						
27	20.9	7.4	35.2	6.9	33.1						
29	21.1	7.8	36.8	7.2	34.1						
31	21.2	7.9	37.5	7.9	37.5						
33	21.3	8.1	38.1	8.1	38.1						
35	21.4	8.3	38.6	8.3	38.6						
37	21.5	8.4	39.2	8.4	39.2						
39	21.6	8.6	39.8	8.6	39.8						

Appendix D. Plan view, weighted useable areas and passage criteria assessments for bull trout, Chinook salmon, and steelhead trout for lower Champion Creek (CC1), upper Salmon River Basin, Idaho, 2004.



Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T1	44° 1' 28.19" N	114° 50' 16.22" W
RB T1	44° 1' 28.06" N	114° 50' 16.15" W
LB T2	44° 1' 28.30" N	114° 50' 16.01" W
RB T2	44° 1' 28.14" N	114° 50' 15.90" W
LB T3	44° 1' 28.34" N	114° 50' 15.34" W
RB T3	44° 1' 28.14" N	114° 50' 15.47" W
LB T4	44° 1' 27.41" N	114° 50' 15.07" W

Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
RB T4	44° 1' 27.36" N	114° 50' 15.46" W
LB T5	44° 1' 26.88" N	114° 50' 14.44" W
RB T5	44° 1' 26.80" N	114° 50' 14.75" W
LB T6	44° 1' 26.65" N	114° 50' 14.46" W
RB T6	44° 1' 26.65" N	114° 50' 14.66" W
LB T7	44° 1' 26.00" N	114° 50' 13.87" W
RB T7	44° 1' 25.84" N	114° 50' 14.27" W

For reference only; stream schematic not to scale.

Figure D1. Plan view of lower Champion Creek (CC1), upper Salmon River Basin, Idaho, 2004.

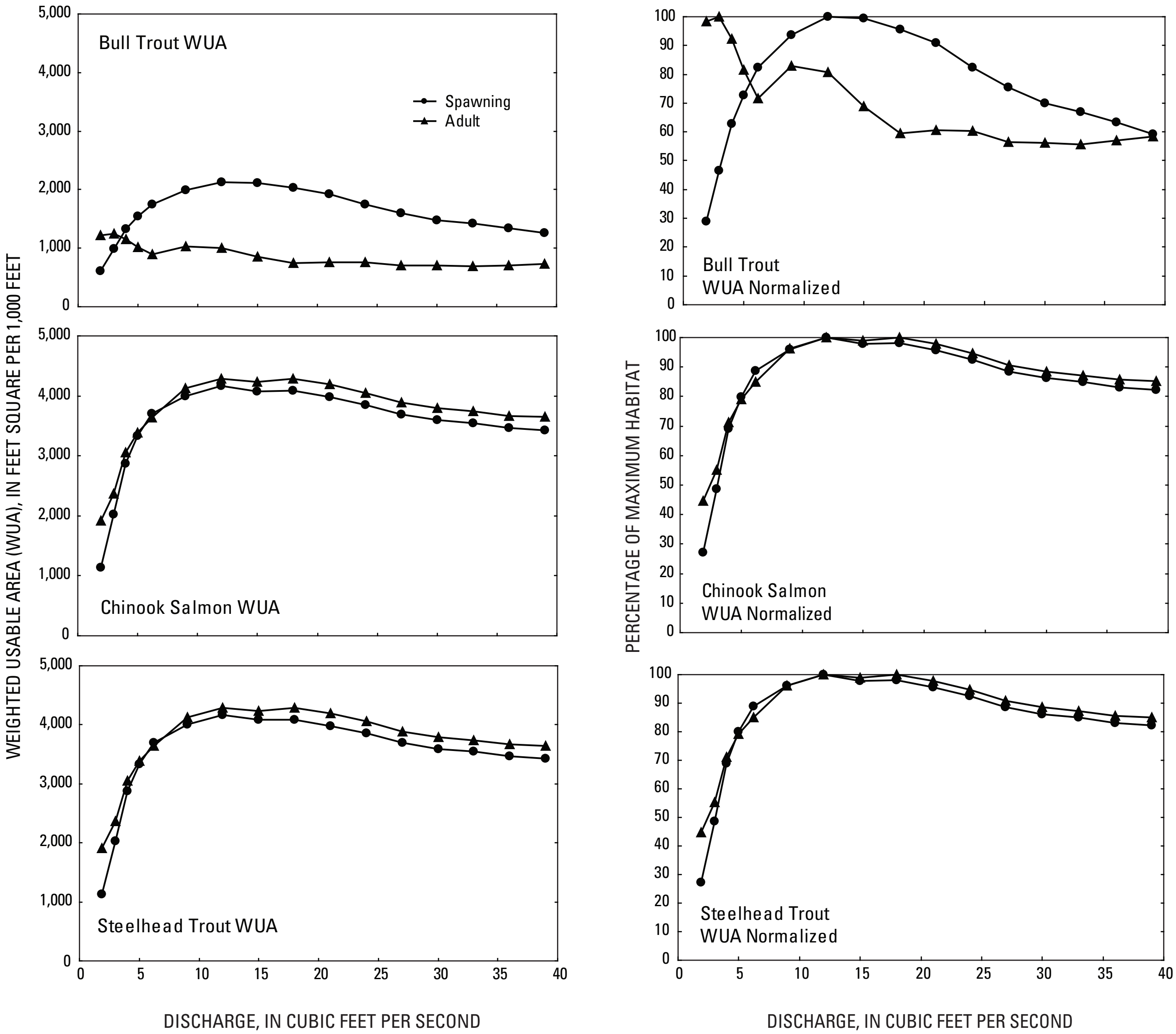


Figure D2. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, lower Champion Creek (CC1), upper Salmon River Basin, Idaho, 2004.

Table D1. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site CC1, lower Champion Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; $ft^2/1,000$ ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1,000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
1.9	9,841	1,214	612	98.3	28.8
3	10,212	1,247	989	100.0	46.6
4	10,704	1,178	1,331	92.3	62.8
5	11,022	1,055	1,545	81.5	72.8
6.2	11,685	951	1,748	71.5	82.4
9	12,294	1,176	1,987	82.9	93.7
12	12,478	1,134	2,121	80.6	100.0
15	12,630	940	2,109	69.0	99.4
18	12,731	901	2,030	59.5	95.7
21	12,798	861	1,929	60.6	91.0
24	12,863	901	1,745	60.4	82.3
27	12,933	928	1,604	56.6	75.6
30	13,006	941	1,483	56.3	69.9
33	13,075	965	1,419	55.7	66.9
36	13,145	981	1,345	57.0	63.4
39	13,213	992	1,256	58.5	59.2
Chinook salmon					
1.9	9,841	1,914	1,131	44.1	27.2
3	10,212	2,366	2,024	55.2	48.6
4	10,704	3,051	2,876	71.2	69.0
5	11,022	3,387	3,330	79.1	79.9
6.2	11,685	3,641	3,701	85.0	88.8
9	12,294	4,123	3,999	96.2	96.0
12	12,478	4,284	4,167	100.0	100.0
15	12,630	4,234	4,080	98.8	97.9
18	12,731	4,282	4,090	99.9	98.2
21	12,798	4,192	3,985	97.8	95.6
24	12,863	4,053	3,853	94.6	92.5
27	12,933	3,887	3,690	90.7	88.6
30	13,006	3,790	3,593	88.5	86.2
33	13,075	3,737	3,544	87.2	85.1
36	13,145	3,668	3,461	85.6	83.1
39	13,213	3,646	3,431	85.1	82.3
Steelhead trout					
1.9	9,841	1,914	1,131	44.7	27.2
3	10,212	2,366	2,024	55.2	48.6
4	10,704	3,051	2,876	71.2	69.0
5	11,022	3,387	3,330	79.1	79.9
6.2	11,685	3,641	3,701	85.0	88.8
9	12,294	4,123	3,999	96.2	96.0
12	12,478	4,284	4,167	100.0	100.0
15	12,630	4,234	4,080	98.8	97.9
18	12,731	4,282	4,090	99.9	98.2
21	12,798	4,192	3,985	97.8	95.6
24	12,863	4,053	3,853	94.6	92.5
27	12,933	3,887	3,690	90.7	88.6
30	13,006	3,790	3,593	88.5	86.2
33	13,075	3,737	3,544	87.2	85.1
36	13,145	3,668	3,461	85.6	83.1
39	13,213	3,646	3,431	85.1	82.3

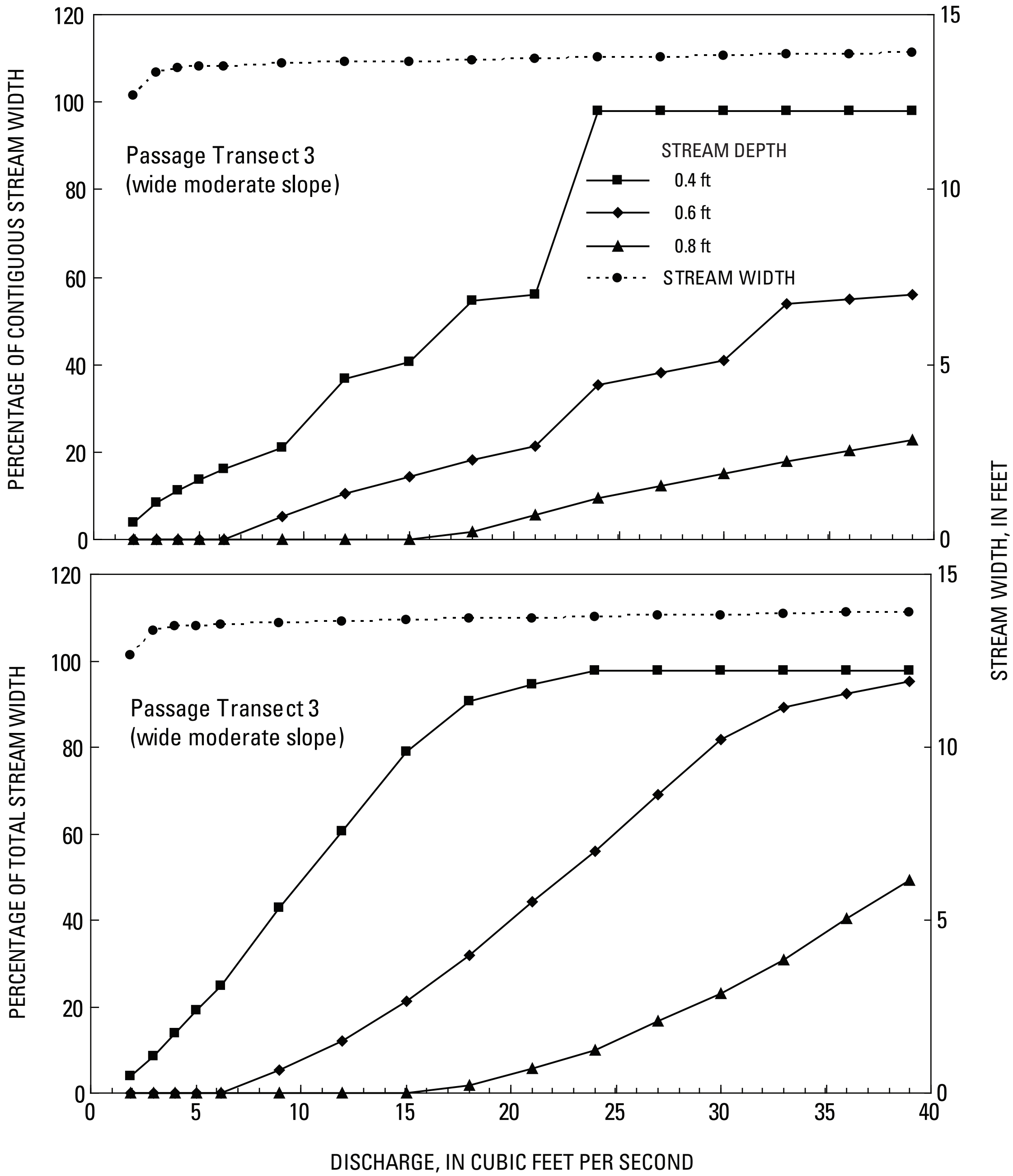


Figure D3. Percentages of contiguous and total stream width for passage transect 3, lower Champion Creek (CC1), upper Salmon River Basin, Idaho, 2004.

Table D2. Passage criteria assessment for transect 3 (wide moderate slope), site CC1, lower Champion Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
1.9	12.7	0.5	3.9	0.5	3.9
3	13.4	1.1	8.5	1.1	8.5
4	13.5	1.9	13.8	1.5	11.2
5	13.5	2.6	19.2	1.8	13.6
6.2	13.5	3.4	24.9	2.2	16.1
9	13.6	5.8	42.7	2.9	21.1
12	13.6	8.3	60.7	5.0	36.6
15	13.7	10.8	78.8	5.6	40.6
18	13.7	12.4	90.6	7.5	54.5
21	13.7	13.0	94.5	7.7	56.0
24	13.8	13.5	97.8	13.5	97.8
27	13.8	13.5	97.8	13.5	97.8
30	13.8	13.5	97.8	13.5	97.8
33	13.8	13.6	97.9	13.6	97.9
36	13.9	13.6	97.9	13.6	97.9
39	13.9	13.6	97.9	13.6	97.9
		Stream widths greater than 0.6-ft depth			
1.9	12.7	0.0	0.0	0.0	0.0
3	13.4	.0	.0	.0	.0
4	13.5	.0	.0	.0	.0
5	13.5	.0	.0	.0	.0
6.2	13.5	.0	.0	.0	.0
9	13.6	.7	5.2	.7	5.2
12	13.6	1.6	12.0	1.4	10.4
15	13.7	2.9	21.3	2.0	14.4
18	13.7	4.4	32.0	2.5	18.1
21	13.7	6.1	44.1	2.9	21.4
24	13.8	7.7	56.1	4.9	35.4
27	13.8	9.5	69.0	5.3	38.2
30	13.8	11.3	81.7	5.7	41.0
33	13.8	12.4	89.3	7.4	53.8
36	13.9	12.8	92.4	7.6	55.0
39	13.9	13.2	95.3	7.8	56.1
		Stream widths greater than 0.8-ft depth			
1.9	12.7	0.0	0.0	0.0	0.0
3	13.4	.0	.0	.0	.0
4	13.5	.0	.0	.0	.0
5	13.5	.0	.0	.0	.0
6.2	13.5	.0	.0	.0	.0
9	13.6	.0	.0	.0	.0
12	13.6	.0	.0	.0	.0
15	13.7	.0	.0	.0	.0
18	13.7	.2	1.8	.2	1.8
21	13.7	.8	5.7	.8	5.7
24	13.8	1.4	9.9	1.3	9.4
27	13.8	2.3	16.5	1.7	12.3
30	13.8	3.2	23.0	2.1	15.1
33	13.8	4.3	30.8	2.4	17.7
36	13.9	5.6	40.4	2.8	20.3
39	13.9	6.8	49.1	3.1	22.6

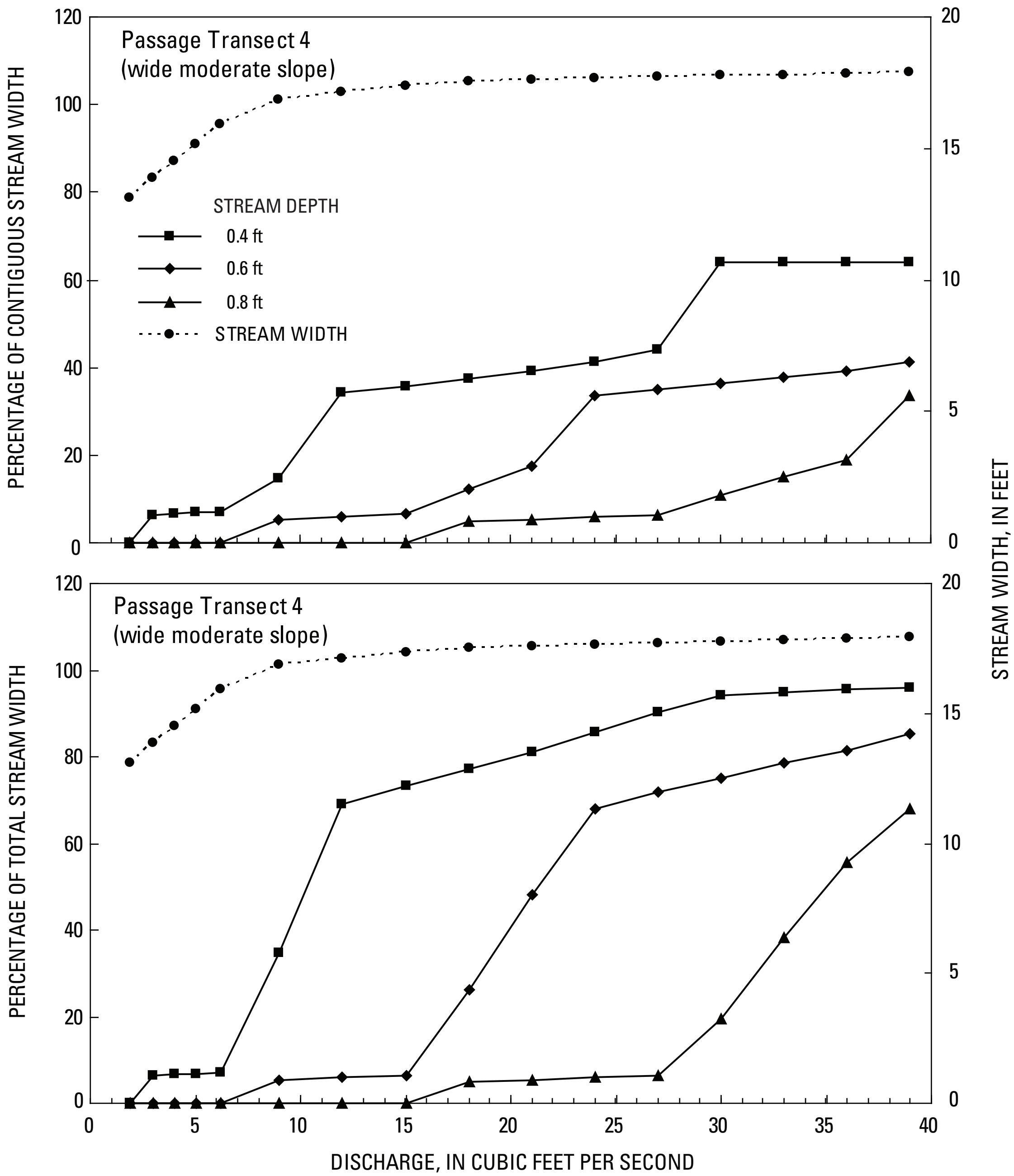


Figure D4. Percentages of contiguous and total stream width for passage transect 4, lower Champion Creek (CC1), upper Salmon River Basin, Idaho, 2004.

Table D3. Passage criteria assessment for transect 4 (wide moderate slope), site CC1, lower Champion Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
1.9	13.1	0.0	0.0	0.0	0.0
3	13.9	.9	6.4	.9	6.4
4	14.5	1.0	6.7	1.0	6.7
5	15.1	1.0	6.9	1.0	6.9
6.2	15.9	1.1	7.1	1.1	7.1
9	16.8	5.9	34.8	2.5	14.6
12	17.1	11.8	68.9	5.8	34.2
15	17.4	12.7	73.2	6.2	35.9
18	17.5	13.6	77.3	6.6	37.5
21	17.6	14.3	81.2	6.9	39.1
24	17.6	15.1	85.6	7.3	41.2
27	17.7	16.0	90.3	7.8	44.0
30	17.8	16.7	94.2	11.3	63.9
33	17.8	16.9	94.8	11.4	64.0
36	17.9	17.1	95.5	11.4	64.1
39	17.9	17.2	96.1	11.5	64.1
		Stream widths greater than 0.6-ft depth			
1.9	13.1	0.0	0.0	0.0	0.0
3	13.9	.0	.0	.0	.0
4	14.5	.0	.0	.0	.0
5	15.1	.0	.0	.0	.0
6.2	15.9	.0	.0	.0	.0
9	16.8	.9	5.2	.9	5.2
12	17.1	1.0	5.9	1.0	5.9
15	17.4	1.1	6.5	1.1	6.5
18	17.5	4.6	26.3	2.2	12.4
21	17.6	8.4	48.0	3.1	17.3
24	17.6	12.0	68.0	5.9	33.6
27	17.7	12.7	71.7	6.2	35.2
30	17.8	13.3	75.1	6.5	36.5
33	17.8	14.0	78.5	6.8	37.9
36	17.9	14.6	81.6	7.0	39.2
39	17.9	15.3	85.3	7.4	41.2
		Stream widths greater than 0.8-ft depth			
1.9	13.1	0.0	0.0	0.0	0.0
3	13.9	.0	.0	.0	.0
4	14.5	.0	.0	.0	.0
5	15.1	.0	.0	.0	.0
6.2	15.9	.0	.0	.0	.0
9	16.8	.0	.0	.0	.0
12	17.1	.0	.0	.0	.0
15	17.4	.0	.0	.0	.0
18	17.5	.8	4.8	.8	4.8
21	17.6	.9	5.4	.9	5.4
24	17.6	1.0	5.9	1.0	5.9
27	17.7	1.1	6.4	1.1	6.4
30	17.8	3.5	19.5	1.9	10.7
33	17.8	6.8	38.3	2.7	15.0
36	17.9	9.9	55.4	3.4	19.0
39	17.9	12.2	67.8	6.0	33.5

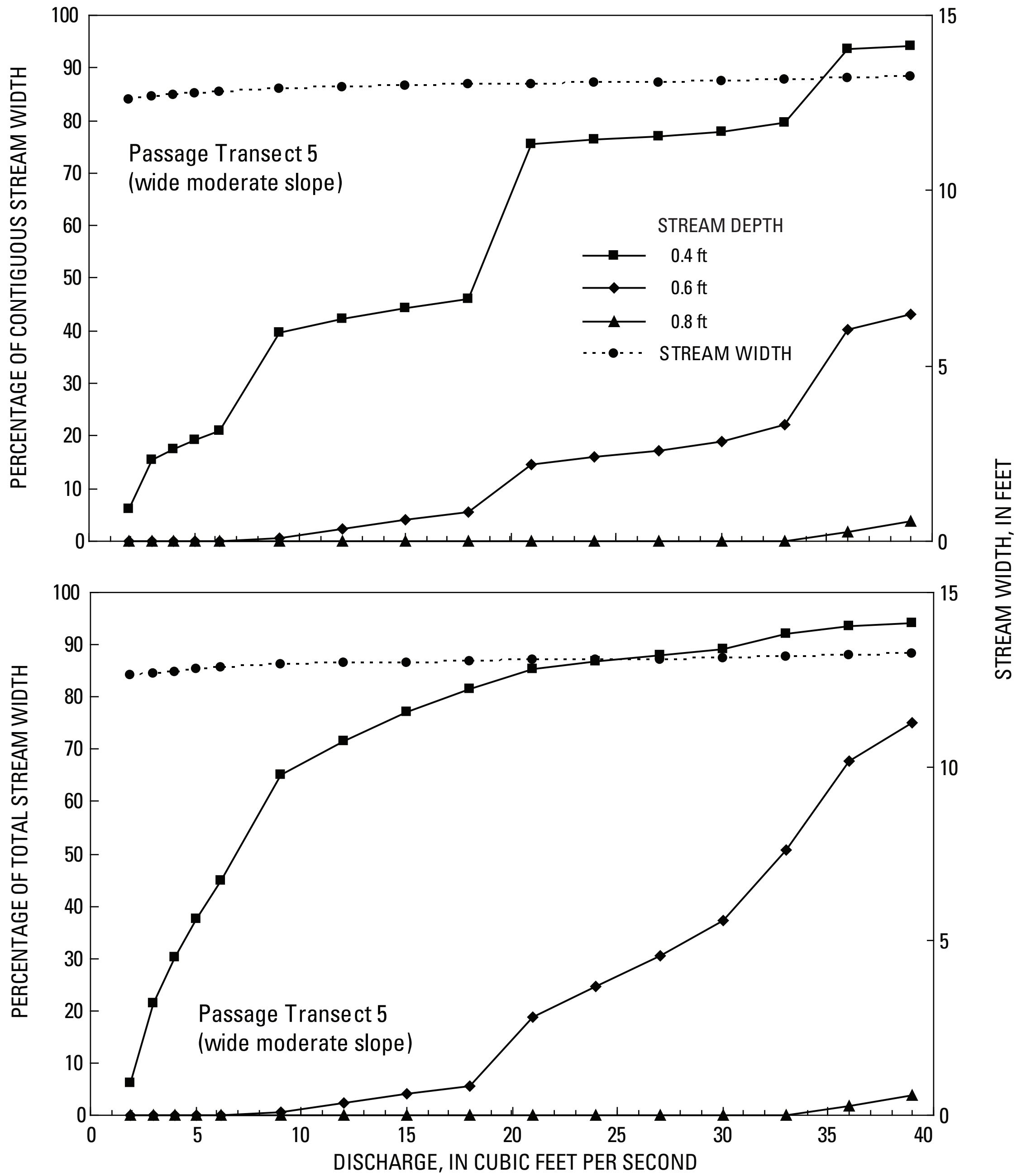


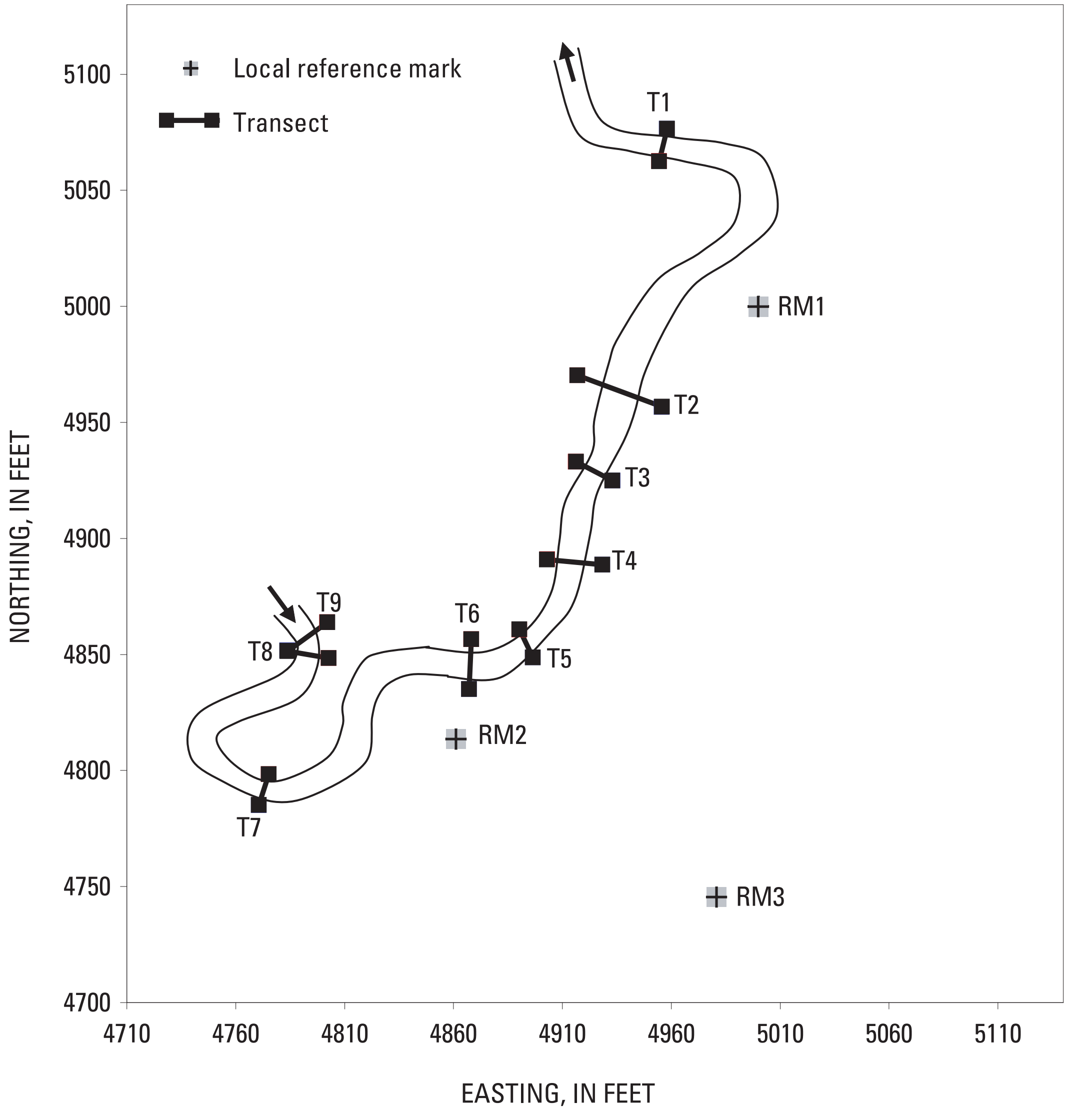
Figure D5. Percentages of contiguous and total stream width for passage transect 5, lower Champion Creek (CC1), upper Salmon River Basin, Idaho, 2004.

Table D4. Passage criteria assessment for transect 5 (wide moderate slope), site CC1, lower Champion Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
1.9	12.6	0.8	6.2	0.8	6.2
3	12.7	2.7	21.4	2.0	15.4
4	12.7	3.9	30.4	2.2	17.5
5	12.8	4.8	37.4	2.4	19.2
6.2	12.8	5.8	44.8	2.7	20.9
9	12.9	8.4	65.0	5.1	39.6
12	13.0	9.9	71.6	5.5	42.2
15	13.0	10.0	77.1	5.8	44.3
18	13.0	10.6	81.6	6.0	46.1
21	13.0	11.2	85.5	9.8	75.5
24	13.1	11.3	86.7	10.0	76.2
27	13.1	11.5	87.9	10.1	77.0
30	13.1	11.7	89.3	10.2	77.9
33	13.2	12.1	92.1	10.5	79.6
36	13.2	12.3	93.5	12.3	93.5
39	13.2	12.5	94.2	12.5	94.2
		Stream widths greater than 0.6-ft depth			
1.9	12.6	0.0	0.0	0.0	0.0
3	12.7	.0	.0	.0	.0
4	12.7	.0	.0	.0	.0
5	12.8	.0	.0	.0	.0
6.2	12.8	.0	.0	.0	.0
9	12.9	.1	.5	.1	.5
12	13.0	.3	2.5	.3	2.5
15	13.0	.5	4.1	.5	4.1
18	13.0	.7	5.5	.7	5.5
21	13.0	2.5	18.9	1.9	14.5
24	13.1	3.2	24.8	2.1	15.9
27	13.1	4.0	30.6	2.3	17.3
30	13.1	4.9	37.2	2.5	18.9
33	13.2	6.7	50.7	2.9	22.1
36	13.2	8.9	67.6	5.3	40.3
39	13.2	10.0	75.1	5.7	43.3
		Stream widths greater than 0.8-ft depth			
1.9	12.6	0.0	0.0	0.0	0.0
3	12.7	.0	.0	.0	.0
4	12.7	.0	.0	.0	.0
5	12.8	.0	.0	.0	.0
6.2	12.8	.0	.0	.0	.0
9	12.9	.0	.0	.0	.0
12	13.0	.0	.0	.0	.0
15	13.0	.0	.0	.0	.0
18	13.0	.0	.0	.0	.0
21	13.0	.0	.0	.0	.0
24	13.1	.0	.0	.0	.0
27	13.1	.0	.0	.0	.0
30	13.1	.0	.0	.0	.0
33	13.2	.0	.0	.0	.0
36	13.2	.2	1.6	.2	1.6
39	13.2	.5	3.9	.5	3.9

Appendix E. Plan view, weighted useable areas and passage criteria assessments for bull trout, Chinook salmon, and steelhead trout for lower Iron Creek (IC1), upper Salmon River Basin, Idaho, 2004.



Point	Latitude	Longitude
LB T1	44° 13' 7.64" N	114° 58' 2.48" W
RB T1	44° 13' 7.51" N	114° 58' 2.52" W
LB T2	44° 13' 6.46" N	114° 58' 2.48" W
RB T2	44° 13' 6.59" N	114° 58' 3.01" W
LB T3	44° 13' 6.15" N	114° 58' 2.78" W
RB T3	44° 13' 6.23" N	114° 58' 3.01" W
LB T4	44° 13' 5.79" N	114° 58' 2.83" W
RB T4	44° 13' 5.81" N	114° 58' 3.18" W
LB T5	44° 13' 5.39" N	114° 58' 3.26" W

Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
RB T5	44° 13' 5.51" N	114° 58' 3.35" W
LB T6	44° 13' 5.25" N	114° 58' 3.66" W
RB T6	44° 13' 5.46" N	114° 58' 3.65" W
LB T7	44° 13' 4.74" N	114° 58' 4.97" W
RB T7	44° 13' 4.87" N	114° 58' 4.91" W
LB T8	44° 13' 5.40" N	114° 58' 4.81" W
RB T8	44° 13' 5.37" N	114° 58' 4.55" W
LB T9	44° 13' 5.40" N	114° 58' 4.81" W
RB T9	44° 13' 5.52" N	114° 58' 4.56" W

For reference only; stream schematic not to scale.

Figure E1. Plan view of lower Iron Creek (IC1), upper Salmon River Basin, Idaho, 2004.

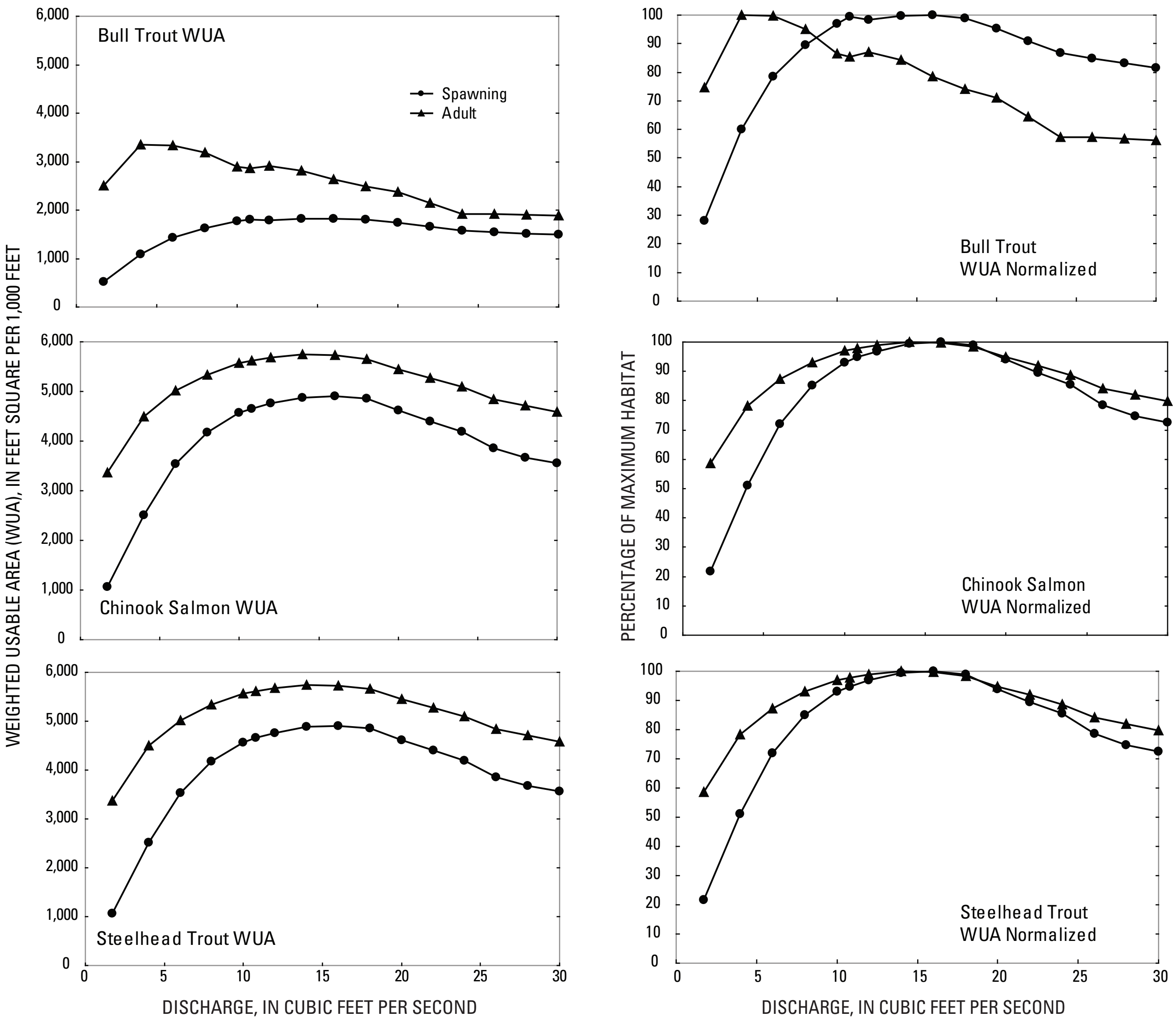


Figure E2. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, lower Iron Creek (IC1), upper Salmon River Basin, Idaho, 2004.

Table E1. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site IC1, lower Iron Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; $ft^2/1,000$ ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1,000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
1.7	10,035	2,496	514	74.6	28.2
4	10,410	3,346	1,096	100.0	60.1
6	10,562	3,340	1,430	99.8	78.4
8	10,684	3,181	1,630	95.1	89.4
10	10,784	2,896	1,769	86.6	97.0
10.8	10,820	2,861	1,813	85.5	99.4
12	10,870	2,914	1,791	87.1	98.2
14	11,110	2,817	1,819	84.2	99.8
16	11,238	2,630	1,821	78.6	100.0
18	11,359	2,483	1,802	74.2	98.9
20	11,469	2,380	1,739	71.1	95.4
22	11,634	2,154	1,656	64.4	90.9
24	11,798	1,919	1,583	57.4	86.8
26	11,949	1,915	1,547	57.2	84.9
28	12,028	1,898	1,514	56.7	83.1
30	12,140	1,881	1,488	56.2	81.6
Chinook salmon					
1.7	10,035	3,372	1,065	58.7	21.7
4	10,410	4,497	2,509	78.3	51.1
6	10,562	5,011	3,535	87.3	72.0
8	10,684	5,338	4,178	93.0	85.1
10	10,784	5,566	4,565	96.9	93.0
10.8	10,820	5,614	4,654	97.7	94.8
12	10,870	5,676	4,755	98.8	96.8
14	11,110	5,743	4,880	100.0	99.4
16	11,238	5,734	4,910	99.8	100.0
18	11,359	5,655	4,854	98.5	98.9
20	11,469	5,447	4,614	94.8	94.0
22	11,634	5,277	4,398	91.9	89.6
24	11,798	5,096	4,197	88.7	85.5
26	11,949	4,837	3,856	84.2	78.5
28	12,028	4,708	3,674	82.0	74.8
30	12,140	4,585	3,560	79.8	72.5
Steelhead trout					
1.7	10,035	3,372	1,065	58.7	21.7
4	10,410	4,497	2,509	78.3	51.1
6	10,562	5,011	3,535	87.3	72.0
8	10,684	5,338	4,178	93.0	85.1
10	10,784	5,566	4,565	96.9	93.0
10.8	10,820	5,614	4,654	97.7	94.8
12	10,870	5,676	4,755	98.8	96.8
14	11,110	5,743	4,880	100.0	99.4
16	11,238	5,734	4,910	99.8	100.0
18	11,359	5,655	4,854	98.5	98.9
20	11,469	5,447	4,614	94.8	94.0
22	11,634	5,277	4,398	91.9	89.6
24	11,798	5,096	4,197	88.7	85.5
26	11,949	4,837	3,856	84.2	78.5
28	12,028	4,708	3,674	82.0	74.8
30	12,140	4,585	3,560	79.8	72.5

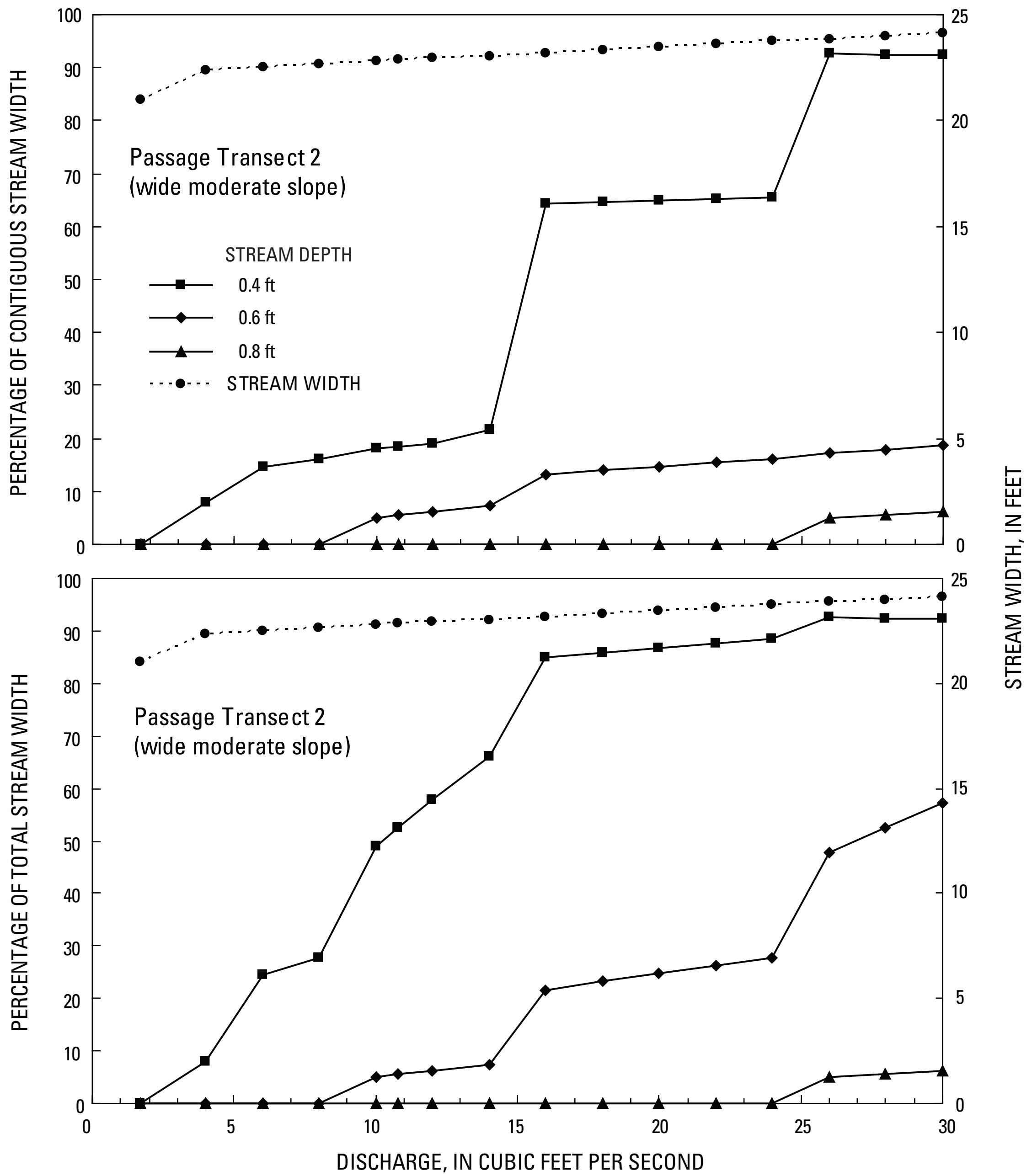


Figure E3. Percentages of contiguous and total stream width for passage transect 2, lower Iron Creek (IC1), upper Salmon River Basin, Idaho, 2004.

Table E2. Passage criteria assessment for transect 2 (wide moderate slope), site IC1, lower Iron Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
1.7	21.0	0.0	0.0	0.0	0.0
4	22.3	1.8	8.0	1.8	8.0
6	22.5	5.5	24.6	3.3	14.7
8	22.7	6.3	27.6	3.6	16.1
10	22.8	11.2	49.0	4.1	18.1
10.8	22.9	12.0	52.6	4.2	18.4
12	22.9	13.3	57.8	4.4	19.0
14	23.0	15.2	66.1	5.0	21.6
16	23.2	19.6	84.8	14.9	64.2
18	23.3	20.0	85.8	15.1	64.6
20	23.4	20.4	86.8	15.2	65.0
22	23.6	20.7	87.7	15.4	65.3
24	23.7	21.0	88.5	15.6	65.6
26	23.9	22.1	92.6	22.1	92.6
28	24.0	22.2	92.4	22.2	92.4
30	24.1	22.2	92.3	22.2	92.3
		Stream widths greater than 0.6-ft depth			
1.7	21.0	0.0	0.0	0.0	0.0
4	22.3	.0	.0	.0	.0
6	22.5	.0	.0	.0	.0
8	22.7	.0	.0	.0	.0
10	22.8	1.2	5.0	1.2	5.0
10.8	22.9	1.3	5.6	1.3	5.6
12	22.9	1.4	6.3	1.4	6.3
14	23.0	1.7	7.4	1.7	7.4
16	23.2	5.0	21.6	3.1	13.2
18	23.3	5.4	23.3	3.2	13.9
20	23.4	5.8	24.8	3.4	14.7
22	23.6	6.2	26.3	3.6	15.4
24	23.7	6.6	27.7	3.8	16.0
26	23.9	11.4	47.8	4.2	17.4
28	24.0	12.6	52.5	4.3	17.8
30	24.1	13.8	57.2	4.5	18.7
		Stream widths greater than 0.8-ft depth			
1.7	21.0	0.0	0.0	0.0	0.0
4	22.3	.0	.0	.0	.0
6	22.5	.0	.0	.0	.0
8	22.7	.0	.0	.0	.0
10	22.8	.0	.0	.0	.0
10.8	22.9	.0	.0	.0	.0
12	22.9	.0	.0	.0	.0
14	23.0	.0	.0	.0	.0
16	23.2	.0	.0	.0	.0
18	23.3	.0	.0	.0	.0
20	23.4	.0	.0	.0	.0
22	23.6	.0	.0	.0	.0
24	23.7	.0	.0	.0	.0
26	23.9	1.2	5.0	1.2	5.0
28	24.0	1.3	5.6	1.3	5.6
30	24.1	1.5	6.3	1.5	6.3

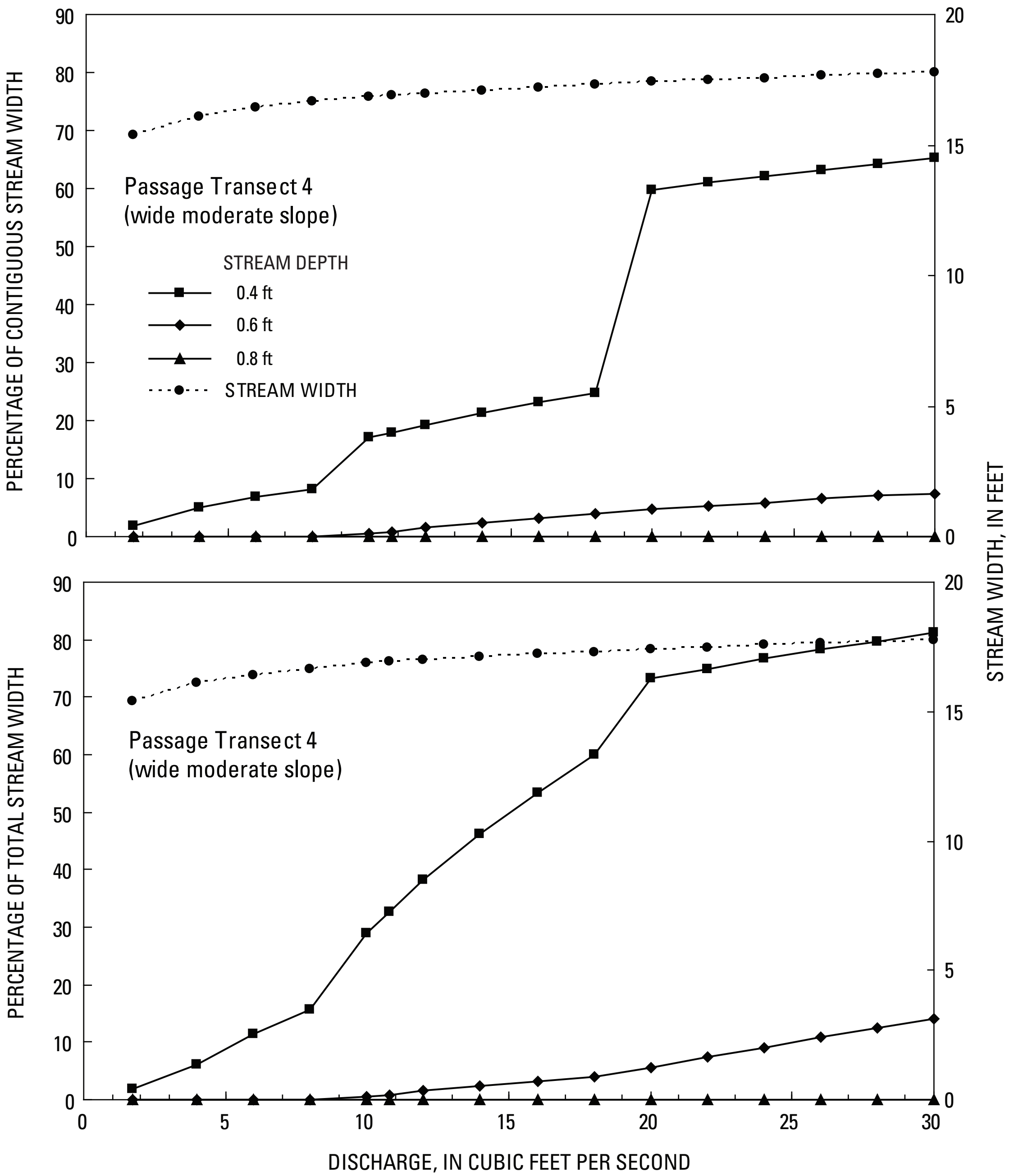


Figure E4. Percentages of contiguous and total stream width for passage transect 4, lower Iron Creek (IC1), upper Salmon River Basin, Idaho, 2004.

Table E3. Passage criteria assessment for transect 4 (wide moderate slope), site IC1, lower Iron Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
1.7	15.4	0.3	1.9	0.3	1.9
4	16.1	1.0	6.1	.8	5.1
6	16.4	1.9	11.5	1.1	6.9
8	16.7	2.6	15.7	1.4	8.2
10	16.9	4.9	29.0	2.9	17.1
10.8	16.9	5.5	32.8	3.0	18.0
12	17.0	6.5	38.2	3.3	19.3
14	17.1	7.9	46.2	3.6	21.3
16	17.2	9.2	53.3	4.0	23.0
18	17.3	10.4	60.1	4.3	24.7
20	17.4	12.7	73.2	10.4	59.8
22	17.5	13.1	74.9	10.7	61.0
24	17.6	13.4	76.6	10.9	62.2
26	17.6	13.8	78.2	11.2	63.2
28	17.7	14.1	79.7	11.4	64.3
30	17.8	14.4	81.2	11.6	65.3
		Stream widths greater than 0.6-ft depth			
1.7	15.4	0.0	0.0	0.0	0.0
4	16.1	.0	.0	.0	.0
6	16.4	.0	.0	.0	.0
8	16.7	.0	.0	.0	.0
10	16.9	.1	.5	.1	.5
10.8	16.9	.2	.9	.2	.9
12	17.0	.3	1.5	.3	1.5
14	17.1	.4	2.4	.4	2.4
16	17.2	.6	3.2	.6	3.2
18	17.3	.7	4.0	.7	4.0
20	17.4	1.0	5.5	.8	4.7
22	17.5	1.3	7.3	.9	5.3
24	17.6	1.6	9.1	1.0	5.9
26	17.6	1.9	10.8	1.1	6.4
28	17.7	2.2	12.5	1.2	7.0
30	17.8	2.5	14.0	1.3	7.5
		Stream widths greater than 0.8-ft depth			
1.7	15.4	0.0	0.0	0.0	0.0
4	16.1	.0	.0	.0	.0
6	16.4	.0	.0	.0	.0
8	16.7	.0	.0	.0	.0
10	16.9	.0	.0	.0	.0
10.8	16.9	.0	.0	.0	.0
12	17.0	.0	.0	.0	.0
14	17.1	.0	.0	.0	.0
16	17.2	.0	.0	.0	.0
18	17.3	.0	.0	.0	.0
20	17.4	.0	.0	.0	.0
22	17.5	.0	.0	.0	.0
24	17.6	.0	.0	.0	.0
26	17.6	.0	.0	.0	.0
28	17.7	.0	.0	.0	.0
30	17.8	.0	.0	.0	.0

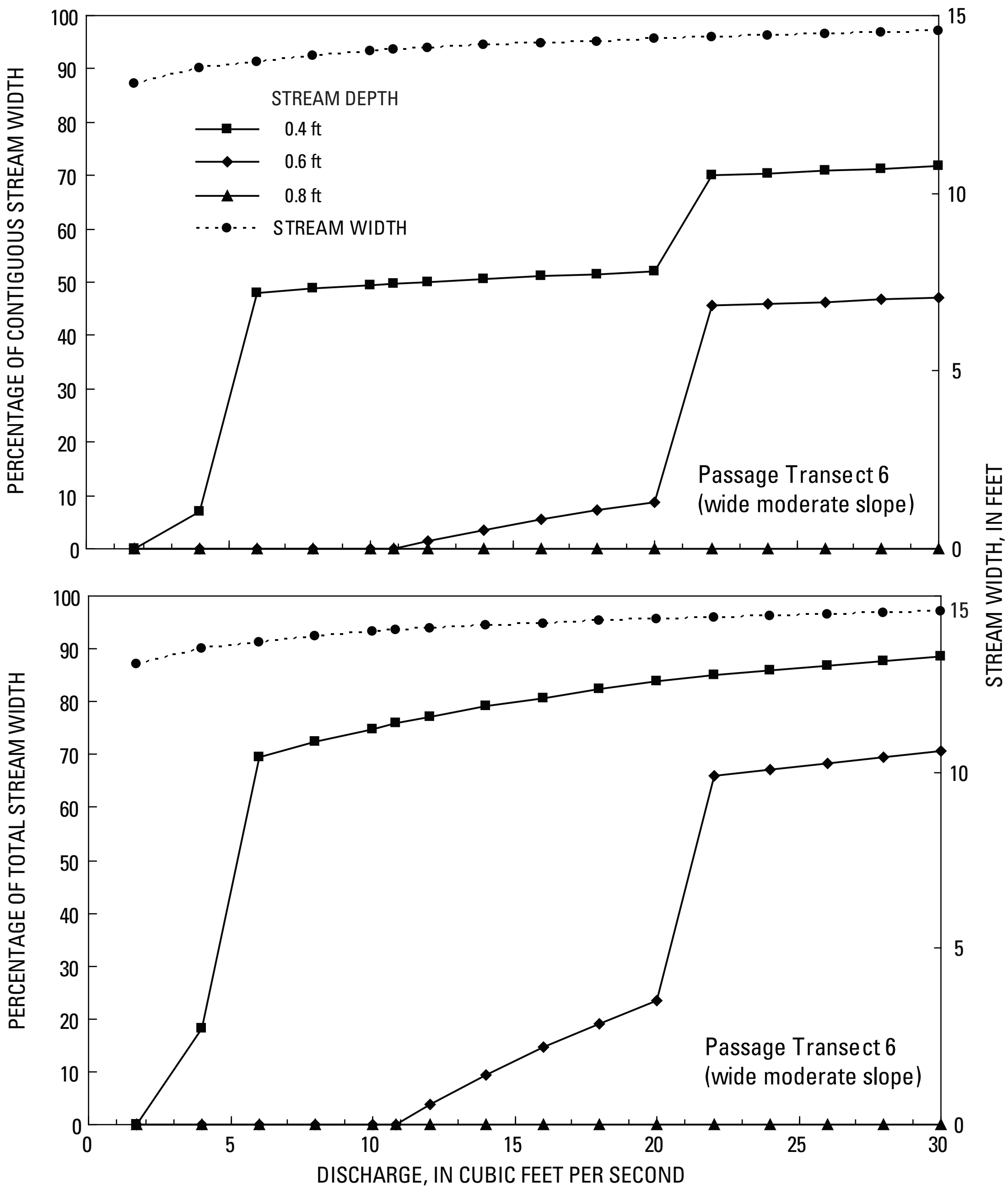


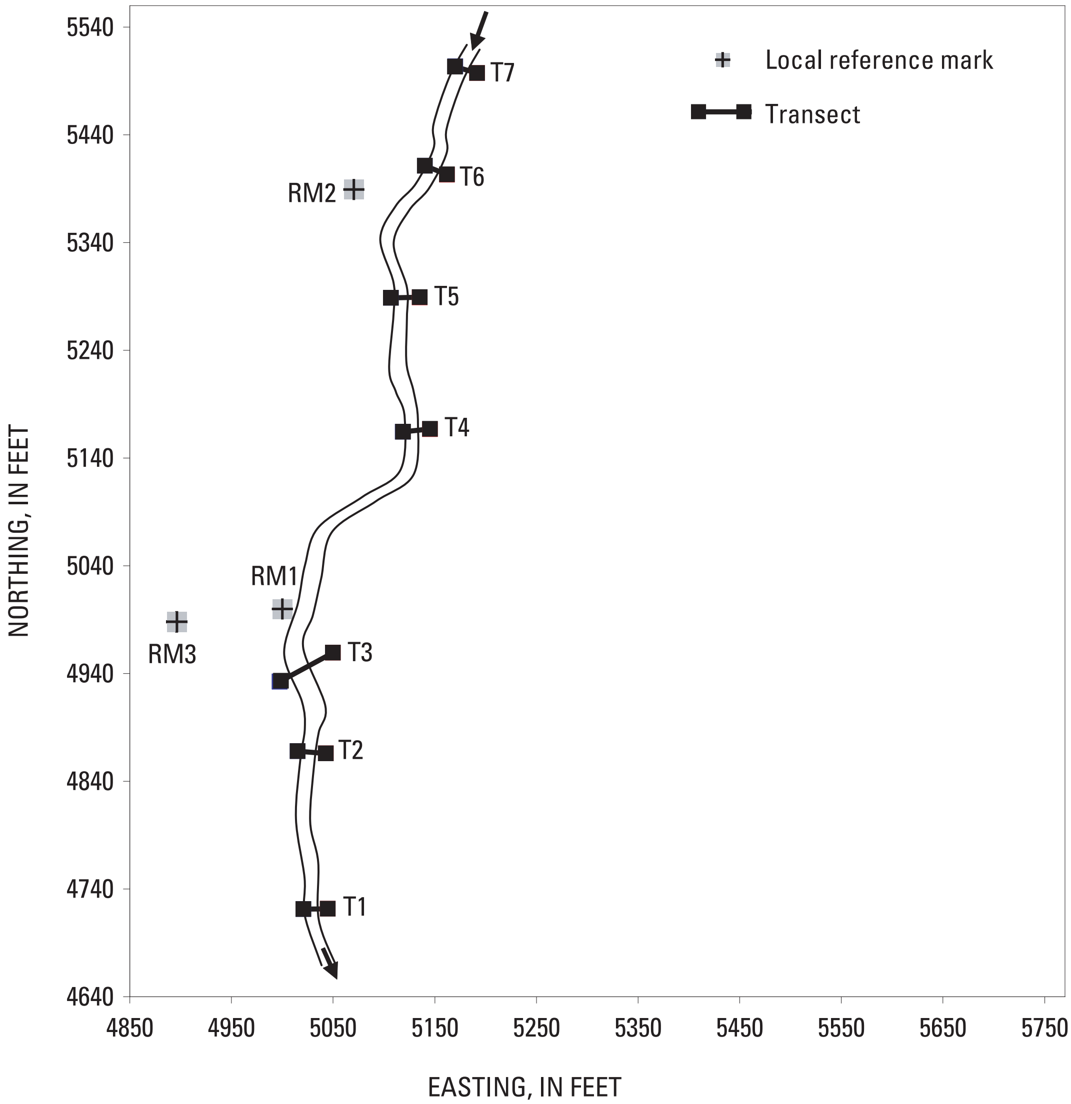
Figure E5. Percentages of contiguous and total stream width for passage transect 6, lower Iron Creek (IC1), upper Salmon River Basin, Idaho, 2004.

Table E4. Passage criteria assessment for transect 6 (wide moderate slope), site IC1, lower Iron Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
1.7	13.1	0.0	0.0	0.0	0.0
4	13.5	2.4	18.1	.9	6.8
6	13.7	9.5	69.6	6.6	48.0
8	13.8	10.0	72.5	6.8	48.8
10	14.0	10.5	74.9	6.9	49.4
10.8	14.0	10.6	75.8	7.0	49.7
12	14.1	10.9	77.1	7.0	50.1
14	14.2	11.2	79.1	7.2	50.6
16	14.2	11.5	80.8	7.3	51.1
18	14.3	11.8	82.4	7.4	51.6
20	14.3	12.0	83.8	7.4	52.0
22	14.4	12.2	84.9	10.1	69.9
24	14.4	12.4	85.9	10.2	70.4
26	14.5	12.6	86.9	10.3	70.8
28	14.5	12.8	87.8	10.4	71.3
30	14.6	12.9	88.6	10.4	71.7
		Stream widths greater than 0.6-ft depth			
1.7	13.1	0.0	0.0	0.0	0.0
4	13.5	.0	.0	.0	.0
6	13.7	.0	.0	.0	.0
8	13.8	.0	.0	.0	.0
10	14.0	.0	.0	.0	.0
10.8	14.0	.0	.0	.0	.0
12	14.1	.5	3.8	.2	1.4
14	14.2	1.3	9.5	.5	3.6
16	14.2	2.1	14.5	.8	5.5
18	14.3	2.7	19.1	1.0	7.2
20	14.3	3.4	23.4	1.3	8.8
22	14.4	9.5	65.9	6.6	45.6
24	14.4	9.7	67.2	6.6	46.0
26	14.5	9.9	68.4	6.7	46.4
28	14.5	10.1	69.6	6.8	46.7
30	14.6	10.3	70.7	6.8	47.0
		Stream widths greater than 0.8-ft depth			
1.7	13.1	0.0	0.0	0.0	0.0
4	13.5	.0	.0	.0	.0
6	13.7	.0	.0	.0	.0
8	13.8	.0	.0	.0	.0
10	14.0	.0	.0	.0	.0
10.8	14.0	.0	.0	.0	.0
12	14.1	.0	.0	.0	.0
14	14.2	.0	.0	.0	.0
16	14.2	.0	.0	.0	.0
18	14.3	.0	.0	.0	.0
20	14.3	.0	.0	.0	.0
22	14.4	.0	.0	.0	.0
24	14.4	.0	.0	.0	.0
26	14.5	.0	.0	.0	.0
28	14.5	.0	.0	.0	.0
30	14.6	.0	.0	.0	.0

Appendix F. Plan view, weighted useable areas and passage criteria assessments for bull trout, Chinook salmon, and steelhead trout for lower Thompson Creek (TC1), upper Salmon River Basin, Idaho, 2004.



Transect Endpoint Coordinates (NAD 83)			Transect Endpoint Coordinates (NAD 83)		
Point	Latitude	Longitude	Point	Latitude	Longitude
LB T1	44° 15' 12.95" N	114° 30' 54.08" W	RB T4	44° 15' 17.15" N	114° 30' 55.82" W
RB T1	44° 15' 12.85" N	114° 30' 54.41" W	LB T5	44° 15' 18.62" N	114° 30' 55.31" W
LB T2	44° 15' 14.53" N	114° 30' 54.02" W	RB T5	44° 15' 18.50" N	114° 30' 55.70" W
RB T2	44° 15' 14.39" N	114° 30' 54.40" W	LB T6	44° 15' 19.78" N	114° 30' 55.78" W
LB T3	44° 15' 15.30" N	114° 30' 53.78" W	RB T6	44° 15' 19.60" N	114° 30' 56.08" W
RB T3	44° 15' 15.36" N	114° 30' 54.50" W	LB T7	44° 15' 20.63" N	114° 30' 56.20" W
LB T4	44° 15' 17.24" N	114° 30' 55.46" W	RB T7	44° 15' 20.48" N	114° 30' 56.49" W

For reference only; stream schematic not to scale.

Figure F1. Plan view of lower Thompson Creek (TC1), upper Salmon River Basin, Idaho, 2004.

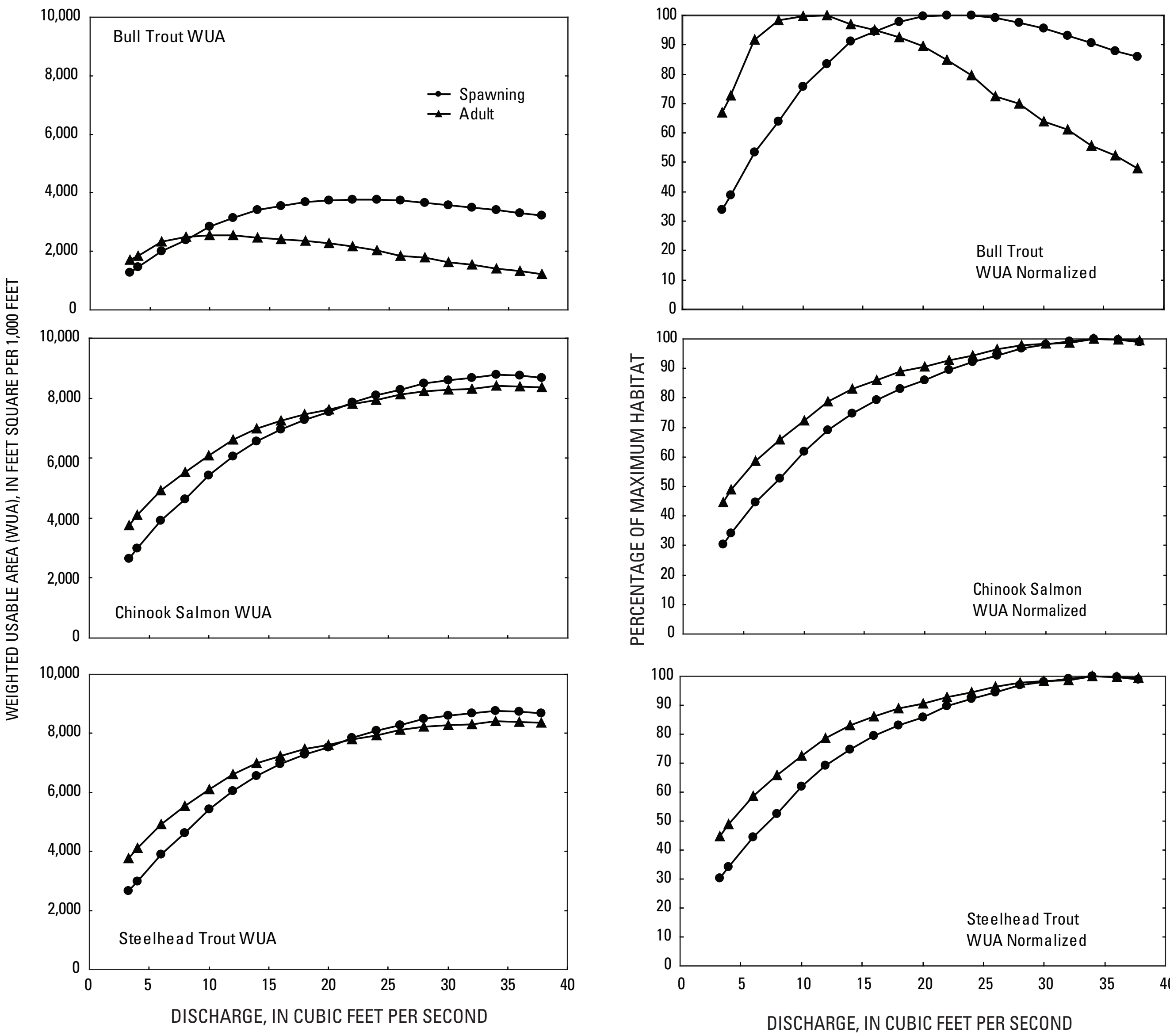


Figure F2. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, Lower Thompson Creek (TC1), upper Salmon River Basin, Idaho, 2004.

Table F1. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site TC1, lower Thompson Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; $ft^2/1,000$ ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA ($ft^2/1,000$ ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
3.3	12,444	1,702	1,272	66.9	33.8
4	13,364	1,850	1,462	72.7	38.9
6	14,426	2,333	2,010	91.7	53.5
8	14,725	2,499	2,398	98.2	63.8
10	15,202	2,540	2,852	99.8	75.8
12	15,806	2,545	3,142	100.0	83.6
14	16,520	2,470	3,423	97.1	91.1
16	16,758	2,421	3,552	95.2	94.5
18	16,986	2,358	3,681	92.7	97.9
20	17,356	2,275	3,749	89.4	99.7
22	17,564	2,161	3,756	84.9	99.9
24	17,766	2,029	3,759	79.7	100.0
26	17,948	1,843	3,733	72.4	99.3
28	18,080	1,781	3,664	70.0	97.4
30	18,206	1,629	3,590	64.0	95.5
32	18,325	1,555	3,497	61.1	93.0
34	18,437	1,418	3,407	55.7	90.6
36	18,546	1,329	3,307	52.2	88.0
37.8	18,965	1,218	3,227	47.9	85.8
Chinook salmon					
3.3	12,444	3,758	2,658	44.7	30.3
4	13,364	4,109	2,992	48.9	34.1
6	14,426	4,920	3,905	58.5	44.5
8	14,725	5,539	4,617	65.9	52.6
10	15,202	6,090	5,421	72.4	61.8
12	15,806	6,613	6,056	78.6	69.0
14	16,520	6,994	6,567	83.2	74.9
16	16,758	7,236	6,968	86.1	79.4
18	16,986	7,472	7,277	88.9	83.0
20	17,356	7,620	7,539	90.6	85.9
22	17,564	7,809	7,861	92.9	89.6
24	17,766	7,942	8,089	94.4	92.2
26	17,948	8,110	8,279	96.4	94.4
28	18,080	8,224	8,494	97.8	96.8
30	18,206	8,269	8,603	98.3	98.1
32	18,325	8,298	8,690	98.7	99.1
34	18,437	8,408	8,772	100.0	100.0
36	18,546	8,387	8,747	99.7	99.7
37.8	18,965	8,368	8,672	99.5	98.8
Steelhead trout					
3.3	12,444	3,758	2,658	44.7	30.3
4	13,364	4,109	2,992	48.9	34.1
6	14,426	4,920	3,905	58.5	44.5
8	14,725	5,539	4,617	65.9	52.6
10	15,202	6,090	5,423	72.4	61.8
12	15,806	6,613	6,056	78.6	69.0
14	16,520	6,994	6,567	83.2	74.9
16	16,758	7,236	6,968	86.1	79.4
18	16,986	7,472	7,277	88.9	83.0
20	17,356	7,620	7,539	90.6	85.9
22	17,564	7,809	7,861	92.9	89.6
24	17,766	7,942	8,089	94.4	92.2
26	17,948	8,110	8,279	96.4	94.4
28	18,080	8,224	8,494	97.8	96.8
30	18,206	8,269	8,603	98.3	98.1
32	18,325	8,298	8,690	98.7	99.1
34	18,437	8,408	8,772	100.0	100.0
36	18,546	8,387	8,747	99.7	99.7
37.8	18,965	8,368	8,672	99.5	98.8

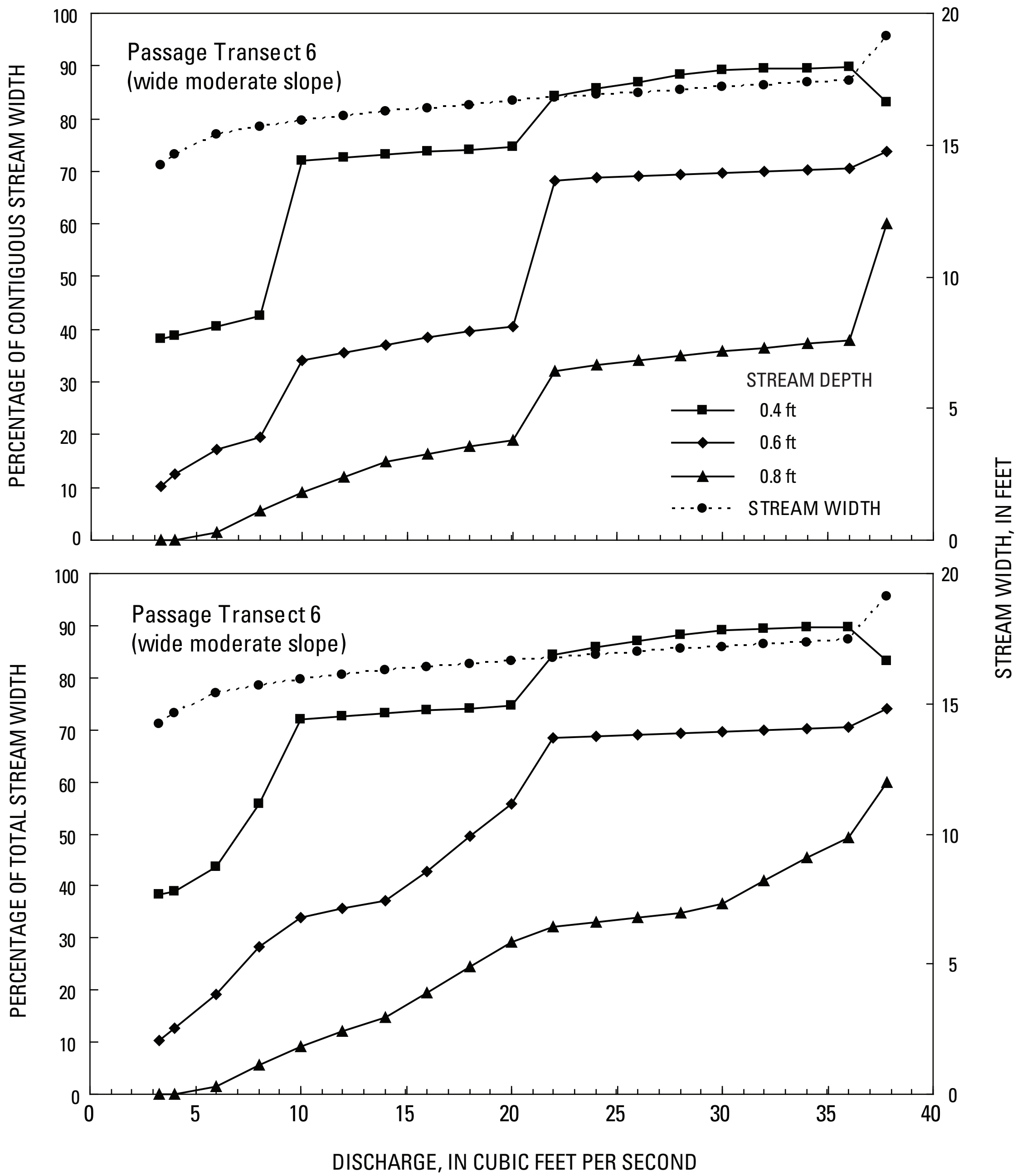


Figure F3. Percentages of contiguous and total stream width for passage transect lower Thompson Creek (TC1), upper Salmon River Basin, Idaho, 2004.

Table F2. Passage criteria assessment for transect 6 (wide moderate slope), site TC1, lower Thompson Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
3.3	14.2	5.4	38.2	5.4	38.2
4	14.6	5.7	38.9	5.7	38.9
6	15.4	6.7	43.8	6.2	40.5
8	15.7	8.8	55.8	6.7	42.4
10	15.9	11.5	72.1	11.5	72.1
12	16.1	11.7	72.7	11.7	72.7
14	16.3	11.9	73.2	11.9	73.2
16	16.4	12.1	73.7	12.1	73.7
18	16.5	12.2	74.1	12.2	74.1
20	16.6	12.4	74.5	12.4	74.5
22	16.8	14.1	84.3	14.1	84.3
24	16.9	14.5	85.7	14.5	85.7
26	17.0	14.8	87.0	14.8	87.0
28	17.1	15.1	88.3	15.1	88.3
30	17.2	15.3	89.2	15.3	89.2
32	17.3	15.4	89.4	15.4	89.4
34	17.4	15.6	89.6	15.6	89.6
36	17.4	15.7	89.8	15.7	89.8
37.8	19.1	15.9	83.2	15.9	83.2
		Stream widths greater than 0.6-ft depth			
3.3	14.2	1.5	10.3	1.5	10.3
4	14.6	1.8	12.6	1.8	12.6
6	15.4	3.0	19.3	2.6	17.1
8	15.7	4.5	28.4	3.1	19.5
10	15.9	5.4	34.1	5.4	34.1
12	16.1	5.7	35.7	5.7	35.7
14	16.3	6.0	37.1	6.0	37.1
16	16.4	7.0	42.8	6.3	38.4
18	16.5	8.2	49.5	6.5	39.6
20	16.6	9.3	55.8	6.8	40.6
22	16.8	11.5	68.3	11.5	68.3
24	16.9	11.6	68.7	11.6	68.7
26	17.0	11.7	69.4	11.7	69.1
28	17.1	11.9	69.4	11.9	69.4
30	17.2	12.0	69.7	12.0	69.7
32	17.3	12.1	70.0	12.1	70.0
34	17.4	12.2	70.3	12.2	70.3
36	17.4	12.3	70.6	12.3	70.6
37.8	19.1	14.1	73.9	14.1	73.9
		Stream widths greater than 0.8-ft depth			
3.3	14.2	0.0	0.0	0.0	0.0
4	14.6	.0	.0	.0	.0
6	15.4	.2	1.4	.2	1.4
8	15.7	.9	5.6	.9	5.6
10	15.9	1.4	9.1	1.4	9.1
12	16.1	1.9	12.0	1.9	12.0
14	16.3	2.4	14.7	2.4	14.7
16	16.4	3.2	19.3	2.7	16.4
18	16.5	4.0	24.4	2.9	17.8
20	16.6	4.8	29.1	3.2	19.0
22	16.8	5.4	32.1	5.4	32.1
24	16.9	5.6	33.1	5.6	33.1
26	17.0	5.8	34.0	5.8	34.0
28	17.1	6.0	34.9	6.0	34.9
30	17.2	6.3	36.5	6.1	35.7
32	17.3	7.1	41.0	6.3	36.5
34	17.4	7.9	45.3	6.5	37.3
36	17.4	8.6	49.3	6.6	38.0
37.8	19.1	11.4	59.9	11.4	59.9

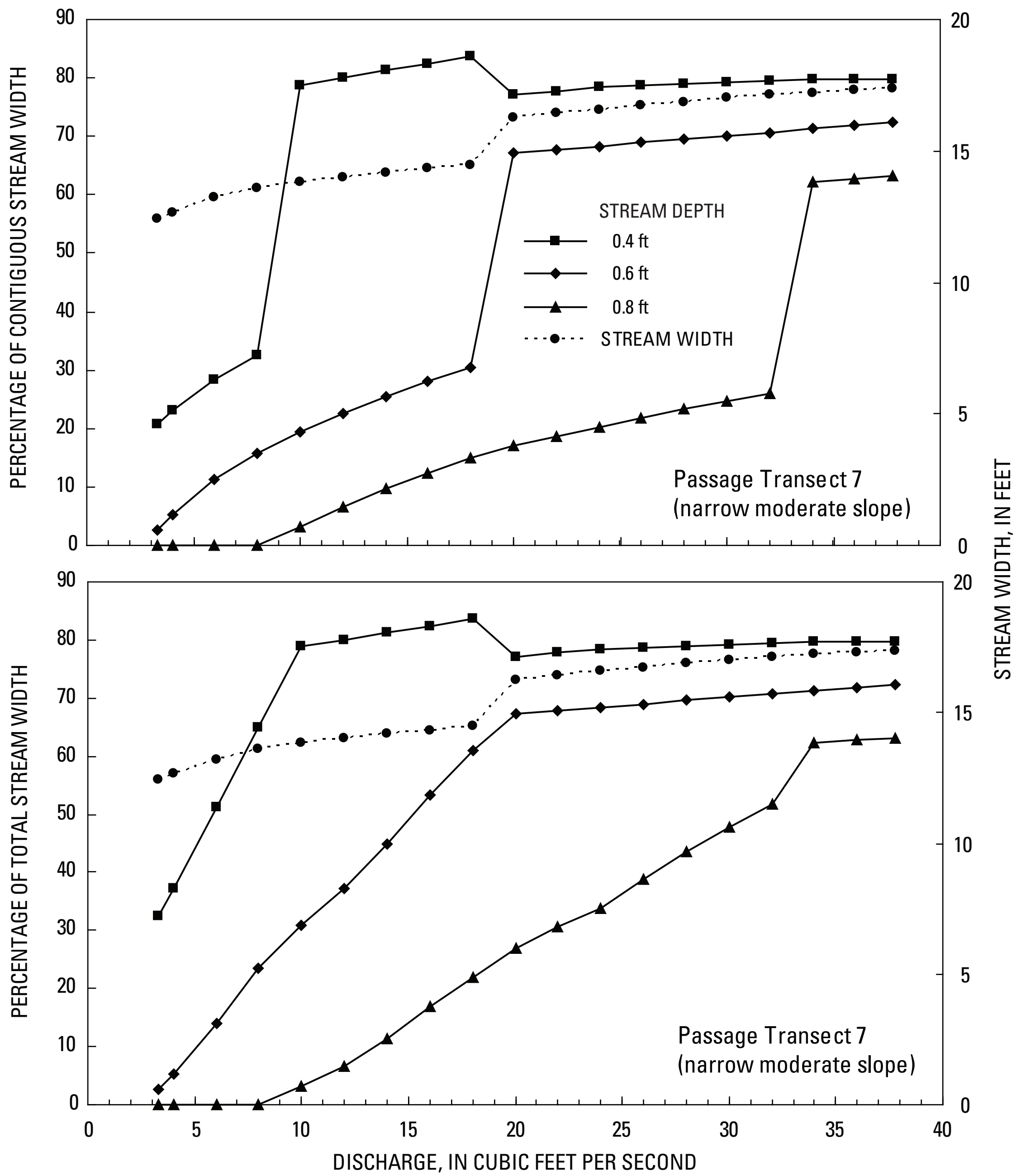


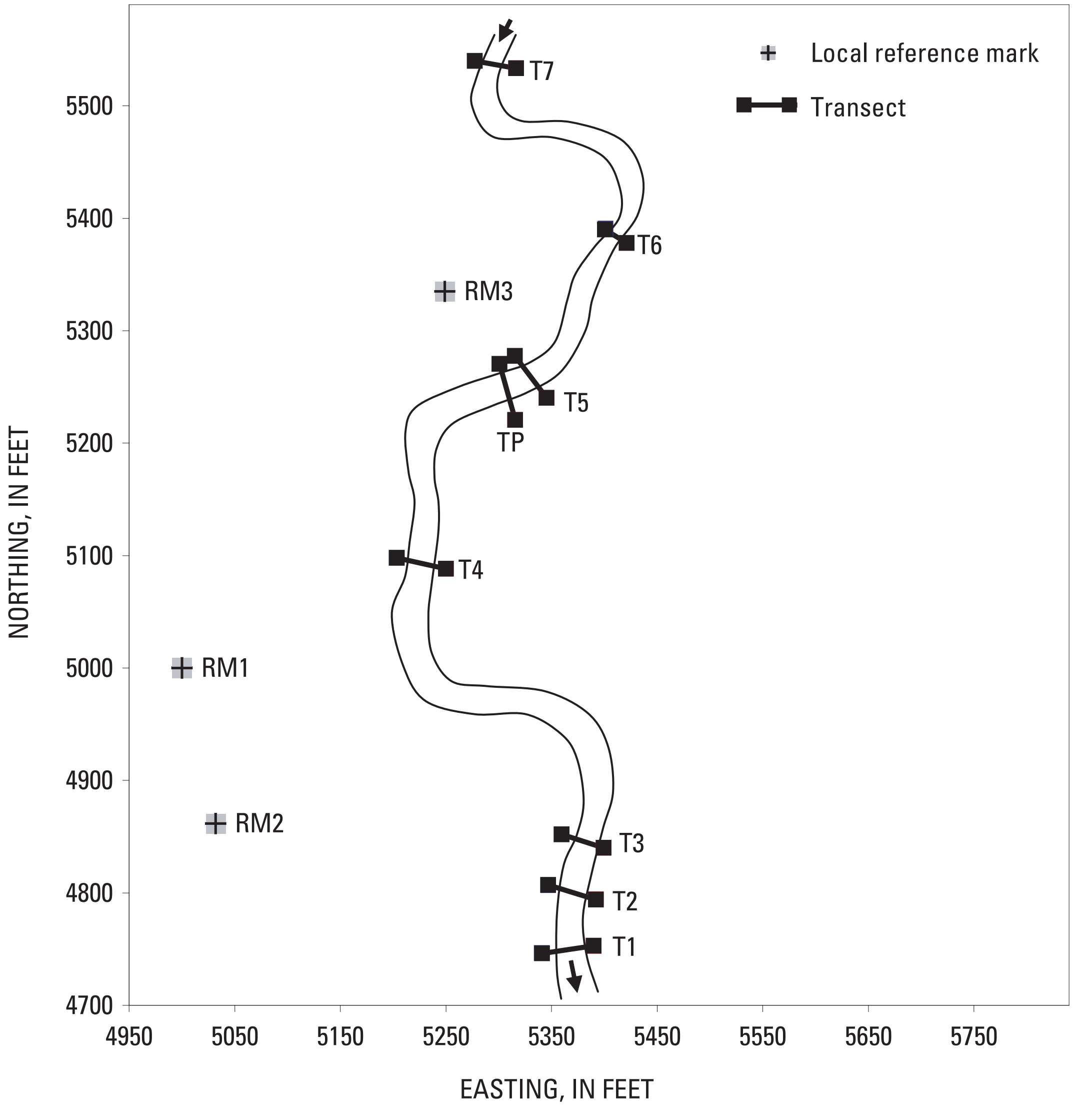
Figure F4. Percentages of contiguous and total stream width for passage transect lower Thompson Creek (TC1), upper Salmon River Basin, Idaho, 2004.

Table F3. Passage criteria assessment for transect 7 (wide high slope), site TC1, lower Thompson Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
3.3	12.4	4.0	32.4	2.6	20.7
4	12.7	4.7	37.2	2.9	23.1
6	13.2	6.8	51.1	3.7	28.3
8	13.6	8.8	64.8	4.4	32.5
10	13.8	10.9	78.8	10.9	78.8
12	14.0	11.2	80.0	11.2	80.0
14	14.2	11.5	81.2	11.5	81.2
16	14.3	11.8	82.5	11.8	82.5
18	14.5	12.1	83.6	12.1	83.6
20	16.3	12.5	77.1	12.5	77.1
22	16.4	12.8	77.8	12.8	77.7
24	16.6	13.0	78.4	13.0	78.4
26	16.7	13.2	78.7	13.2	78.7
28	16.9	13.3	79.0	13.3	79.0
30	17.0	13.5	79.3	13.5	79.3
32	17.1	13.6	79.5	13.6	79.5
34	17.2	13.7	79.7	13.7	79.7
36	17.3	13.8	79.8	13.8	79.8
37.8	17.4	13.9	79.8	13.9	79.8
		Stream widths greater than 0.6-ft depth			
3.3	12.4	0.3	2.6	0.3	2.6
4	12.7	.7	5.3	.7	5.3
6	13.2	1.8	14.0	1.5	11.3
8	13.6	3.2	23.4	2.2	15.8
10	13.8	4.3	30.8	2.7	19.5
12	14.0	5.2	37.3	3.2	22.7
14	14.2	6.4	44.9	3.6	25.5
16	14.3	7.6	53.2	4.0	28.0
18	14.5	8.8	60.9	4.4	30.5
20	16.3	11.0	67.3	11.0	67.3
22	16.4	11.1	67.8	11.1	67.8
24	16.6	11.3	68.3	11.3	68.3
26	16.7	11.5	69.0	11.5	69.0
28	16.9	11.7	69.6	11.7	69.6
30	17.0	11.9	70.2	11.9	70.2
32	17.1	12.1	70.7	12.1	70.7
34	17.2	12.3	71.3	12.3	71.3
36	17.3	12.4	71.9	12.4	71.9
37.8	17.4	12.6	72.4	12.6	72.4
		Stream widths greater than 0.8-ft depth			
3.3	12.4	0.0	0.0	0.0	0.0
4	12.7	.0	.0	.0	.0
6	13.2	.0	.0	.0	.0
8	13.6	.0	.0	.0	.0
10	13.8	.4	3.2	.4	3.2
12	14.0	.9	6.6	.9	6.6
14	14.2	1.6	11.3	1.4	9.6
16	14.3	2.4	16.8	1.8	12.3
18	14.5	3.2	21.9	2.2	14.8
20	16.3	4.4	27.0	2.8	17.0
22	16.4	5.0	30.5	3.1	18.7
24	16.6	5.6	33.7	3.4	20.2
26	16.7	6.5	38.8	3.6	21.8
28	16.9	7.3	43.5	3.9	23.3
30	17.0	8.1	47.8	4.2	24.6
32	17.1	8.8	51.7	4.4	25.9
34	17.2	10.7	62.2	10.7	62.2
36	17.3	10.9	62.7	10.9	62.7
37.8	17.4	11.0	63.2	11.0	63.2

Appendix G. Plan view, weighted useable areas and passage criteria assessments for bull trout, Chinook salmon, and steelhead trout for lower Squaw Creek (SC1), upper Salmon River Basin, Idaho, 2004.



Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB T1	44° 14' 58.21" N	114° 27' 21.77" W
RB T1	44° 14' 58.35" N	114° 27' 20.99" W
LB T2	44° 14' 58.82" N	114° 27' 21.70" W
RB T2	44° 14' 58.76" N	114° 27' 20.97" W
LB T3	44° 14' 59.29" N	114° 27' 21.52" W
RB T3	44° 14' 59.23" N	114° 27' 20.88" W
LB T4	44° 15' 1.52" N	114° 27' 24.13" W
RB T4	44° 15' 1.49" N	114° 27' 23.38" W

Transect Endpoint Coordinates (NAD 83)

Point	Latitude	Longitude
LB P	44° 15' 3.38" N	114° 27' 22.64" W
RB P	44° 15' 2.91" N	114° 27' 22.38" W
LB T5	44° 15' 3.48" N	114° 27' 22.41" W
RB T5	44° 15' 3.15" N	114° 27' 21.91" W
LB T6	44° 15' 4.73" N	114° 27' 21.08" W
RB T6	44° 15' 4.64" N	114° 27' 20.76" W
LB T7	44° 15' 6.04" N	114° 27' 23.14" W
RB T7	44° 15' 6.04" N	114° 27' 22.50" W

For reference only; stream schematic not to scale.

Figure G1. Plan view of lower Squaw Creek (SC1), upper Salmon River Basin, Idaho, 2004.

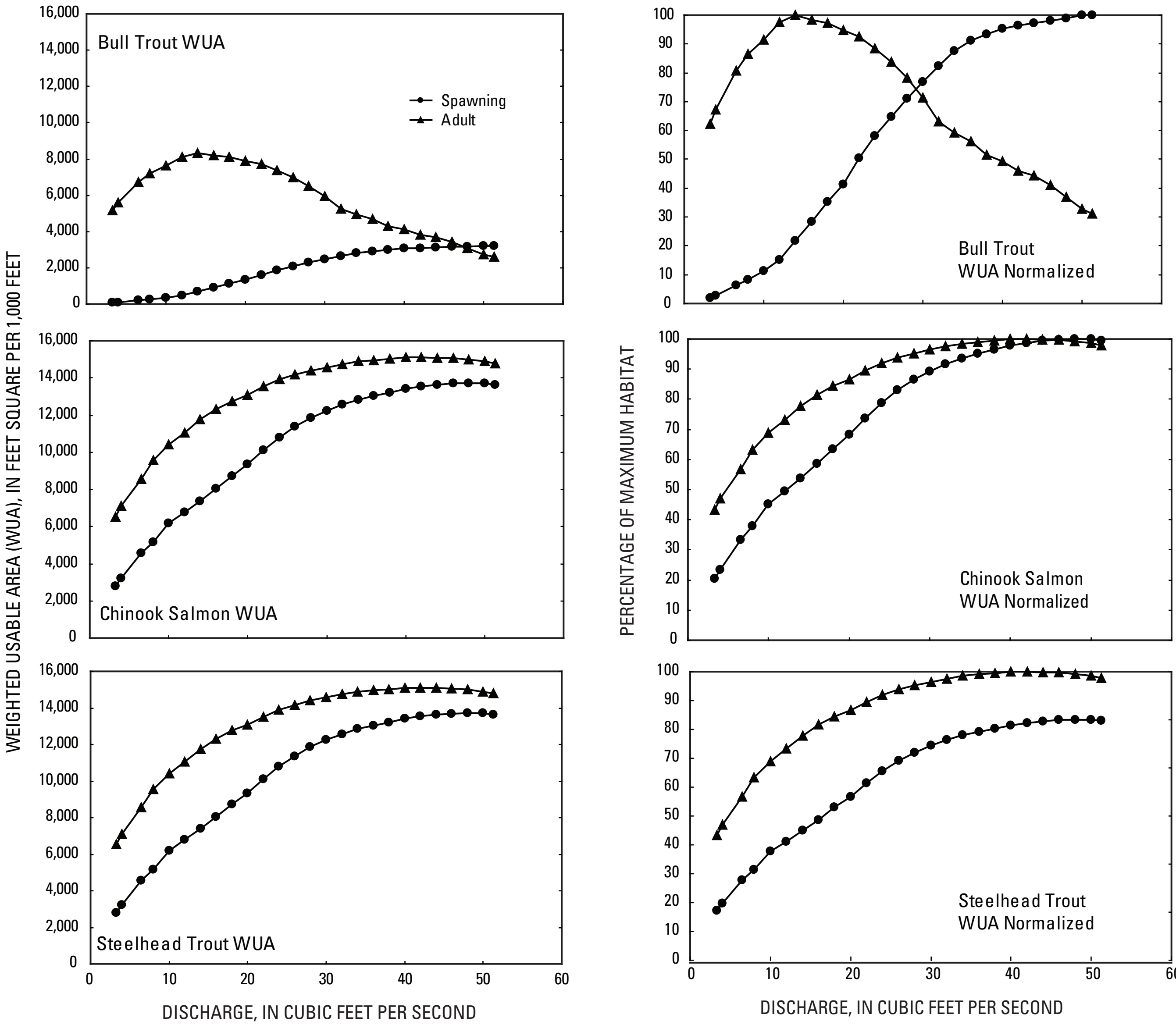


Figure G2. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout, lower Squaw Creek (SC1), upper Salmon River Basin, Idaho, 2004.

Table G1. Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, and steelhead trout life stages, site SC1, lower Squaw Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: WUA, weighted usable area; ft^3/s, cubic foot per second; ft^2, square foot; ft^2/1,000 ft, square foot per 1,000 feet]

Discharge (ft^3/s)	Total area (ft^2)	Summary of WUA (ft^2/1,000 ft)		Percentage of maximum habitat	
		Adult	Spawning	Adult	Spawning
Bull trout					
3.3	21,563	5,177	65	62.2	2.0
4	22,582	5,608	86	67.3	2.7
6.5	24,306	6,723	204	80.7	6.4
8	24,644	7,201	270	86.5	8.4
10	25,725	7,620	366	91.5	11.4
12	25,992	8,129	485	97.6	15.1
14	26,249	8,329	703	100.0	21.9
16	26,481	8,194	909	98.4	28.3
18	26,692	8,097	1,133	97.2	35.3
20	26,878	7,902	1,325	94.9	41.2
22	27,026	7,707	1,616	92.5	50.3
24	27,166	7,365	1,864	88.43	58.1
26	27,299	6,972	2,077	83.7	64.7
28	27,422	6,507	2,285	78.1	71.2
30	27,536	5,940	2,468	71.3	76.8
32	27,630	5,257	2,648	63.1	82.5
34	27,721	4,939	2,815	59.3	87.7
36	27,804	4,680	2,924	56.2	91.1
38	27,888	4,291	3,000	51.5	93.4
40	27,970	4,114	3,058	49.4	95.2
42	28,050	3,835	3,100	46.1	96.5
44	28,131	3,683	3,124	44.2	97.3
46	28,212	3,416	3,152	41.0	98.2
48	28,313	3,085	3,180	37.0	99.0
50	28,411	2,730	3,211	32.8	100.0
51.3	28,487	2,596	3,210	31.2	100.0
Chinook salmon					
3.3	21,563	6,528	2,814	43.2	20.5
4	22,582	7,102	3,225	47.0	23.5
6.5	24,306	8,554	4,569	56.6	33.3
8	24,644	9,549	5,179	63.2	37.8
10	25,725	10,405	6,196	68.9	45.2
12	25,992	11,059	6,788	73.2	49.5
14	26,249	11,750	7,382	77.8	53.8
16	26,481	12,321	8,022	81.6	58.5
18	26,692	12,758	8,716	84.4	63.6
20	26,878	13,085	9,347	86.6	68.2
22	27,026	13,525	10,109	89.5	73.7
24	27,166	13,908	10,794	92.1	78.7
26	27,299	14,168	11,374	93.8	82.9
28	27,422	14,393	11,857	95.3	86.5
30	27,536	14,574	12,248	96.5	89.3
32	27,630	14,742	12,556	97.6	91.6
34	27,721	14,882	12,842	98.5	93.6
36	27,804	14,962	13,045	99.0	95.1
38	27,888	15,026	13,219	99.5	96.4
40	27,970	15,099	13,400	99.9	97.7
42	28,050	15,108	13,527	100.0	98.6
44	28,131	15,082	13,629	99.8	99.4
46	28,212	15,054	13,694	99.6	99.9
48	28,313	14,995	13,713	99.3	100.0
50	28,411	14,899	13,712	98.6	100.0
51.3	28,487	14,785	13,647	97.9	99.5
Steelhead trout					
3.3	21,563	6,528	2,814	43.2	20.5
4	22,582	7,102	3,225	47.0	23.5
6.5	24,306	8,554	4,569	56.6	33.3
8	24,644	9,549	5,179	63.2	37.8
10	25,725	10,405	6,196	68.9	45.2
12	25,992	11,059	6,788	73.2	49.5
14	26,249	11,750	7,382	77.8	53.8
16	26,481	12,321	8,022	81.6	58.5
18	26,692	12,758	8,716	84.4	63.6
20	26,878	13,085	9,347	86.6	68.2
22	27,026	13,525	10,109	89.5	73.7
24	27,166	13,908	10,794	92.1	78.7
26	27,299	14,168	11,374	93.8	82.9
28	27,422	14,393	11,857	95.3	86.5
30	27,536	14,574	12,248	96.5	89.3
32	27,630	14,742	12,556	97.6	91.6
34	27,721	14,882	12,842	98.5	93.6
36	27,804	14,962	13,045	99.0	95.1
38	27,888	15,026	13,219	99.5	96.4
40	27,970	15,099	13,400	99.9	97.7
42	28,050	15,108	13,527	100.0	98.6
44	28,131	15,082	13,629	99.8	99.4
46	28,212	15,054	13,694	99.6	99.9
48	28,313	14,995	13,713	99.2	100.0
50	28,411	14,899	13,712	98.6	100.0
51.3	28,487	14,785	13,647	97.9	99.5

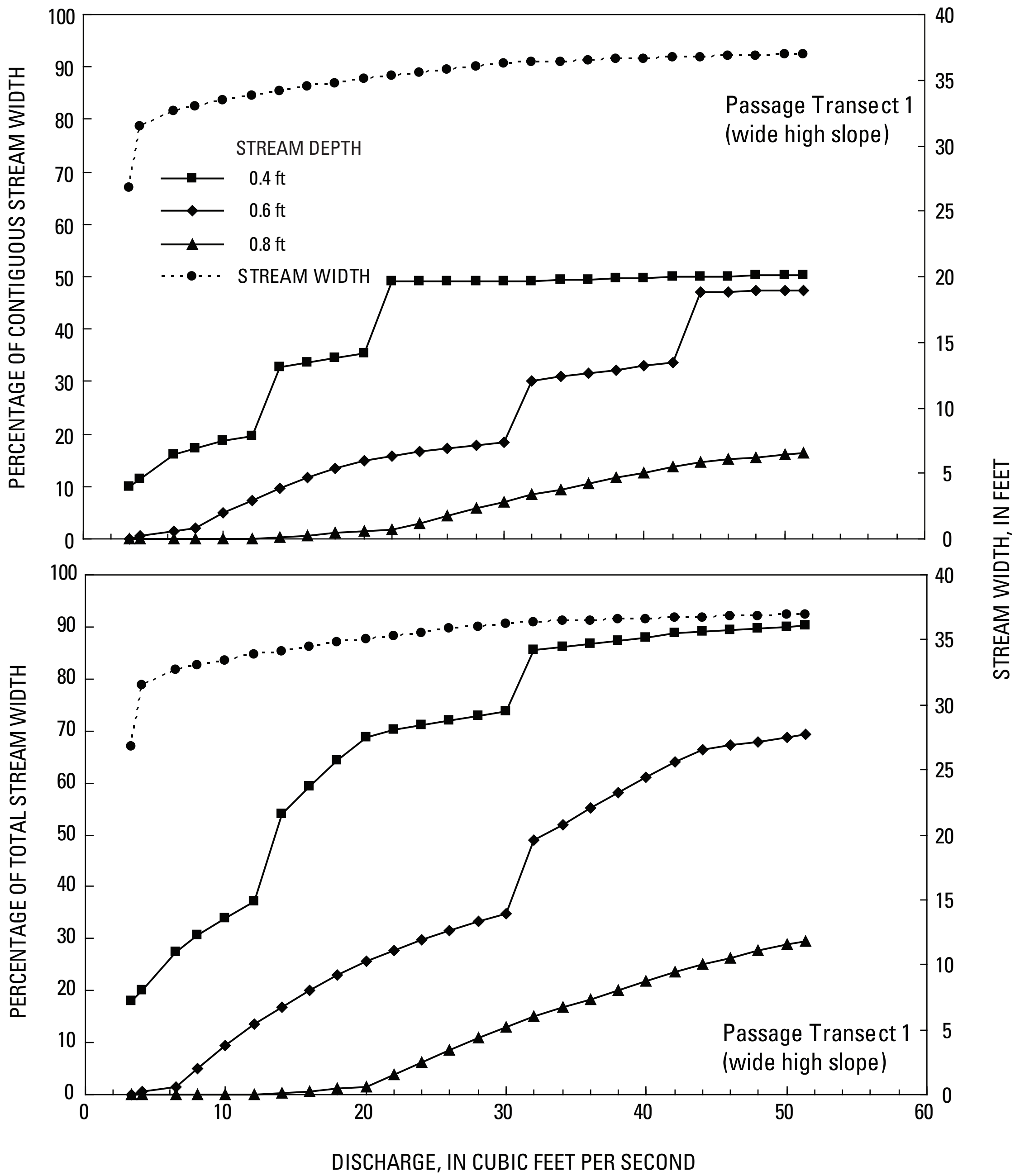


Figure G3. Percentages of contiguous and total stream width for passage transect 1, lower Squaw Creek (SC1), upper Salmon River Basin, Idaho, 2004.

Table G2. Passage criteria assessment for transect 1 (wide high slope), site SC1, lower Squaw Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
3.3	26.8	4.8	17.9	2.6	9.9
4	31.5	6.3	19.9	3.6	11.3
6.5	32.7	9.0	27.4	5.2	16.1
8	33.0	10.1	30.6	5.7	17.3
10	33.4	11.4	34.0	6.2	18.6
12	33.8	12.6	37.1	6.7	19.7
14	34.2	18.5	54.0	11.2	32.6
16	34.5	20.5	59.4	11.6	33.7
18	34.8	22.3	64.2	12.1	34.6
20	35.1	24.1	68.7	12.4	35.5
22	35.3	24.8	70.2	17.4	49.1
24	35.6	25.3	71.1	17.5	49.1
26	35.8	25.8	72.1	17.6	49.1
28	36.0	26.3	72.9	17.7	49.1
30	36.3	26.7	73.8	17.8	49.0
32	36.4	31.1	85.5	17.9	49.2
34	36.4	31.4	86.2	18.0	49.3
36	36.5	31.7	86.8	18.1	49.4
38	36.6	32.0	87.4	18.1	49.6
40	36.6	32.2	88.0	18.2	49.7
42	36.7	32.5	88.6	18.3	49.9
44	36.7	32.8	89.1	18.4	50.0
46	36.8	32.9	89.4	18.4	50.1
48	36.9	33.1	89.7	18.5	50.2
50	36.9	33.2	90.0	18.6	50.3
51.3	36.9	33.3	90.2	18.6	50.4
		Stream widths greater than 0.6-ft depth			
3.3	26.8	0.0	0.0	0.0	0.0
4	31.5	.2	.6	.2	.6
6.5	32.7	.5	1.5	.5	1.5
8	33.0	1.7	5.1	.7	2.2
10	33.4	3.2	9.6	1.7	5.0
12	33.8	4.6	13.5	2.5	7.4
14	34.2	5.8	16.9	3.3	9.6
16	34.5	6.9	20.1	4.0	11.6
18	34.8	8.0	23.0	4.6	13.4
20	35.1	9.0	25.7	5.3	15.0
22	35.3	9.8	27.8	5.6	15.9
24	35.6	10.6	29.7	5.9	16.6
26	35.8	11.3	31.5	6.2	17.2
28	36.0	12.0	33.2	6.4	17.9
30	36.3	12.6	34.8	6.7	18.5
32	36.4	17.8	49.0	11.0	30.2
34	36.4	19.0	52.1	11.3	30.9
36	36.5	20.1	55.1	11.5	31.6
38	36.6	21.2	58.1	11.8	32.3
40	36.6	22.4	61.1	12.1	32.9
42	36.7	23.5	64.0	12.3	33.6
44	36.7	24.4	66.3	17.3	47.0
46	36.8	24.7	67.1	17.3	47.1
48	36.9	25.0	67.9	17.4	47.2
50	36.9	25.4	68.7	17.5	47.4
51.3	36.9	25.6	69.2	17.5	47.4

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.8-ft depth			
3.3	26.8	0.0	0.0	0.0	0.0
4	31.5	.0	.0	.0	.0
6.5	32.7	.0	.0	.0	.0
8	33.0	.0	.0	.0	.0
10	33.4	.0	.0	.0	.0
12	33.8	.0	.0	.0	.0
14	34.2	.1	.3	.1	.3
16	34.5	.2	.7	.2	.7
18	34.8	.4	1.1	.4	1.1
20	35.1	.5	1.4	.5	1.4
22	35.3	1.3	3.8	.6	1.7
24	35.6	2.2	6.2	1.1	3.0
26	35.8	3.1	8.6	1.6	4.4
28	36.0	3.9	10.8	2.1	5.8
30	36.3	4.7	12.9	2.6	7.1
32	36.4	5.4	14.9	3.1	8.4
34	36.4	6.1	16.7	3.4	9.5
36	36.5	6.7	18.4	3.9	10.6
38	36.6	7.4	20.2	4.3	11.6
40	36.6	8.0	21.9	4.6	12.7
42	36.7	8.6	23.6	5.1	13.8
44	36.7	9.2	25.0	5.4	14.6
46	36.8	9.7	26.4	5.6	15.1
48	36.9	10.2	27.6	5.8	15.6
50	36.9	10.6	28.8	5.9	16.1
51.3	36.9	10.9	29.6	6.0	16.4

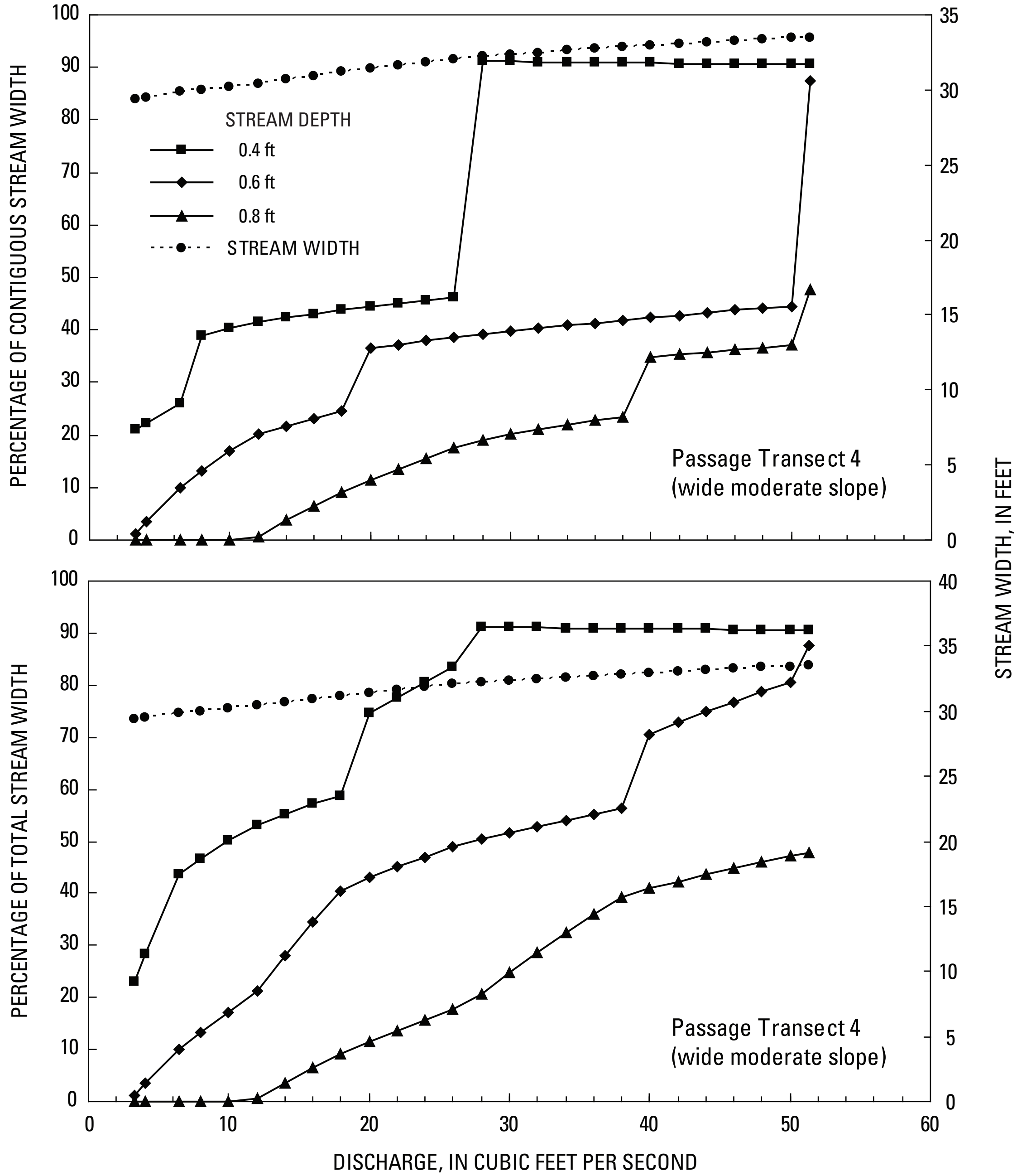


Figure G4. Percentages of contiguous and total stream width for passage transect 4, lower Squaw Creek (SC1), upper Salmon River Basin, Idaho, 2004.

Table G3. Passage criteria assessment for transect 4 (wide moderate slope), site SC1, lower Squaw Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft^3/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
3.3	29.4	6.8	23.1	6.2	21.1
4	29.5	8.4	28.4	6.6	22.4
6.5	29.8	13.0	43.5	7.8	26.0
8	30.0	14.0	46.6	11.7	38.9
10	30.2	15.1	50.1	12.1	40.2
12	30.4	16.2	53.1	12.6	41.4
14	30.7	16.9	55.2	13.0	42.3
16	31.0	17.7	57.1	13.3	43.1
18	31.2	18.4	58.8	13.7	43.8
20	31.4	23.4	74.5	14.0	44.5
22	31.6	24.6	77.7	14.3	45.2
24	31.9	25.7	80.6	14.6	45.8
26	32.1	26.8	83.5	14.9	46.3
28	32.2	29.4	91.2	29.4	91.2
30	32.4	29.5	91.1	29.5	91.1
32	32.5	29.6	91.0	29.6	91.0
34	32.6	29.7	91.0	29.7	91.0
36	32.7	29.8	90.9	29.8	90.9
38	32.8	29.8	90.9	29.8	90.9
40	32.9	29.9	90.8	29.9	90.8
42	33.1	30.0	90.8	30.0	90.8
44	33.2	30.1	90.7	30.1	90.7
46	33.2	30.2	90.7	30.2	90.7
48	33.4	30.2	90.6	30.2	90.6
50	33.4	30.3	90.6	30.3	90.6
51.3	33.5	30.3	90.6	30.3	90.6
		Stream widths greater than 0.6-ft depth			
3.3	29.4	0.3	1.1	0.3	1.1
4	29.5	1.0	3.4	1.0	3.4
6.5	29.8	3.0	10.0	3.0	10.0
8	30.0	4.0	13.3	4.0	13.3
10	30.2	5.1	17.0	5.1	17.0
12	30.4	6.4	21.1	6.1	20.1
14	30.7	8.6	28.1	6.7	21.7
16	31.0	10.7	34.5	7.2	23.2
18	31.2	12.6	40.4	7.6	24.5
20	31.4	13.6	43.2	11.5	36.6
22	31.6	14.3	45.2	11.8	37.3
24	31.9	15.0	47.0	12.1	37.9
26	32.1	15.6	48.8	12.4	38.5
28	32.2	16.2	50.3	12.6	39.1
30	32.4	16.7	51.7	12.9	39.8
32	32.5	17.2	52.8	13.1	40.3
34	32.6	17.6	54.1	13.3	40.9
36	32.7	18.1	55.2	13.5	41.4
38	32.8	18.5	56.3	13.7	41.8
40	32.9	23.3	70.6	14.0	42.3
42	33.1	24.1	72.8	14.2	42.8
44	33.2	24.8	74.9	14.4	43.3
46	33.2	25.6	76.8	14.5	43.7
48	33.4	26.2	78.7	14.7	44.1
50	33.4	26.9	80.5	14.9	44.5
51.3	33.5	29.3	87.6	29.3	87.6
		Stream widths greater than 0.8-ft depth			
3.3	29.4	0.0	0.0	0.0	0.0
4	29.5	.0	.0	.0	.0
6.5	29.8	.0	.0	.0	.0
8	30.0	.0	.0	.0	.0
10	30.2	.0	.0	.0	.0
12	30.4	.2	.6	.2	.6
14	30.7	1.1	3.7	1.1	3.7
16	31.0	2.0	6.5	2.0	6.5
18	31.2	2.8	9.1	2.8	9.1
20	31.4	3.6	11.4	3.6	11.4
22	31.6	4.3	13.6	4.3	13.6
24	31.9	5.0	15.6	5.0	15.6
26	32.1	5.6	17.6	5.6	17.6
28	32.2	6.6	20.5	6.2	19.1
30	32.4	8.0	24.8	6.5	20.1
32	32.5	9.3	28.5	6.8	21.0
34	32.6	10.6	32.5	7.2	21.9
36	32.7	11.8	36.0	7.4	22.8
38	32.8	12.9	39.3	7.7	23.5
40	32.9	13.5	40.9	11.4	34.8
42	33.1	14.0	42.3	11.6	35.3
44	33.2	14.4	43.6	11.8	35.7
46	33.2	14.9	44.8	12.0	36.2
48	33.4	15.3	46.0	12.2	36.6
50	33.4	15.7	47.1	12.4	37.1
51.3	33.5	16.0	47.8	16.0	47.8

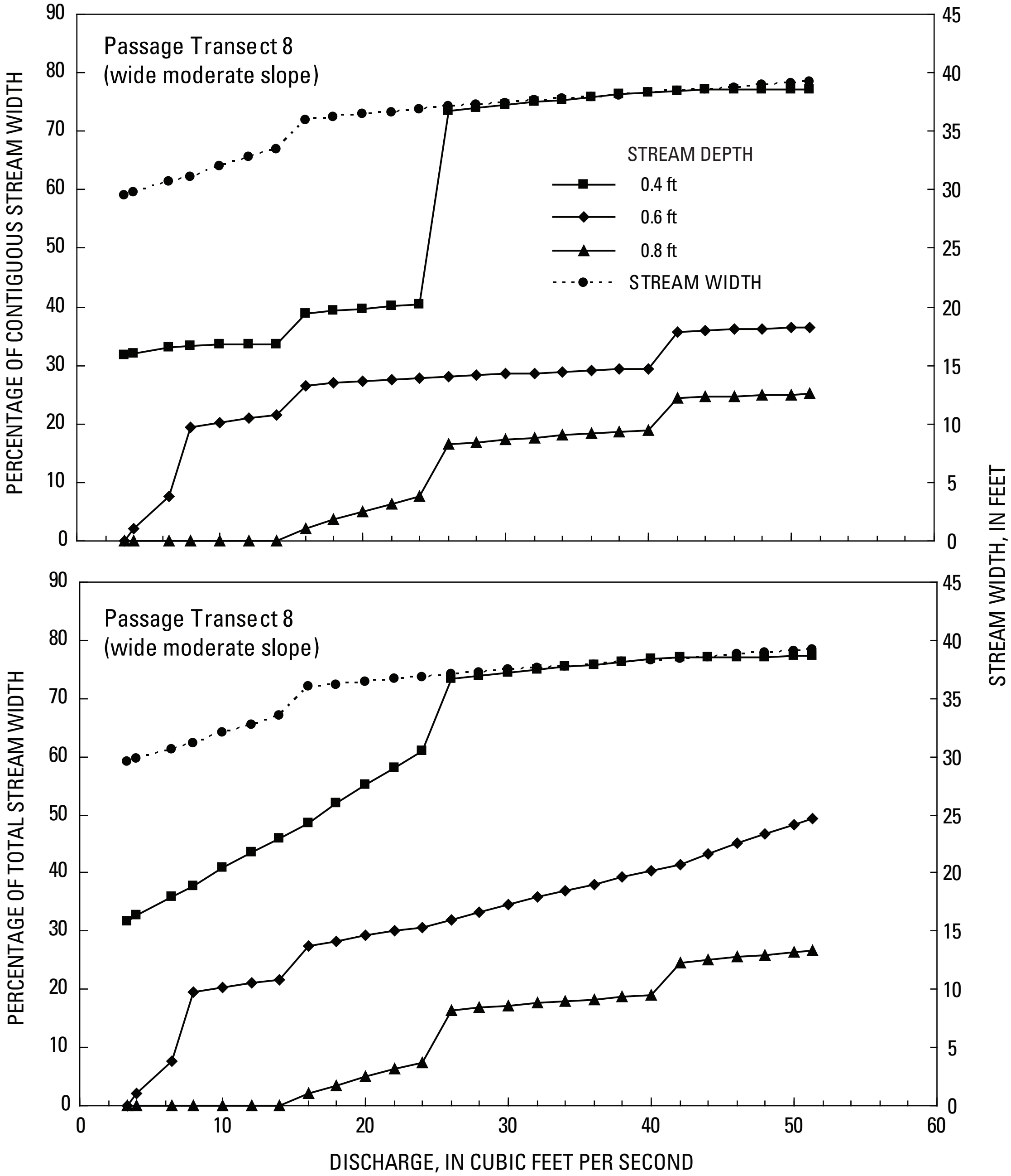


Figure G5. Percentages of contiguous and total stream width for passage transect 8, lower Squaw Creek (SC1), upper Salmon River Basin, Idaho, 2004.

Table G4. Passage criteria assessment for transect 8 (wide moderate slope), site SC1, lower Squaw Creek, upper Salmon River Basin, Idaho, 2004.

[Site location shown in figure 1. **Abbreviations**: ft, foot; ft³/s, cubic foot per second]

Discharge (ft^3/s)	Stream width (ft)	Passage criteria assessment			
		Total	Percentage	Contiguous	Percentage contiguous
		Stream widths greater than 0.4-ft depth			
3.3	29.5	9.3	31.7	9.3	31.6
4	29.8	9.8	32.8	9.5	32.0
6.5	30.7	11.0	35.9	10.1	33.0
8	31.1	11.7	37.6	10.4	33.4
10	32.0	13.1	40.9	10.7	33.5
12	32.8	14.3	43.6	11.0	33.6
14	33.5	15.4	46.0	11.3	33.7
16	36.0	17.4	48.5	14.0	38.9
18	36.2	18.8	52.0	14.2	39.3
20	36.4	20.1	55.2	14.5	39.7
22	36.6	21.2	58.0	14.7	40.1
24	36.9	22.4	60.8	14.9	40.4
26	37.1	27.2	73.4	27.2	73.4
28	37.2	27.5	73.9	27.5	73.9
30	37.4	27.9	74.4	27.9	74.4
32	37.6	28.2	74.9	28.2	74.9
34	37.8	28.5	75.4	28.5	75.4
36	37.9	28.8	75.8	28.8	75.8
38	38.1	29.1	76.3	29.1	76.3
40	38.2	29.3	76.7	29.3	76.7
42	38.4	29.6	77.0	29.6	77.0
44	38.6	29.7	77.0	29.7	77.0
46	38.8	29.9	77.1	29.9	77.1
48	38.9	30.0	77.2	30.0	77.2
50	39.1	30.2	77.2	30.2	77.2
51.3	39.2	30.2	77.2	30.2	77.2
		Stream widths greater than 0.6-ft depth			
3.3	29.5	0.0	0.0	0.0	0.0
4	29.8	.6	2.1	.6	2.1
6.5	30.7	2.3	7.6	2.3	7.6
8	31.1	6.1	19.5	6.1	19.5
10	32.0	6.5	20.3	6.5	20.3
12	32.8	6.9	21.0	6.9	21.0
14	33.5	7.2	21.6	7.2	21.6
16	36.0	9.9	27.4	9.6	26.6
18	36.2	10.3	28.3	9.8	27.0
20	36.4	10.6	29.2	9.9	27.3
22	36.6	11.0	30.0	10.1	27.5
24	36.9	11.3	30.7	10.3	27.8
26	37.1	11.8	31.9	10.4	28.1
28	37.2	12.4	33.2	10.5	28.3
30	37.4	12.9	34.5	10.7	28.5
32	37.6	13.5	35.8	10.8	28.7
34	37.8	14.0	37.0	10.9	28.9
36	37.9	14.5	38.1	11.0	29.1
38	38.1	15.0	39.3	11.2	29.3
40	38.2	15.4	40.3	11.3	29.5
42	38.4	15.9	41.5	13.7	35.7
44	38.6	16.7	43.4	13.9	35.9
46	38.8	17.5	45.1	14.0	36.1
48	38.9	18.2	46.8	14.1	36.3
50	39.1	18.9	48.4	14.2	36.5
51.3	39.2	19.3	49.4	14.3	36.6
		Stream widths greater than 0.8-ft depth			
3.3	29.5	0.0	0.0	0.0	0.0
4	29.8	.0	.0	.0	.0
6.5	30.7	.0	.0	.0	.0
8	31.1	.0	.0	.0	.0
10	32.0	.0	.0	.0	.0
12	32.8	.0	.0	.0	.0
14	33.5	.0	.0	.0	.0
16	36.0	.7	2.0	.7	2.0
18	36.2	1.3	3.6	1.3	3.6
20	36.4	1.8	5.0	1.8	5.0
22	36.6	2.3	6.2	2.3	6.2
24	36.8	2.8	7.5	2.8	7.5
26	37.1	6.1	16.5	6.1	16.5
28	37.2	6.3	16.8	6.3	16.8
30	37.4	6.5	17.2	6.5	17.2
32	37.6	6.6	17.6	6.6	17.6
34	37.8	6.8	18.0	6.8	18.0
36	37.9	7.0	18.3	7.0	18.3
38	38.1	7.1	18.7	7.1	18.7
40	38.2	7.2	19.0	7.2	19.0
42	38.4	9.4	24.5	9.4	24.4
44	38.6	9.6	25.0	9.5	24.6
46	38.8	9.9	25.5	9.6	24.7
48	38.9	10.1	25.9	9.7	24.9
50	39.1	10.3	26.3	9.8	25.0
51.3	39.2	10.42	26.6	9.8	25.1

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