Prepared in cooperation with the Bureau of Reclamation

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Scientific Investigations Report 2006–5230

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

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**U.S. Geological Survey**
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# Conversion Factors, Datum, and Acronyms

## Conversion Factors

| Multiply | By | To obtain |
|---|---|---|
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second |
| foot (ft) | 0.3048 | meter |
| inch (in.) | 2.54 | centimeter |
| inch per year per foot [(in/yr)/ft] | 83.33 | millimeter per year per meter |
| mile (mi) | 1.609 | kilometer |
| square foot ($ft^2$) | 0.09290 | square meter |
| square mile ($mi^2$) | 2.590 | square kilometer |

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

$$°F = (1.8 \times °C) + 32$$

## Datum

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

| | |
|---|---|
| AVDEPTH/AVPERM | Hydraulic parameter option in PHABSIM for Windows |
| BIA | Bureau of Indian Affairs |
| BiOp | Biological Opinion |
| CI | Composite index |
| EPT | Ephemeroptera, Plecoptera, and Trichoptera |
| 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 |
| WY05 | Water year 2005 |

# Instream Flow Characterization of Upper Salmon River Basin Streams, Central Idaho, 2005

By Terry R. Maret, Jon E. Hortness, and Douglas S. Ott


## 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 (PHABSIM) model, a widely applied method to determine relations between habitat and discharge requirements for various fish species and life stages. Model simulation results can be used by resource managers to guide habitat restoration efforts by evaluating potential fish habitat and passage improvements by increasing or decreasing streamflow.

In 2005, instream flow characterization studies were completed on Big Boulder, Challis, Bear, Mill, and Morgan Creeks. Continuous streamflow data were recorded upstream of all diversions on Big Boulder. Instantaneous measurements of discharge were also made at selected sites. In addition, natural summer streamflows were estimated for each study site using regional regression equations.

This report describes PHABSIM 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. In addition, streamflow needs for riffle dwelling invertebrate taxa (Ephemeroptera, Plecoptera, and Trichoptera) are presented. Adult fish passage and discharge relations were evaluated at specific transects that were identified as potential low-streamflow passage barriers 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.

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 decrease 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.

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 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 in 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 is rarely 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, restored streamflows could potentially improve spawning and rearing habitat in 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 and 2004 (Maret and others, 2004; 2005). In addition, instream flow studies were completed on Big Timber, Big Eightmile, Bohannon, and Hayden Creeks in the Lemhi Basin (Sutton and Morris 2004; 2005) .

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.

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.

Continuous summer water temperature data recorded in 2003 and streamflow relations were evaluated for Fourth of July Creek using a Stream Segment Temperature model that simulates mean and maximum daily water temperatures with changes in streamflow. Model simulation results from lower Fourth of July Creek predicted a slight increase in mean daily water temperature of 1.0ºC because of the upstream diversions removing 72 percent of the streamflow (Maret and others, 2005).

## 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.

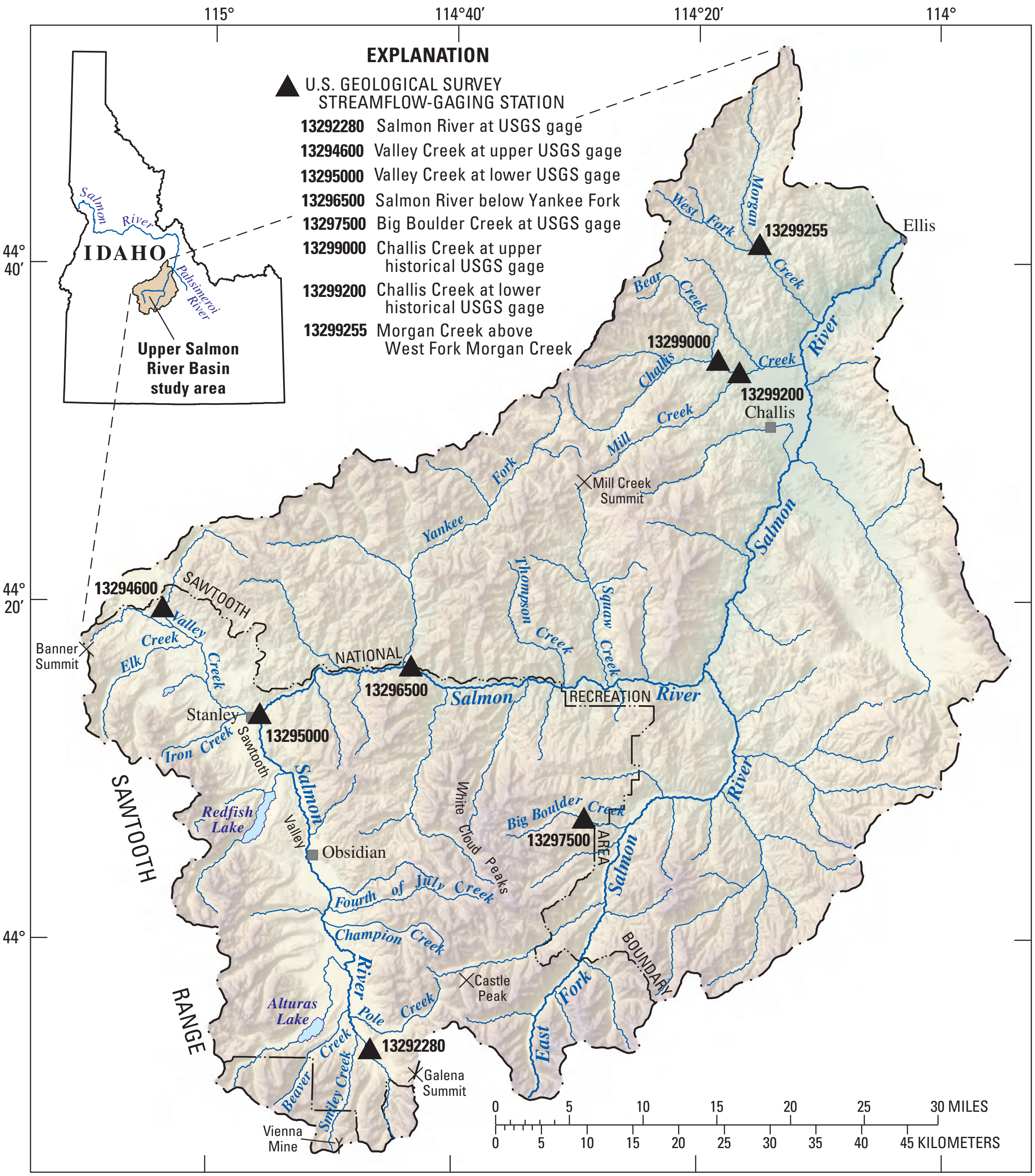
The upper Salmon River Basin geology consists primarily of metamorphic and sedimentary rocks, granite, volcanic rocks, and alluvium (King and Beikman, 1974). Much of the basin is characterized by stream channels deeply incised in bedrock and bordered by steep terrain.

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 beneficial uses for aquatic life 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 supported (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 effect 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 effect on the overall water temperature of the stream.

According to SNRA biologists, the greatest effects 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 used 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). In the past, the endangered sockeye salmon 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 selected streamflow-gaging stations in the upper Salmon River Basin, Idaho.

# 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 2005, due to difficulty gaining access to private lands to walk streams for measuring mesohabitats, representative reaches were selected based on field reconnaissance from nearby public access areas and the use of topographical maps. When possible, a stream length exceeding 40 times the wetted channel width was walked to select a representative reach to assess. The various mesohabitats were measured in each reach and transects were weighted in the PHABSIM model according to their relative lengths in the reach.

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 in 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.

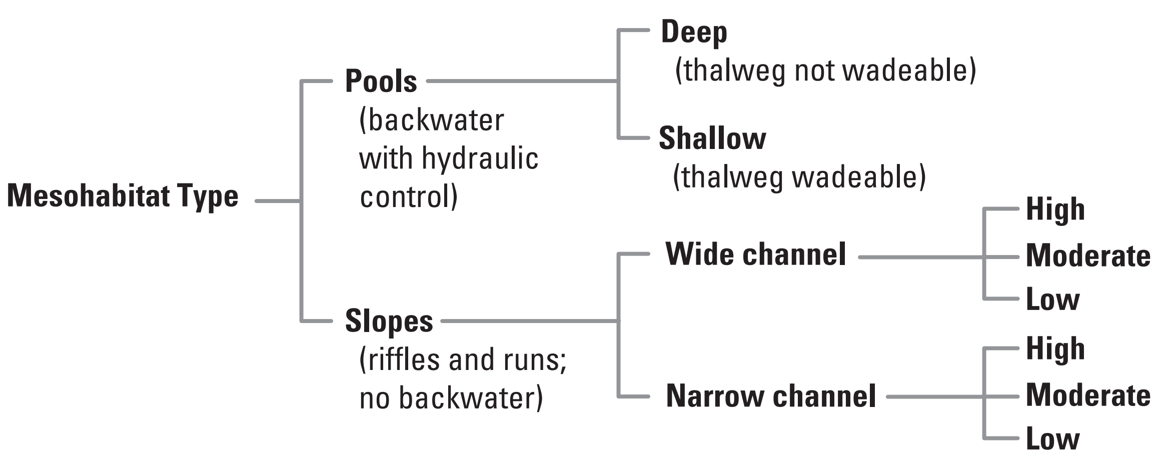



**Figure 2.** Hierarchical habitat classification used in this study. Mesohabitats are equivalent to geomorphic channel units such as riffles, pools, and runs.

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. Transects typically represent the most common habitats and hydraulic controls in each reach. Generally, one to two transects were selected to represent each major mesohabitat in each reach. 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 representative reach. Mesohabitats making up less than 10 percent of the representative reach generally were not included in the assessment.

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 effect 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. Velocity calibration sets were collected during two periods to represent a range of summer streamflows. 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, percentage of canopy opening was estimated at each transect with a clinometer following procedures described by Fitzpatrick and others (1998).

### Stream Temperature

Onset TidbiT™ data loggers 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).

To capture the natural thermal regime and to assess the effects of diversions on stream temperature, data loggers were deployed spatially throughout a stream. Where permission to access private land was granted, a data logger was placed far enough upstream of all diversions to avoid possible effects of diversions. Data loggers also were deployed 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, and substrate) during expected summer (July through September) streamflow. Estimates of fish cover also were recorded, but were not used in the model. 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. Calibration data sets for each study site are available in IFG4 data files at [http://id.water.usgs.gov/projects/salmon_streamflow](http://id.water.usgs.gov/projects/salmon_streamflow).

### 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, 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 fish species HSCs selected for this study were developed in the Pacific Northwest and Idaho. In addition, invertebrate HSCs published by Gore and others (2001) were used to simulate streamflow and habitat suitability for riffle dwelling Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa. These three orders of insects make up the predominant invertebrate fauna of riffle habitat and provide a major food source for stream dwelling trout and salmon (Gore and others 2001; Maret and others, 2001). Evaluating desirable streamflow needs for riffle habitat and associated invertebrates is particularly important because these are the first habitats to become dry when streamflows are reduced below baseflow. According to Jowett (2003) instream flow requirements for fish should also consider habitat for benthic invertebrates, particularly where food availability may limit fish numbers and (or) growth. 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.

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 measure accurately 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 in 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:

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

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 in 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 display 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 they considered bull trout likely 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 in 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; Maret and others, 2004, 2005).

## 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. Also, WUA-discharge curves can be used to estimate how much habitat is gained or lost with incremental streamflow changes. In some cases, small streamflow changes can result in major habitat changes. WUA is an instantaneous representation of how much water it takes to create a certain amount of habitat. Seasonal, monthly, or daily streamflow regimes have to be applied to the instantaneous WUA curves to estimate how much habitat is actually present. 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 selected 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 in 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 less than that required for adult fish passage. In addition, providing streamflow for optimum protection of riffle habitat will ensure healthy invertebrate communities, which are a major food source for fish.

Discharge estimates providing maximum WUA for juvenile salmonid life stages are usually less than summer base flows, indicating a disconnect between the PHABSIM model simulation 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. 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 in 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 2005

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 2005 (WY05). Monthly snowpack levels were significantly below normal between January 1 and June 1, 2005. The average air temperature during WY05 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, as were monthly mean streamflows.

## Climatic Conditions

Average monthly snowpack levels for the Salmon River Basin upstream of Salmon, Idaho, ranged from 34 to 79 percent of normal from January 1 to June 1, 2005. Average snowpack value for this area on April 1, 2005, was 61 percent of normal (Natural Resources Conservation Service, 2006b). The most commonly used snowpack condition indicator is the April 1 value because in most years it is the final value calculated before snowmelt begins.

Measurement sites in the general vicinity of the study sites include Galena Summit (at the headwaters of the Salmon River), Mill Creek Summit (at the headwaters of Yankee Fork), and Morgan Creek (at the headwaters of Morgan Creek). Specific snowpack levels at these sites on April 1, 2005, were: Galena Summit, 79 percent of normal; Mill Creek Summit, 59 percent of normal; and Morgan Creek, 51 percent of normal (Natural Resources Conservation Service, 2006a).

Mean air temperature at Stanley, Idaho, during WY05 was about 1.94ºC (35.5ºF), slightly higher than the 30-year (1971-2000) mean of 1.78ºC (35.2ºF). Mean daily air temperatures generally were higher during July and lower during June, August, and September 2005, 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 October, November, and February were below the 30-year mean; those during December, January, March, and April were above the 30-year mean (Western Regional Climate Center, 2006).

## Hydrologic Conditions

Annual mean streamflows at the long-term USGS streamflow-gaging stations on Valley Creek at Stanley (13295000; 65 years of record) and on the Salmon River below Yankee Fork (13296500; 75 years of record) for WY05 were both about 30 percent below the long-term means. Annual mean streamflow at Valley Creek at Stanley was 139 $ft^3/s$ compared to the long-term mean of 198 $ft^3/s$; and, the annual mean streamflow at the Salmon River below Yankee Fork was 683 $ft^3/s$, compared to the long-term mean of 970 $ft^3/s$. All monthly mean streamflows for Valley Creek at Stanley were less than the long-term means. Similarly, all monthly mean streamflows at Salmon River below Yankee Fork also were less than the long-term means.

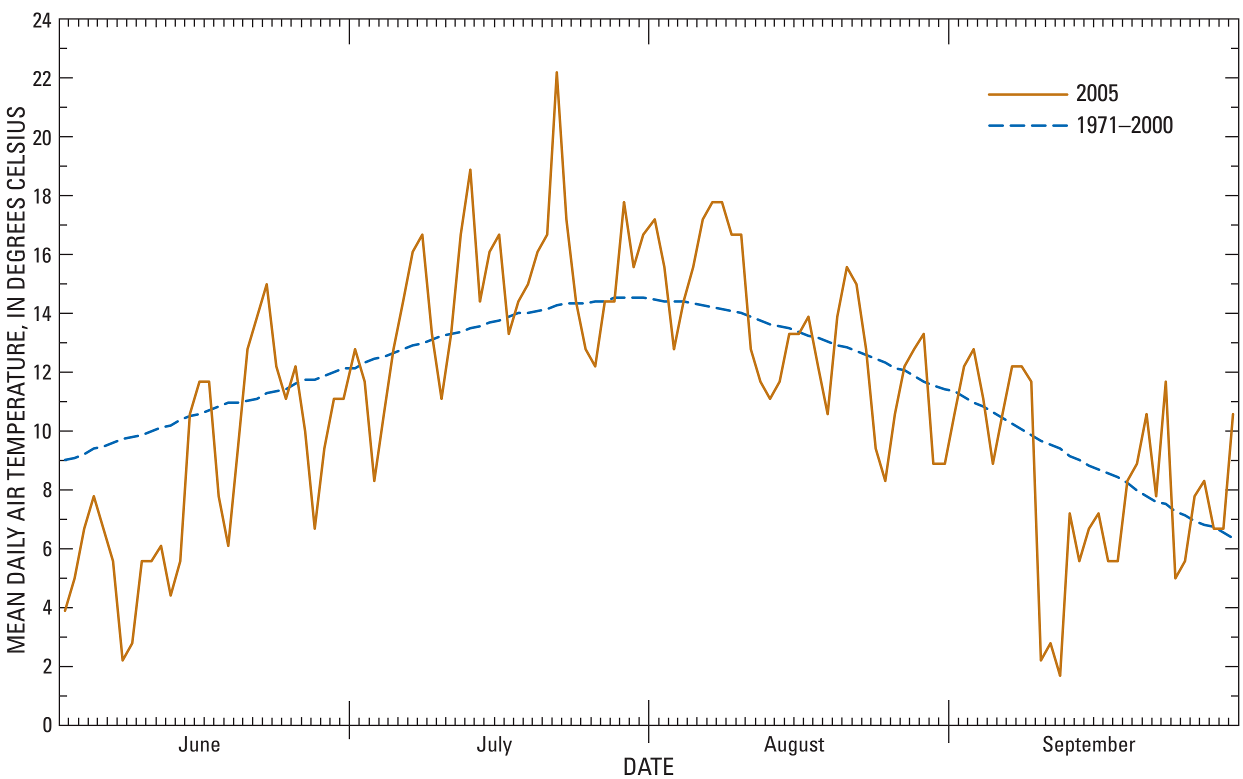



**Figure 3.** Relation between mean daily air temperatures measured at Stanley Ranger Station, June through September 2005, and long-term values (1971 through 2000), upper Salmon River Basin, Idaho.

# Results of Study Site Investigations

PHABSIM investigations were done on six Salmon River tributaries during summer 2005. Data were collected at eight study sites (table 1): one site on lower Big Boulder Creek (BB1), four sites on Challis Creek (CH1, CH2, CH3, and CH4) and two of its perennial tributaries, lower Bear Creek (BE1) and lower Mill Creek (ML1), and one site on lower Morgan Creek (MC1). A plan view of each PHABSIM study site showing locations of specific transects are shown in the appendixes, figs. A1, B1, C1, D1, E1, F1, G1, and H1. Fishery information from Murphy and Yankey (2003a, 2003b) were used to help with selection of study sites on Challis and Morgan Creeks. PHABSIM WUA results are presented for adult and spawning bull trout, Chinook salmon, and steelhead trout for each study site. In addition, WUA results are presented for riffle dwelling invertebrate taxa (Ephemeroptera, Plecoptera, and Trichoptera) for each site. Because of the concerns about PHABSIM modeling results for juveniles, they are not presented in this report. Mulitple 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), Valley Creek (VCGU), Big Boulder Creek (BBG) and Morgan Creek above West Fork Morgan Creek (MCabvWFMC). 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 BBG, BB1, CH4, BE1, CH3, ML1, CH2, CH1, Morgan Creek above Alder Creek (MCabvAC), MCabvWFMC, and MC1. Permission to access private property precluded installation of data loggers above diversions on Bear and Mill Creeks.

## Big Boulder Creek

Big Boulder Creek is an easterly flowing stream in the central part of the upper Salmon River Basin. Big Boulder Creek is a tributary to the East Fork Salmon River and its headwaters originate in the White Cloud Peaks (fig. 1). The Big Boulder Creek basin covers 26.9 $mi^2$, of which about 41 percent is forest. Mean elevation in the basin is about 8,810 ft above sea level and the basin receives an average of 29.1 in/yr of precipitation.

### Hydrology

A short-term streamflow-gaging station (Big Boulder Creek near Clayton; 13297500; BBG) was installed on Big Boulder Creek about 0.75 mi upstream of the confluence with the East Fork Salmon River and operated from April 1 through October 3, 2005. The USGS also operated a long-term streamflow-gaging station at this location from May 1926 through January 1930. This gaging station is upstream of the two active diversions on Big Boulder Creek (fig. 4). A plot of the continuous daily mean discharge at BBG during WY05 is presented in figure 5, along with markers indicating when field data were collected at study site BB1, between the mouth and the first upstream diversion.

Additional analyses were completed to relate streamflows in Big Boulder Creek during WY05 to long-term streamflows. The July, August, and September daily mean discharge hydrograph at BBG for WY05 and the 80-, 50-, and 20-percent monthly exceedance statistics for the period of record (1926-29 and 2005) are presented in figure 6. The plot shows that WY05 streamflows in Big Boulder Creek generally were near or slightly below the long-term median (50-percent exceedance) during the months shown. Analyses of WY05 and long-term monthly exceedance discharge data for Big Boulder Creek are presented in table 2. The July, August, and September 80-percent exceedances for WY05 were slightly above the long-term values, although the 20-percent exceedances were all below the long-term values. Table 2 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 Big Boulder Creek. In this case, the regression estimates tend to be lower than the long-term values, indicating that the equations, to some degree, could underestimate streamflow conditions in Big Boulder Creek.

### Habitat Modeling and Passage Criteria

The lower Big Boulder Creek (BB1) discharges required for maximum WUA ranged from 24 to 39 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 3). Discharge required for maximum WUA was 24 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 18 to 27 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 15 to 27 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively (see transects 1, 4, and 6 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix A provides more information summarizing these study results.

**Table 1.** Basin and site characteristics for streamflow-gaging stations, diversions, and study sites, in the upper Salmon River Basin, Idaho, 2005.

[Site locations shown in figure 1. **Site type:** C, continuous streamflow recorded; 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.) | Study site |
|---|---|---|---|---|---|---|---|---|---|---|
| SRG 13292280 | Salmon River at USGS gaging station | C, M | 435407 | 1144724 | 27.5 | 35 | 8,300 | 65 | 36 | – |
| VCGU 13294600 | Valley Creek at upper USGS gaging station | C, M | 441857 | 1150401 | 29.4 | 30 | 7,695 | 80 | 27 | – |
| VCGL 13295000 | Valley Creek at lower USGS gaging station at Stanley | C, M | 441321 | 1145549 | 148 | 26 | 7,320 | 63 | 24 | – |
| BBG 13297500 | Big Boulder Creek at USGS gaging station near Clayton | C, M, T | 440653 | 1142624 | 26.9 | 37.1 | 8,810 | 41.3 | 29.1 | – |
| BB1 | Lower Big Boulder Creek | M, P, T | 440658 | 1142605 | 27 | 37.1 | 8,810 | 41.2 | 29.1 | Mouth upstream to diversion |
| CH4 | Upper Challis Creek | M, P, T | 443408 | 1142146 | 32.4 | 35.9 | 7,920 | 73.5 | 27.4 | From confluence with Bear Creek upstream to Lodgepole Creek |
| BE1 | Lower Bear Creek | M, P, T | 443411 | 1142150 | 14.1 | 38.6 | 8,170 | 69 | 27.1 | Mouth upstream to diversion |
| CHHGU 13299000 | Challis Creek at upper historical USGS gaging station | C | 443420 | 1141820 | 85 | 37.2 | 7,790 | 62.4 | 25.6 | |
| CH3 | Upper Middle Challis Creek | M, P, T | 443414 | 1141812 | 84.9 | 37.2 | 7,780 | 62.2 | 25.6 | From Highline Ditch Canal upstream to Bear Creek |
| CHHGL 13299200 | Challis Creek at lower historical USGS gaging station | C | 443341 | 1141642 | 91.2 | 36.6 | 7,700 | 58.5 | 24.9 | |
| ML1 | Lower Mill Creek | M, P, T | 443336 | 1141631 | 28.3 | 36.2 | 7,650 | 51 | 24 | Mouth upstream diversion |
| CH2 | Lower Middle Challis Creek | M, P, T | 443344 | 1141448 | 123 | 36.1 | 7,620 | 55.1 | 24.1 | Mouth upstream to Highline Ditch Canal |
| CH1 | Lower Challis Creek | M, P. T | 443411 | 1141120 | 148 | 34.9 | 7,450 | 48.9 | 23.1 | Mouth upstream to Highline Ditch Canal |
| MCabvAC | Morgan Creek above Alder Creek | M, T | 444831 | 1141540 | 3.4 | 33.7 | 7,470 | 77.5 | 24.8 | – |
| MCabvWFMC 13299255 | Morgan Creek above West Fork Morgan Creek | C, M, T | 444102 | 1141447 | 60.2 | 34.9 | 7,320 | 48.2 | 21.9 | – |
| MC1 | Lower Morgan Creek | M, P, T | 443705 | 1141054 | 107 | 35.7 | 7,140 | 443.1 | 20.1 | Mouth upstream to Mud Spring Gulch |

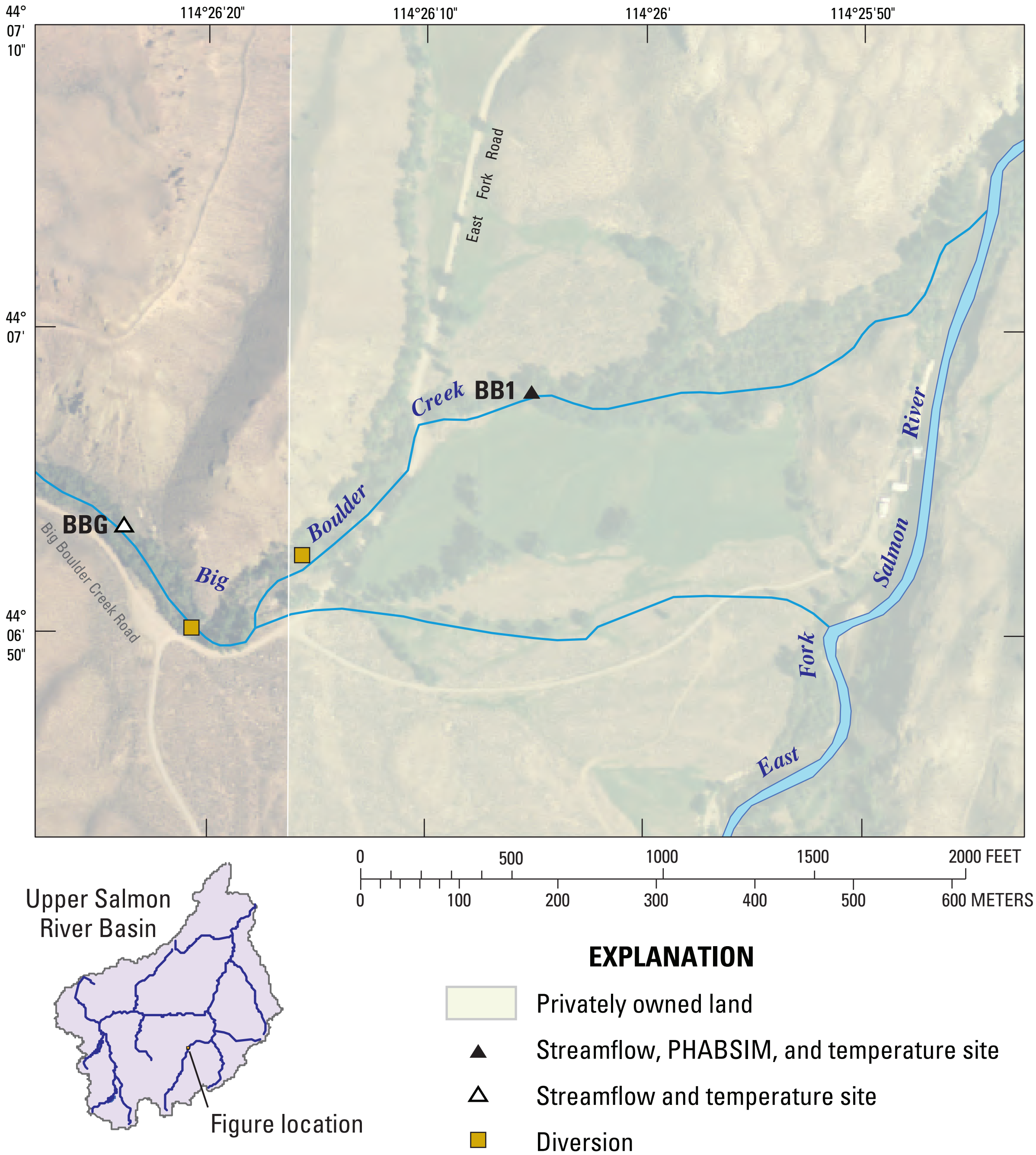



**Figure 4.** Location of study sites on lower Big Boulder Creek, diversions, streamflow-gaging stations, temperature monitoring locations, and Physical Habitat Simulation (PHABSIM) study site, upper Salmon River Basin, Idaho, 2005. Diversion locations were determined by U.S. Geological Survey.

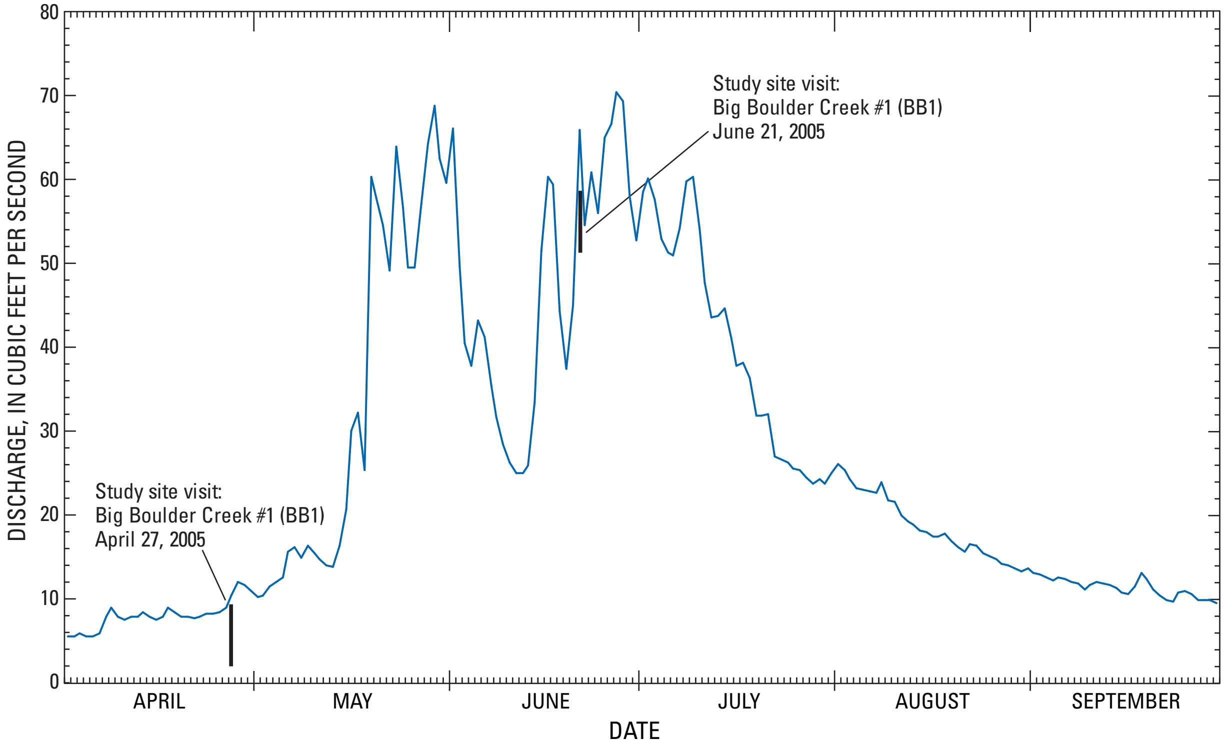



**Figure 5.** Daily mean discharge at Big Boulder Creek near Clayton (13297500), upper Salmon River Basin, Idaho, April 1 through September 30, 2005.

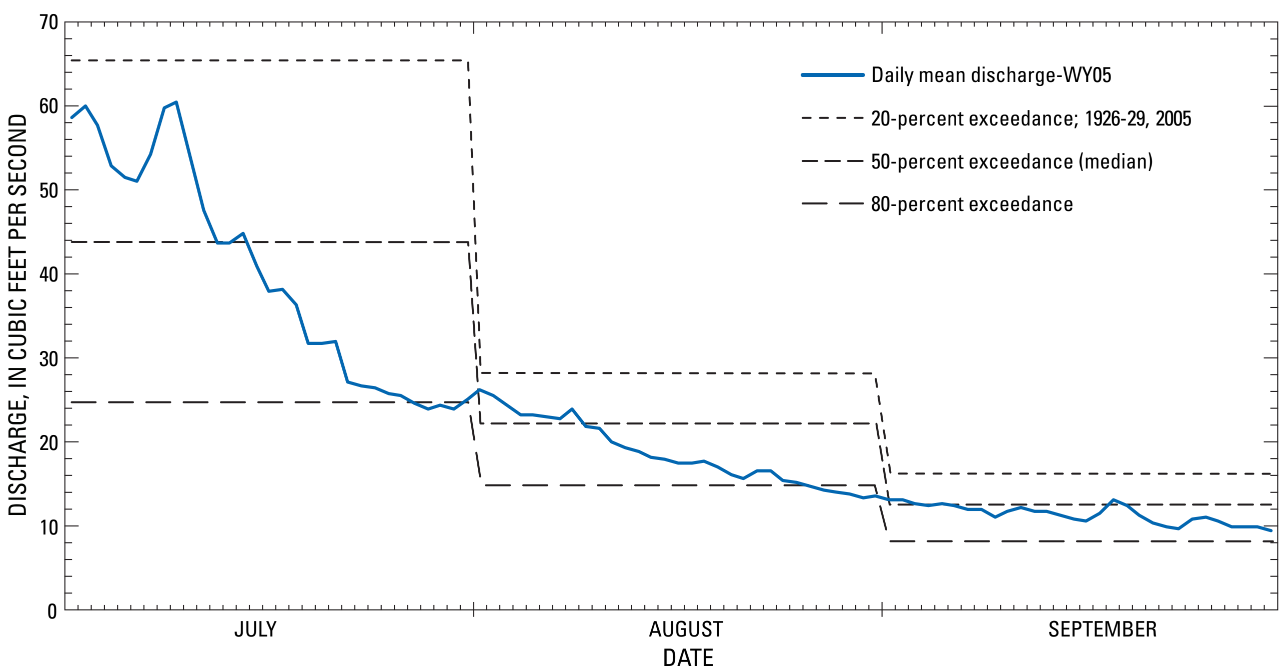



**Figure 6.** Daily mean discharge for water year 2005 and 80-, 50-, and 20-percent exceedance statistics for the period of record (1926–29, 2005) at Big Boulder Creek near Clayton (13297500), upper Salmon River Basin, Idaho, July 1 through September 30.

**Table 2.** Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Big Boulder Creek near Clayton (13297500), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Long term:** Based on data for water years 1926–29 and 2005]

| | July | | | August | | | September | | |
|---|---|---|---|---|---|---|---|---|---|
| | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 |
| Water year 2005 | 25.7 | 38.2 | 54.1 | 15.1 | 17.8 | 22.9 | 10.3 | 11.5 | 12.4 |
| Long term | 24.7 | 43.6 | 65.4 | 14.7 | 22.1 | 28.0 | 8.00 | 12.5 | 16.0 |
| Regional regression equations | | | | | | | | | |
| Upper confidence limit | 40.4 | 58.6 | 81.1 | 21.4 | 32.7 | 36.9 | 15.4 | 22.2 | 23.2 |
| Estimate | 18.2 | 32.0 | 51.8 | 10.2 | 15.0 | 23.1 | 7.56 | 10.6 | 15.0 |
| Lower confidence limit | 8.21 | 17.5 | 33.1 | 4.85 | 6.88 | 14.4 | 3.71 | 5.06 | 9.69 |

**Table 3.** Summary of habitat and hydrologic measurements for lower Big Boulder Creek (BB1), upper Salmon River Basin, Idaho, 2005.

[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. **Channel width:** Represents measurements at three transects. **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; EPT, Ephemeroptera, Plecoptera, and Trichoptera taxa; 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 | EPT inverte-brates | 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 | 24 | 39 | 39 | ND | 27, 18, 21 | 27, 15, 15 | 18.2 | 32.1 | 52.0 | 10.2 | 15.1 | 23.2 | 7.6 | 10.7 | 15.1 | 15.2 |
| Spawning | 33 | 39 | 39 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 24 | ND | ND | | | | | | | | | | |

Summer (July through September) discharges for BB1 were estimated on the basis of regression equations and are listed in table 3. Median discharge (Q.50) estimates were 32.1 ft$^3$/s for July, 15.1 ft$^3$/s for August, and 10.7 ft$^3$/s for September. The mean annual discharge estimate was 15.2 ft$^3$/s.

## Stream Temperature

Temperature recording data loggers were deployed at BBG and BB1 in early June 2005 (fig. 7). Data loggers were retrieved in mid-September 2005. After downloading and reviewing the data, June 12 through September 12 (93 days) was selected as the period of record for calculating stream temperature metrics.

Analysis of the stream temperature records for Big Boulder Creek indicated a slight warming trend downstream of BBG to BB1 (fig. 7). However, the difference in temperature between BBG and BB1 was only slightly greater than the measurement error associated with the temperature recording data logger (± 0.4). The difference in MDMT between BBG and BB1 on any given day was less than 0.5ºC, 97 percent (3 of 93 days) of the time.

Individual metric calculation results showed the MDMT was 16.2ºC at BBG and 16.6ºC at BB1, well 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. The MDMT at both sites also was below the 18.0ºC threshold that may block bull trout migration (J. Dunham, U.S. Forest Service, written commun., 2004).

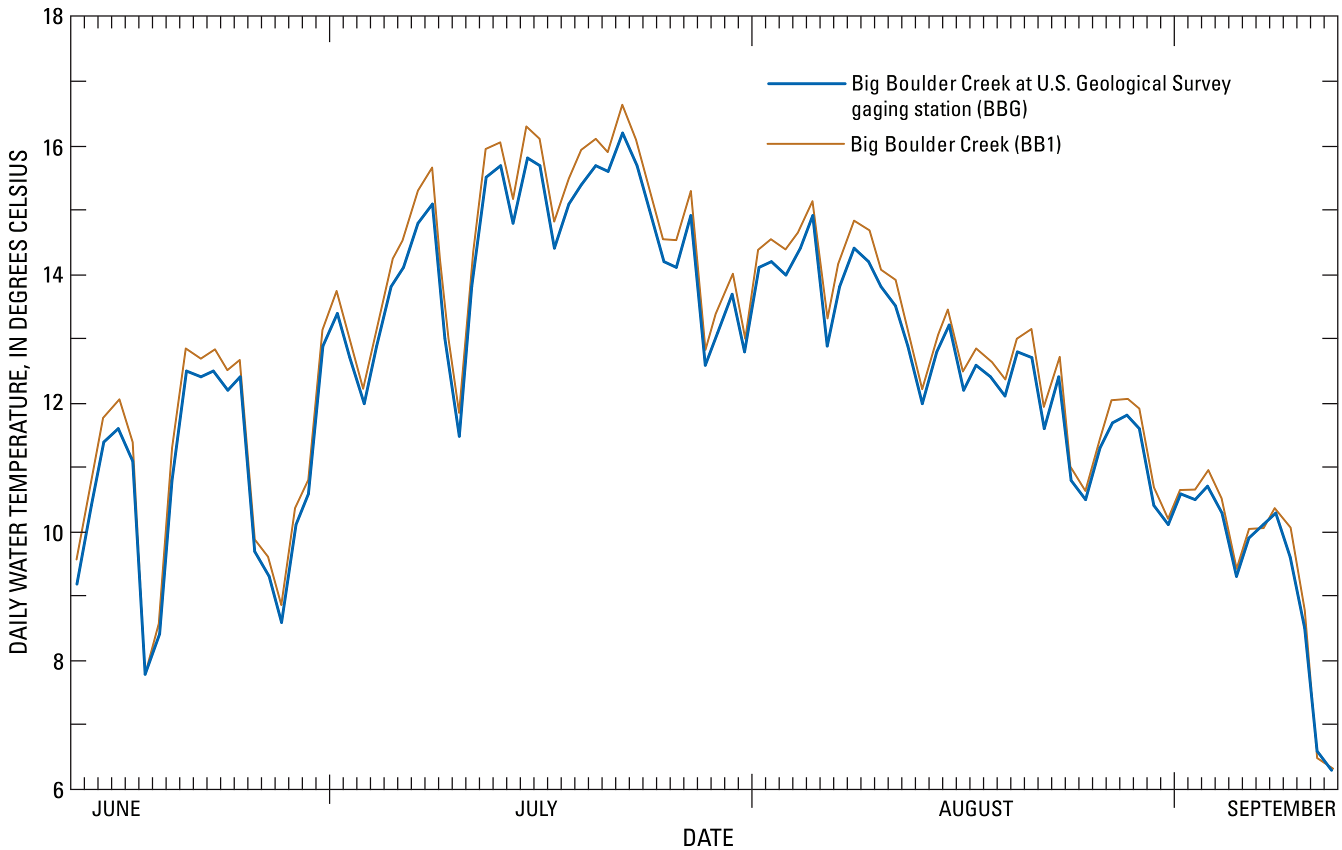



**Figure 7.** Maximum daily water temperature at Big Boulder Creek, upper Salmon River Basin, Idaho, June 12 through September 12, 2005.

The MDAT was 13.5ºC at BBG and 14.0ºC at BB1, 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.

Comparing the temperature regime at the two sites on Big Boulder Creek to the IDEQ criteria for protection of coldwater biota (applicable from June 22 through September 21) indicates the temperature regime at BBG and BB1 was below the 19.0ºC MDAT and 22.0ºC MDMT criteria. A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

## Challis Creek and Major Tributaries

Challis Creek is an easterly flowing tributary to the Salmon River with its mouth just north of Challis, Idaho. The Challis Creek headwaters are along the northern-most boundary of the upper Salmon River Basin (fig. 1). The Challis Creek Basin covers about 148 mi$^2$, of which about 49 percent is forested. Mean elevation in the basin is about 7,450 ft above sea level and the basin receives an average of 23.1 in/yr of precipitation. Six study sites were in the Challis Creek Basin. Four of those sites were on the main stem of Challis Creek (CH1, CH2, CH3, and CH4) and the other two sites were on Bear Creek (BE1) and Mill Creek (ML1), both major tributaries of Challis Creek (fig. 8).

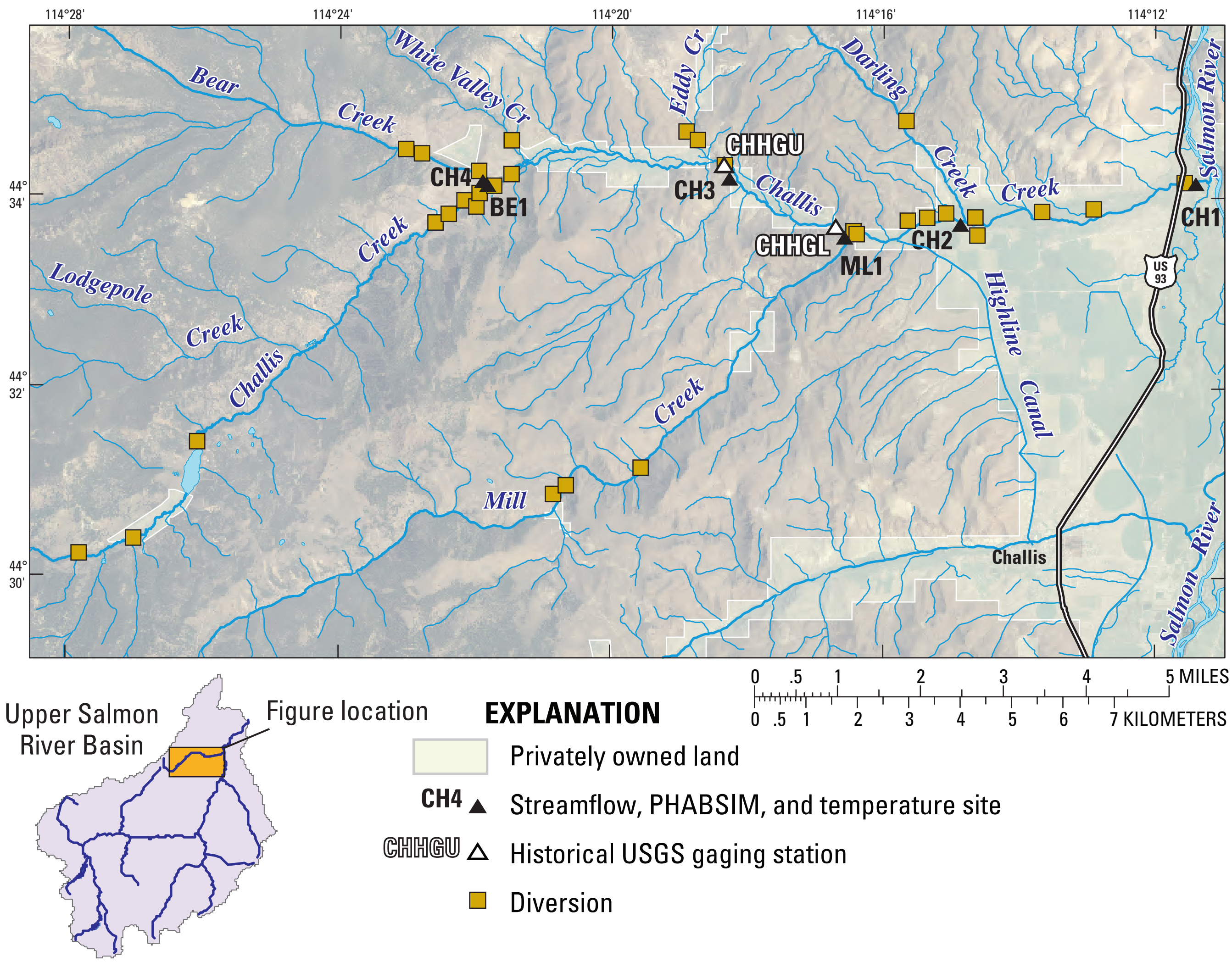



**Figure 8.** Location of study sites on Challis, Bear, and Mill Creeks, diversions, streamflow-gaging stations, temperature monitoring locations, and Physical Habitat Simulation (PHABSIM) study sites, upper Salmon River Basin, Idaho, 2005. Diversion locations were taken from Montgomery and others (2002).

## Hydrology

No continuous record streamflow data were collected on Challis Creek during WY05. Historical continuous record streamflow data are available for locations on Challis Creek about 6.9 (Challis Creek near Challis; 13299000) and 4.9 mi (Challis Creek below Jeffs Creek, near Challis; 13299200) upstream of the mouth for water years 1944-63 and 1963-70, respectively. The 80-, 50-, and 20-percent monthly exceedance discharge values for those gaging stations for the periods of record along with exceedance estimates derived from regional regression equations (Hortness and Berenbrock, 2001) are presented in tables 4 and 5. These values indicate that the regression equations generally may tend to underestimate monthly streamflow statistics in the Challis Creek Basin. In addition to historical data, instantaneous discharge measurements were made at all study sites during water WY05 and are presented in table 6. Because of their proximity, the similarities in size, and other basin characteristics of the Challis and Morgan Creek basins, it also may be possible to make some inferences as to the characteristics of streamflow in Challis Creek based on information from Morgan Creek.

## Habitat Modeling and Passage Criteria

Upper Challis Creek (CH4) discharges required for maximum WUA ranged from 22 to 37 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 7). Discharge required for maximum WUA was 16 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 16 to 22 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 10 to 19 $ft^3/s$ 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). Appendix B provides more information summarizing these study results.

Summer (July through September) discharges for CH4 were estimated on the basis of regression equations and are listed in table 7. Median discharge (Q.50) estimates were 17.3 $ft^3/s$ for July, 8.7 $ft^3/s$ for August, and 6.9 $ft^3/s$ for September. The mean annual discharge estimate was 17.4 $ft^3/s$.

Lower Bear Creek (BE1) discharges required for maximum WUA ranged from 8 to 26 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 7). Discharge required for maximum WUA was 11 $ft^3/s$

**Table 4.** Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Challis Creek near Challis (13299000), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Long term:** Based on data for water years 1944–63]

| | July | | | August | | | September | | |
|---|---|---|---|---|---|---|---|---|---|
| | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 |
| Long term | 48.1 | 60.7 | 82.8 | 29.6 | 38.5 | 48.4 | 21.2 | 25.7 | 32.0 |
| Regional regression equations | | | | | | | | | |
| Upper confidence limit | 61.4 | 88.2 | 129 | 34.5 | 52.6 | 57.4 | 29.5 | 41.7 | 42.7 |
| Estimate | 27.7 | 48.4 | 82.4 | 16.4 | 24.1 | 35.9 | 14.5 | 19.9 | 27.6 |
| Lower confidence limit | 12.5 | 26.2 | 52.6 | 7.80 | 11.1 | 22.5 | 7.10 | 9.50 | 17.8 |

**Table 5.** Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Challis Creek below Jeffs Creek, near Challis (13299200), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second. **Long term:** Based on data for water years 1963–70]

| | July | | | August | | | September | | |
|---|---|---|---|---|---|---|---|---|---|
| | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 |
| Long term | 47.0 | 67.6 | 102 | 37.1 | 46.0 | 54.7 | 22.4 | 27.1 | 38.2 |
| Regional regression equations | | | | | | | | | |
| Upper confidence limit | 59.4 | 85.6 | 127 | 33.6 | 51.2 | 56.8 | 29.1 | 41.3 | 42.9 |
| Estimate | 26.8 | 46.7 | 81.1 | 16.0 | 23.5 | 35.5 | 14.3 | 19.7 | 27.7 |
| Lower confidence limit | 12.1 | 25.5 | 51.8 | 7.60 | 10.8 | 22.2 | 7.00 | 9.40 | 17.9 |

**Table 6.** Summary of instantaneous discharge measurements for the Challis Creek Basin, upper Salmon River Basin, Idaho, water year 2005.

[Site locations shown in figure 8. **Discharge:** Values presented in cubic feet per second. **Abbreviations:** –, no data available]

| Date | Discharge | | | | | |
|---|---|---|---|---|---|---|
| | CH4 | BE1 | CH3 | ML1 | CH2 | CH1 |
| 04-20-05 | – | – | – | – | – | 2.89 |
| 04-21-05 | – | – | – | – | 6.18 | – |
| 04-22-05 | – | – | 10.99 | 3.24 | – | – |
| 04-25-05 | 6.97 | – | – | – | – | – |
| 04-26-05 | – | 3.72 | – | – | – | – |
| 05-22-05 | – | 32.6 | – | 27.4 | – | – |
| 05-23-05 | 49.0 | – | – | – | – | – |
| 05-24-05 | – | – | 102 | – | 85.5 | 74.4 |
| 06-06-05 | – | – | – | – | 57.9 | 46.8 |
| 06-07-05 | 35.1 | 27.4 | 78.1 | 24.4 | – | – |
| 07-15-05 | 13.4 | 14.4 | 35.9 | 6.07 | – | 2.52 |
| 08-12-05 | 17.3 | 7.22 | 29.7 | 3.28 | 4.59 | .73 |
| 09-13-05 | 13.2 | 4.84 | 21.2 | 2.89 | .68 | .41 |

for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 5 to 14 ft$^3$/s for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 4 to 14 ft$^3$/s greater than 10 percent of the contiguous channel width, respectively (see transects 3, 5, and 6 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix C provides more information summarizing these study results.

Summer (July through September) discharges for BE1 were estimated on the basis of regression equations and are listed in table 7. Median discharge (Q.50) estimates were 10.1 ft$^3$/s for July, 5.1 ft$^3$/s for August, and 3.8 ft$^3$/s for September. The mean annual discharge estimate was 8.9 ft$^3$/s.

Upper middle Challis Creek (CH3) discharges required for maximum WUA ranged from 19 to 67 ft$^3$/s for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 7). Discharge required for maximum WUA was 27 ft$^3$/s for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from <11 to 23 ft$^3$/s for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and <11 to 11 ft$^3$/s greater than 10 percent of the contiguous channel width, respectively (see transects 1, 5, and 6 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). In some cases, the passage criteria were less than the lower limit of the model conditions. In those cases graphs for a given transect may be useful to estimate the discharge required for passage. Appendix D provides more information summarizing these study results.

**Table 7.** Summary of habitat and hydrologic measurements for Challis Creek and major tributaries including upper Challis Creek (CH4), lower Bear Creek (BE1), upper middle Challis Creek (CH3), lower Mill Creeks (ML1), lower middle Challis Creek (CH2), and lower Challis Creek (CH1), upper Salmon River Basin, Idaho, 2005.

[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. **Channel width:** Represents measurements at three transects. **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; EPT, Ephemeroptera, Plecoptera, and Trichoptera taxa; ND, not determined; <, less 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 | EPT inverte-brates | 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 |
| **Upper Challis Creek (CH4)** | | | | | | | | | | | | | | | | |
| Adult | 25 | 34 | 34 | ND | 22, 16, 19 | 19, 10, 13 | 9.9 | 17.3 | 31.0 | 6.0 | 8.7 | 14.0 | 5.0 | 6.9 | 10.3 | 17.4 |
| Spawning | 22 | 37 | 37 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 16 | ND | ND | | | | | | | | | | |
| **Lower Bear Creek (BE1)** | | | | | | | | | | | | | | | | |
| Adult | 8 | 20 | 20 | ND | 14, 11, 5 | 14, 8, 4 | 6.0 | 10.1 | 17.8 | 3.6 | 5.1 | 8.1 | 2.8 | 3.8 | 5.6 | 8.9 |
| Spawning | 26 | 26 | 26 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 11 | ND | ND | | | | | | | | | | |
| **Upper Middle Challis Creek (CH3)** | | | | | | | | | | | | | | | | |
| Adult | 19 | 67 | 67 | ND | 23, <11, <11 | 11, <11, <11 | 27.6 | 47.8 | 82.0 | 16.3 | 24.0 | 35.7 | 14.4 | 19.9 | 27.5 | 46.6 |
| Spawning | 35 | 67 | 67 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 27 | ND | ND | | | | | | | | | | |
| **Lower Mill Creek (ML1)** | | | | | | | | | | | | | | | | |
| Adult | 9 | 18 | 18 | ND | 9,12, 6 | 3, 9, 3 | 6.8 | 11.7 | 21.8 | 4.2 | 6.0 | 9.9 | 3.7 | 4.9 | 7.5 | 15.4 |
| Spawning | 15 | 18 | 18 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 9 | ND | ND | | | | | | | | | | |
| **Lower Middle Challis Creek (CH2)** | | | | | | | | | | | | | | | | |
| Adult | 26 | 50 | 50 | ND | <6, 14, 18 | <6, 6, 14 | 33.9 | 59.6 | 103.0 | 20.3 | 29.9 | 45.0 | 18.5 | 25.5 | 35.9 | 64.5 |
| Spawning | 26 | 50 | 50 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 22 | ND | ND | | | | | | | | | | |
| **Lower Challis Creek (CH1)** | | | | | | | | | | | | | | | | |
| Adult | 15 | 55 | 55 | ND | 15, 19, 15 | 7, 11, 11 | 33.1 | 59.2 | 105.0 | 20.2 | 29.8 | 45.9 | 19.0 | 26.1 | 37.7 | 74.1 |
| Spawning | 47 | 55 | 55 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 35 | ND | ND | | | | | | | | | | |

Summer (July through September) discharges for CH3 were estimated on the basis of regression equations and are listed in table 7. Median discharge (Q.50) estimates were 47.8 $ft^3/s$ for July, 24.0 $ft^3/s$ for August, and 19.9 $ft^3/s$ for September. The mean annual discharge estimate was 46.6 $ft^3/s$.

Lower Mill Creek (ML1) discharges required for maximum WUA ranged from 9 to 18 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 7). Discharge required for maximum WUA was 9 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 6 to 9 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 3 to 9 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively (see transects 3, 5, and 6 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix E provides more information summarizing these study results.

Summer (July through September) discharges for ML1 were estimated on the basis of regression equations and are listed in table 7. Median discharge (Q.50) estimates were 11.7 $ft^3/s$ for July, 6.0 $ft^3/s$ for August, and 4.9 $ft^3/s$ for September. The mean annual discharge estimate was 15.4 $ft^3/s$.

Lower middle Challis Creek (CH2) discharges required for maximum WUA ranged from 26 to 50 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 7). Discharge required for maximum WUA was 22 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from <6 to 18 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and <6 to 14 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively (see transects 1, 6, and 7 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). In some cases, the passage criteria were less than the lower limit of the model conditions. In those cases, graphs for a given transect may be useful to estimate the discharge required for passage. Appendix F provides more information summarizing these study results.

Summer (July through September) discharges for CH2 were estimated on the basis of regression equations and are listed in table 7. Median discharge (Q.50) estimates were 59.6 $ft^3/s$ for July, 29.9 $ft^3/s$ for August, and 25.5 $ft^3/s$ for September. The mean annual discharge estimate was 64.5 $ft^3/s$.

Lower Challis Creek (CH1) discharges required for maximum WUA ranged from 15 to 55 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 7). Discharge required for maximum WUA was 35 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 15 to 19 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 7 to 11 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively (see transects 5, 6, and 7 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). Appendix G provides more information summarizing these study results.

Summer (July through September) discharges for CH1 were estimated on the basis of regression equations and are listed in table 7. Median discharge (Q.50) estimates were 59.2 $ft^3/s$ for July, 29.8 $ft^3/s$ for August, and 26.1 $ft^3/s$ for September. The mean annual discharge estimate was 74.1 $ft^3/s$.

## Stream Temperature

Temperature recording data loggers were deployed at four locations in Challis Creek (CH4, CH3, CH2, and CH1), and two major tributaries Bear Creek (BE1) and Mill Creek (ML1) in 2005 (fig. 8). All data loggers were deployed in June 2005. All data loggers were retrieved in mid-September 2005. After downloading and reviewing the data, June 12 through September 12 (93 days) was selected as the period of record for calculating stream temperature metrics.

Analysis of the stream temperature records for Challis Creek indicated a slight cooling trend downstream of CH4 to CH2 and then a pronounced warming trend downstream of CH2 to CH1 (fig. 9). This warming trend appears to strengthen over time and most likely is due to increasing air temperatures and the diversion of streamflow for irrigation over the course of the summer.

Individual metric calculation results showed the MDAT was 16.2ºC at CH4, 15.3ºC at CH3, 16.6ºC at CH2, and 19.5ºC at CH1. The MDAT at CH4, CH3, and CH2 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; however, the MDAT at CH1 was above the 17.8ºC MDAT upper temperature threshold.

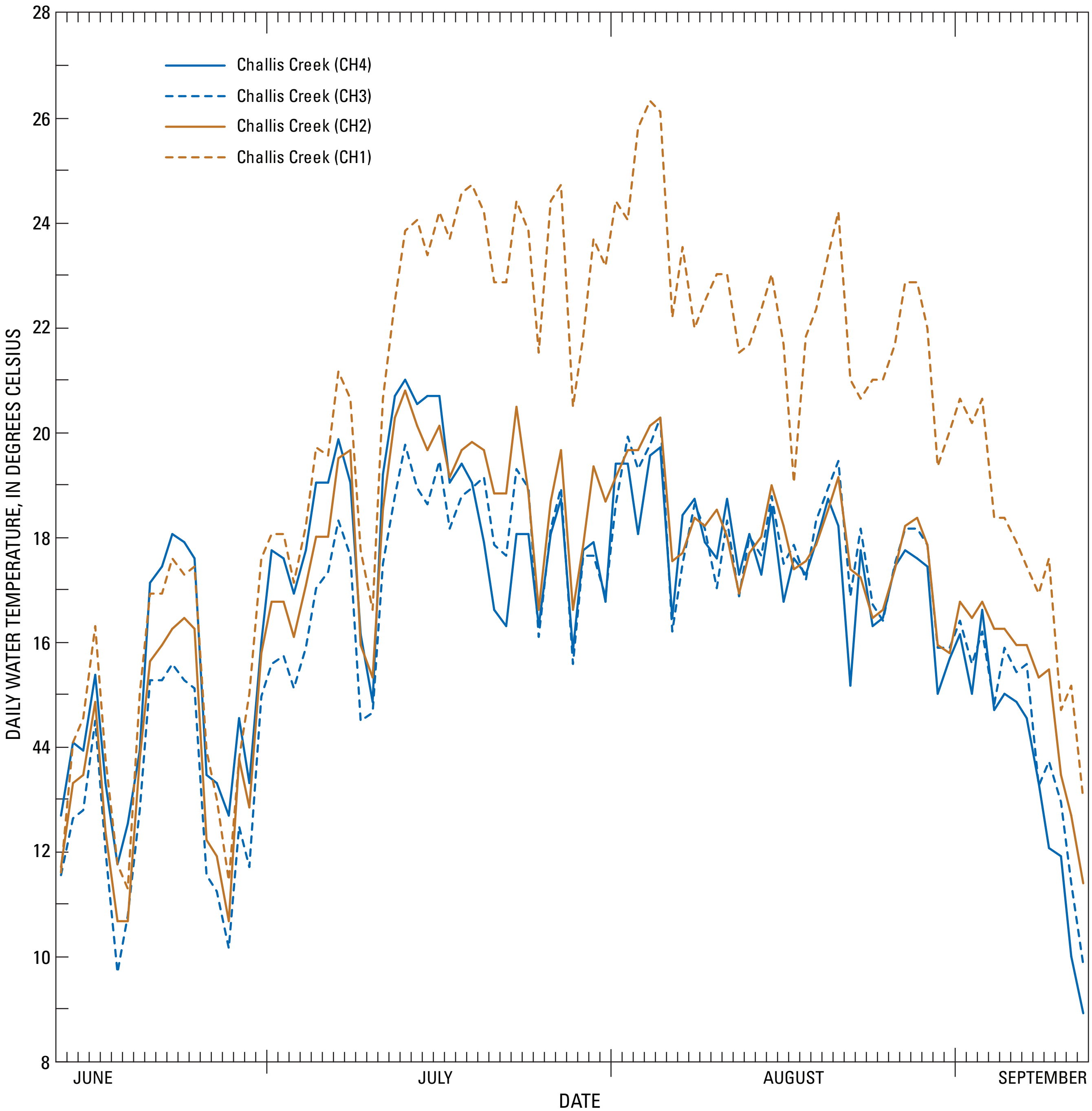



**Figure 9.** Maximum daily water temperature at Challis Creek, upper Salmon River Basin, Idaho, June 12 through September 12, 2005.

The MDMT was 21.0ºC at CH4, 20.2ºC at CH3, 20.8ºC at CH2 and 26.3ºC at CH1. The MDMT at all sites was very near or 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 exceeded the 18.0ºC threshold that may block bull trout migration (J. Dunham, U.S. Forest Service, written commun., 2004).

The temperature regime at all sites except CH1 was 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 all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

A temperature recording data logger was deployed at BE1 downstream of the diversions in early June 2004 (fig. 10). The data logger was retrieved in late September 2004. After downloading and reviewing the data, June 12 through September 12 (93 days) was selected as the period of record for calculating stream temperature metrics.

Individual metric calculation results showed that the MDAT was 11.4ºC at BE1, 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 14.4ºC at BE1, well below the 18.0ºC threshold that may limit bull trout habitat and block passage because of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004). The MDMT also 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.

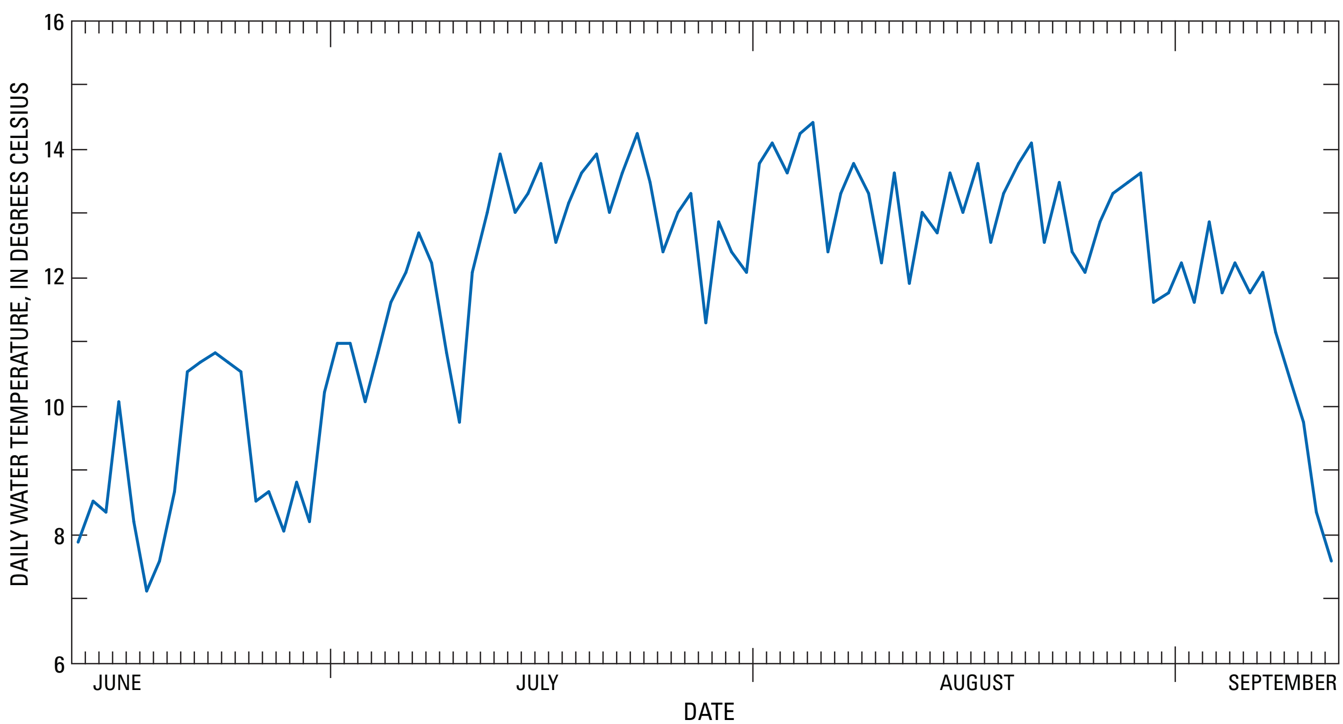



**Figure 10.** Maximum daily water temperature at Bear Creek (BE1), upper Salmon River Basin, Idaho, June 12 through September 12, 2005.

The temperature regime at BE1 also was 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.

A temperature recording data logger was deployed at ML1 downstream of all diversions in early June 2004 (fig. 11). The data logger was retrieved in late September 2004. After downloading and reviewing the data, June 12 through September 12 (93 days) was selected as the period of record for calculating stream temperature metrics.

Individual metric calculation results showed that the MDAT was 18.1ºC at ML1, slightly above 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 22.0ºC at ML1, above the 18.0ºC threshold that may limit bull trout habitat and block passage because of high water temperatures (J. Dunham, U.S. Forest Service, written commun., 2004). The MDMT at ML1 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.

Comparison of the temperature regime at ML1 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, although the MDMT was at 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.

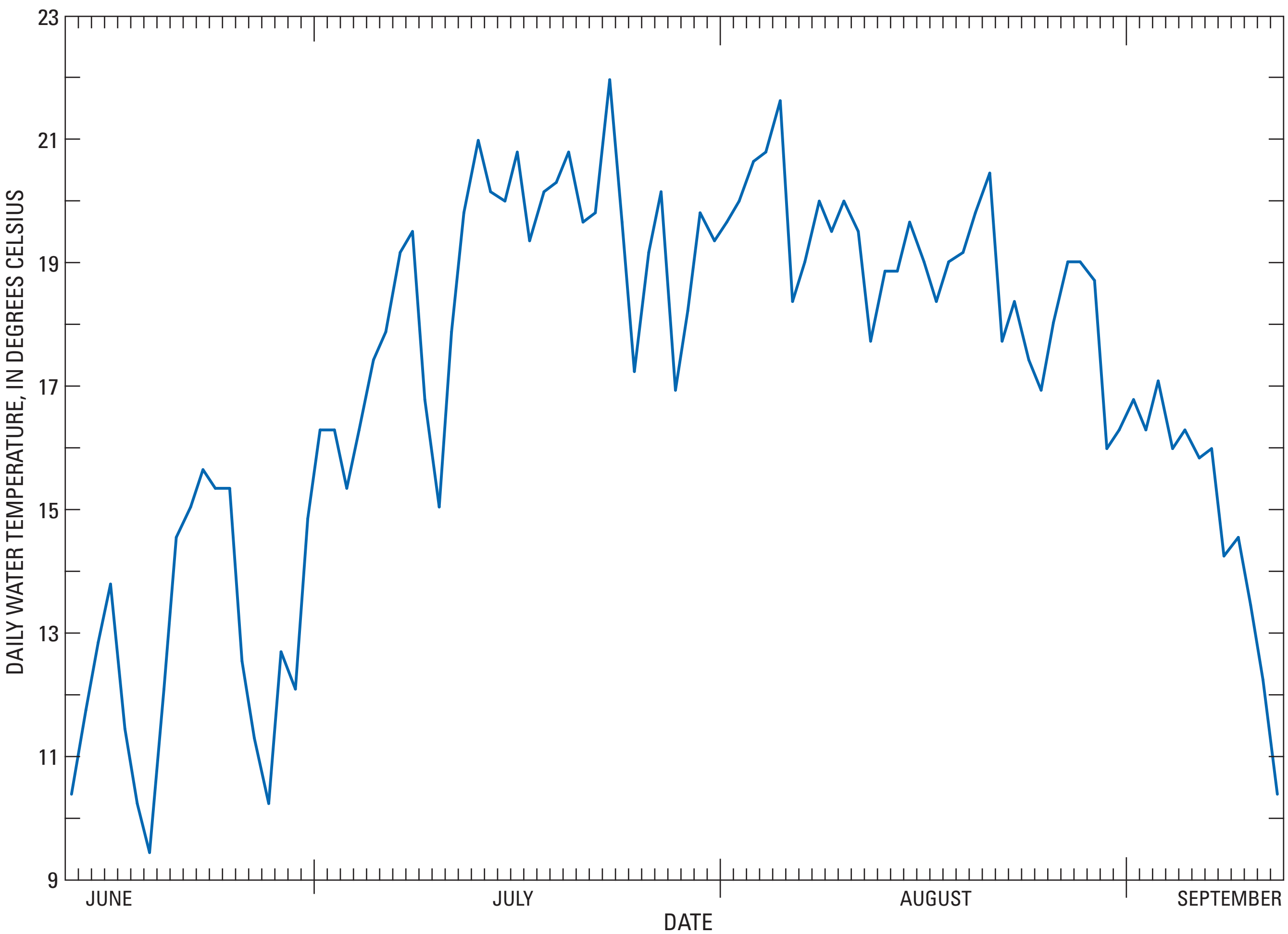



**Figure 11.** Maximum daily water temperature at Mill Creek (ML1), upper Salmon River Basin, Idaho, June 12 through September 12, 2005.

## Morgan Creek

Morgan Creek is an easterly flowing tributary to the Salmon River with its mouth just north of Challis, Idaho. The Morgan Creek headwaters are along the northern-most boundary of the upper Salmon River Basin (fig. 1). The Morgan Creek Basin covers about 107 $mi^2$, of which about 36 percent is forested. Mean elevation of the basin is about 7,140 ft above sea level and the basin receives an average of 20.1 in/yr of precipitation. One study site (MC1) was on Morgan Creek about 0.5 mi upstream of the mouth (fig. 12).

### Hydrology

The USGS began operating a continuous-record streamflow-gaging station on Morgan Creek (Morgan Creek above West Fork Morgan Creek; 13299255; MCabvWFMC) on March 30, 2005, for the U.S. Forest Service. This gaging station is on the main stem of Morgan Creek just upstream of West Fork Morgan Creek and about 6 mi upstream of the mouth. Active streamflow diversions are upstream and downstream of the gaging station and do affect the streamflow at the gaging station. A plot of the continuous daily mean discharge in Morgan Creek for WY05 is presented in figure 13, along with markers indicating the times when field data were collected at the study site (MC1).

Additional analyses were completed that compared streamflows in Morgan Creek to estimates of long-term streamflow statistics. The July, August, and September daily mean discharge hydrograph for MCabvWFMC for WY05 along with the estimated 80-, 50-, and 20-percent monthly exceedances based on regression equations developed by Hortness and Berenbrock (2001) are presented in figure 14. Monthly exceedance statistics for July, August, and September streamflows at MCabvWFMC during WY05 along with the estimated monthly exceedances and their confidence limits (Hortness and Berenbrock, 2001) are presented in table 8. Daily mean discharges for MCabvWFMC are affected by upstream diversions; however, monthly exceedance estimates are indicators of natural streamflow conditions unaffected by diversions. The effects of diversions on streamflow at MCabvWFMC are quite apparent in figure 14, when compared to estimates of long-term monthly statistics.

### Habitat Modeling and Passage Criteria

The lower Morgan Creek (MC1) discharges required for maximum WUA ranged from 15 to 42 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout (table 9). The very low WUA for bull trout spawning shown in appendix figure H2 is attributed to the lack of suitable substrate. Discharge required for maximum WUA was 30 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from <11 to 15 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and <11 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively (see transects 2, 3, and 4 photographs at http://id.water.usgs.gov/projects/salmon_streamflow). In some cases, the passage criteria were less than the lower limit of the model conditions. In those cases, graphs for a given transect may be useful to estimate the discharge required for passage. Appendix H provides more information summarizing these study results.

Summer (July through September) discharges for MC1 were estimated on the basis of regression equations and are listed in table 9. Median discharge (Q.50) estimates were 31.2 $ft^3/s$ for July, 16.4 $ft^3/s$ for August, and 14.9 $ft^3/s$ for September. The mean annual discharge estimate was 55.5 $ft^3/$ s.

### Stream Temperature

Temperature recording data loggers were deployed at three locations in Morgan Creek in 2005 (fig. 15). These locations included MCabvAC, MCabvWFMC, and MC1. All data loggers were deployed in June 2005. All data loggers were retrieved in mid-September 2005. After downloading and reviewing the data, June 12 through September 12 (93 days) was selected as the period of record for calculating stream temperature metrics.

Analysis of the stream temperature records for Morgan Creek indicated a pronounced warming trend downstream of MCabvAC to MC1 (fig. 15). This warming trend appears to strengthen over time and most likely is due to increasing air temperatures and the diversion of streamflow for irrigation over the course of the summer.

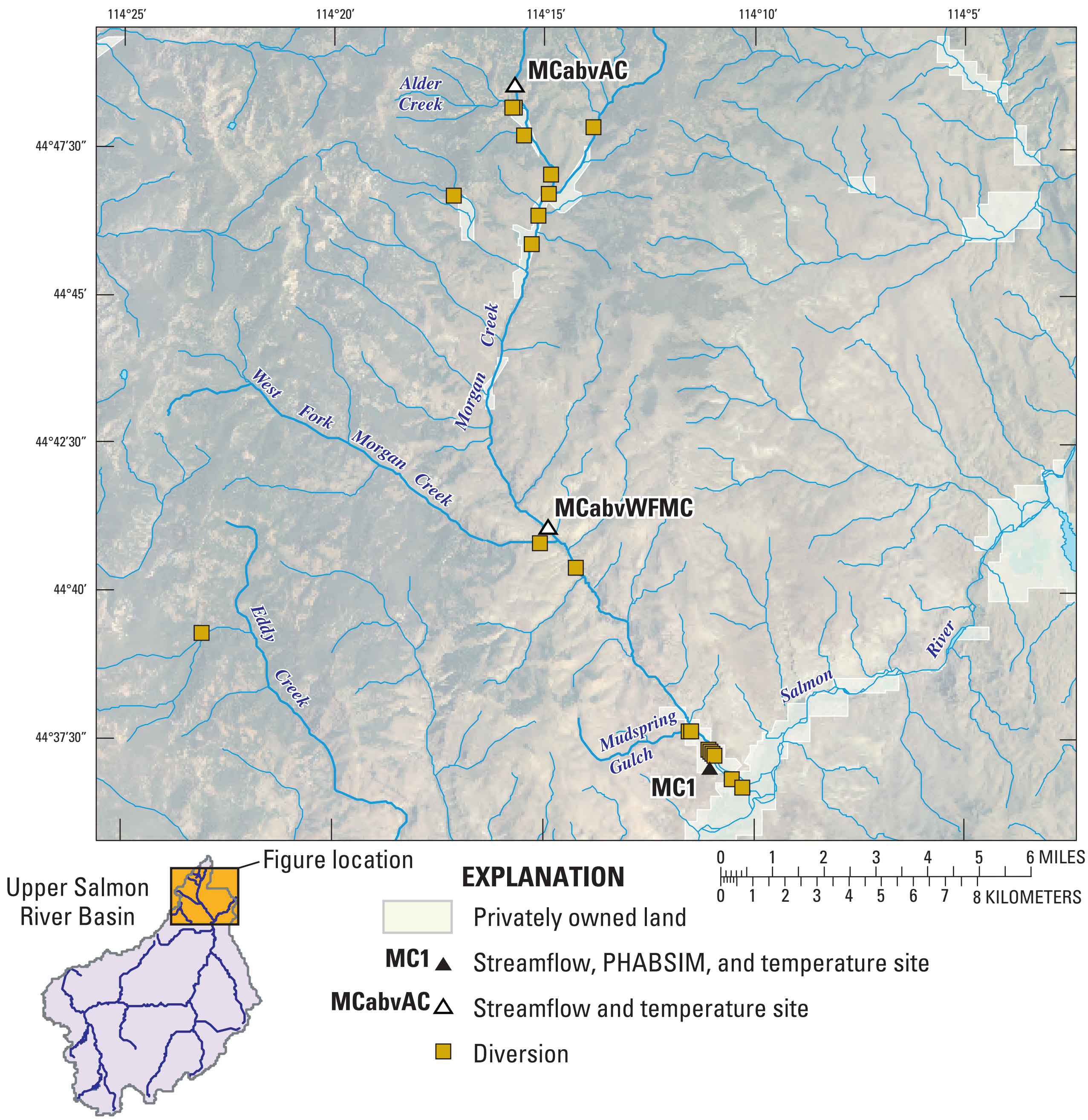



**Figure 12.** Location of study sites on Morgan Creek, diversions, streamflow-gaging stations, temperature monitoring locations, and Physical Habitat Simulation (PHABSIM) study sites, upper Salmon River Basin, Idaho, 2005. Diversion locations were determined by U.S. Geological Survey.

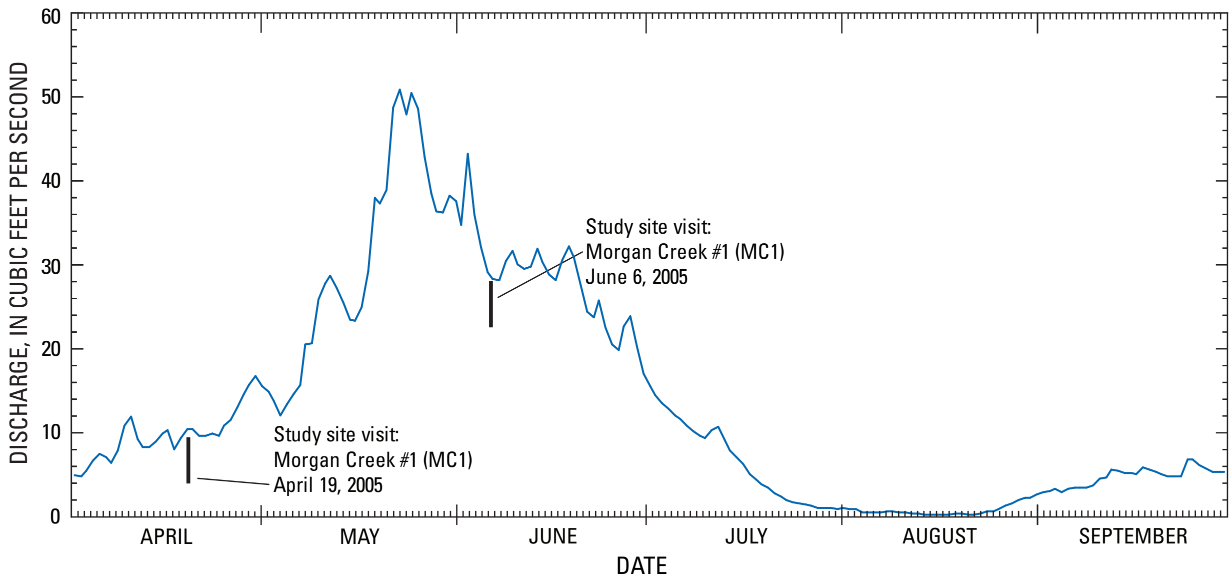



**Figure 13.** Daily mean discharge at Morgan Creek above West Fork Morgan Creek, near Challis (13299255), upper Salmon River Basin, Idaho, March 30 through September 30, 2005.

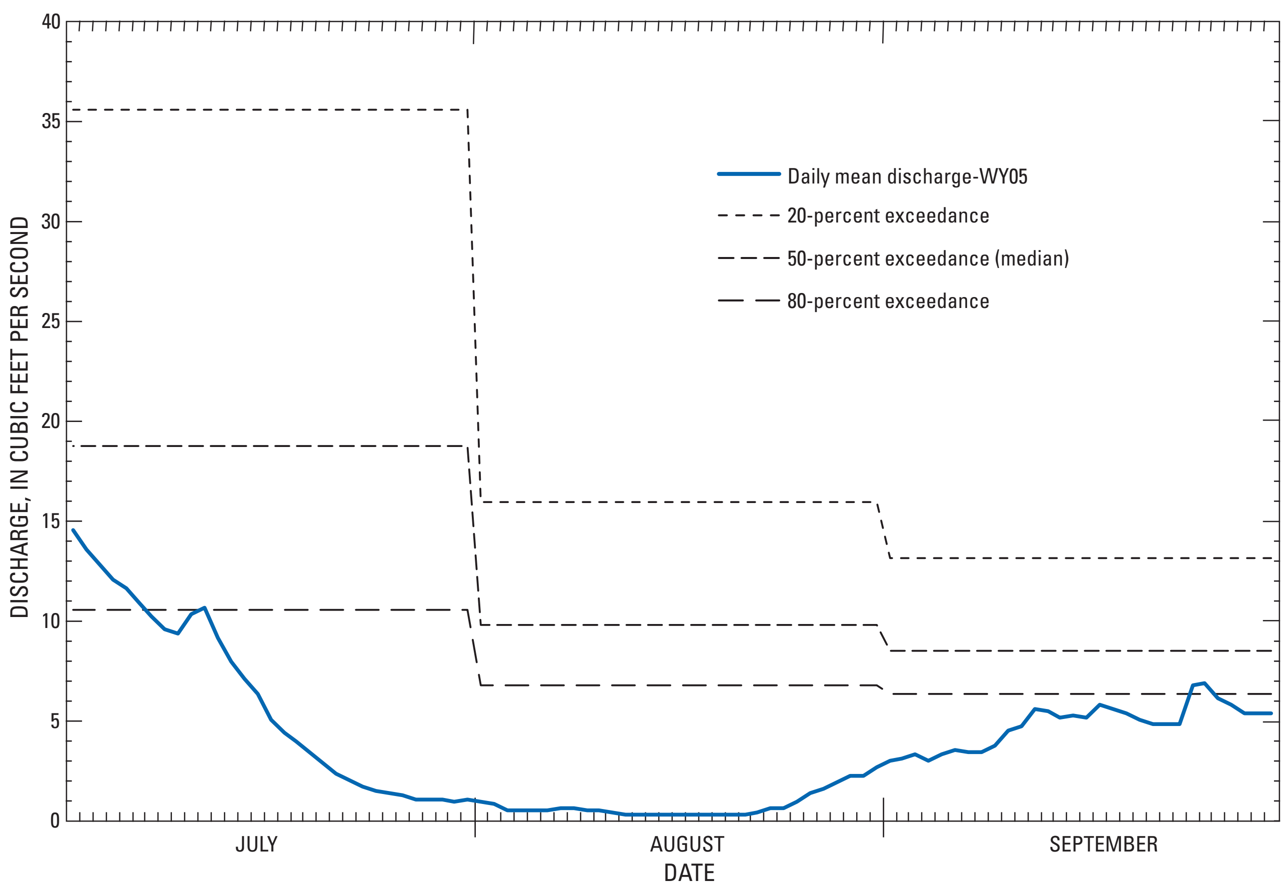



**Figure 14.** Daily mean discharge for water year 2005, estimated long-term daily mean discharge, and estimated 80-, 50-, and 20-percent exceedance statistics at Morgan Creek above West Fork Morgan Creek, near Challis (13299255), upper Salmon River Basin, Idaho, July 1 through September 30.

**Table 8.** Calculated and estimated 80-, 50-, and 20-percent monthly exceedance discharge values for Morgan Creek above West Fork Morgan Creek near Challis (13299255), upper Salmon River Basin, Idaho.

[Values presented in cubic feet per second]

| | July | | | August | | | September | | |
|---|---|---|---|---|---|---|---|---|---|
| | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 | Q.80 | Q.50 | Q.20 |
| Water year 2005 | 1.43 | 5.08 | 10.7 | 0.33 | 0.55 | 0.98 | 3.47 | 5.08 | 5.62 |
| Regional regression equations | | | | | | | | | |
| Upper confidence limit | 23.5 | 34.5 | 55.8 | 14.2 | 21.3 | 25.6 | 13.0 | 17.9 | 20.3 |
| Estimate | 10.6 | 18.8 | 35.6 | 6.77 | 9.76 | 16.0 | 6.36 | 8.52 | 13.1 |
| Lower confidence limit | 4.80 | 10.3 | 22.7 | 3.20 | 4.50 | 10.0 | 3.10 | 4.10 | 8.50 |

**Table 9.** Summary of habitat and hydrologic measurements for lower Morgan Creek (MC1), upper Salmon River Basin, Idaho, 2005.

[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. **Channel width:** Represents measurements at three transects. **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; EPT, Ephemeroptera, Plecoptera, and Trichoptera taxa; ND, not determined; <, less 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 | EPT invertebrates | 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 | 15 | 42 | 42 | ND | 15, <11, 15 | <11, <11, <11 | 17.9 | 31.2 | 58.2 | 11.3 | 16.4 | 25.6 | 11.1 | 14.9 | 21.9 | 55.5 |
| Spawning | 24 | 42 | 42 | ND | ND | ND | | | | | | | | | | |
| Immature | ND | ND | ND | 30 | ND | ND | | | | | | | | | | |

Individual metric calculation results showed the MDAT was 14.8ºC at MCabvAC, 18.6ºC at MCabvWFMC, and 19.0ºC at MC1. The MDAT at MCabvAC was below, while the MDAT at MCabvWFMC and MC1 was above 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 19.0ºC at MCabvAC, 22.2ºC at MCabvWFMC, and 24.1ºC at MC1. The MDMT at MCabvAC was below, while the MDMT at MCabvWFMC and MC1 was 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 exceeded the 18.0ºC threshold that may block bull trout migration (J. Dunham, U.S. Forest Service, written commun., 2004).

The temperature regime at MCabvAC was below the 19.0ºC MDAT and the 22.0ºC MDMT IDEQ criteria, for protection of coldwater biota (applicable from June 22 through September 21). The temperature regime at MCabvWFMC was below the 19.0ºC MDAT, but above the 22.0ºC MDMT criteria. The temperature regime at MC1 was above the 19.0ºC MDAT and the 22.0ºC MDMT criteria. A summary of individual temperature metrics for all study sites can be accessed at http://id.water.usgs.gov/projects/salmon_streamflow.

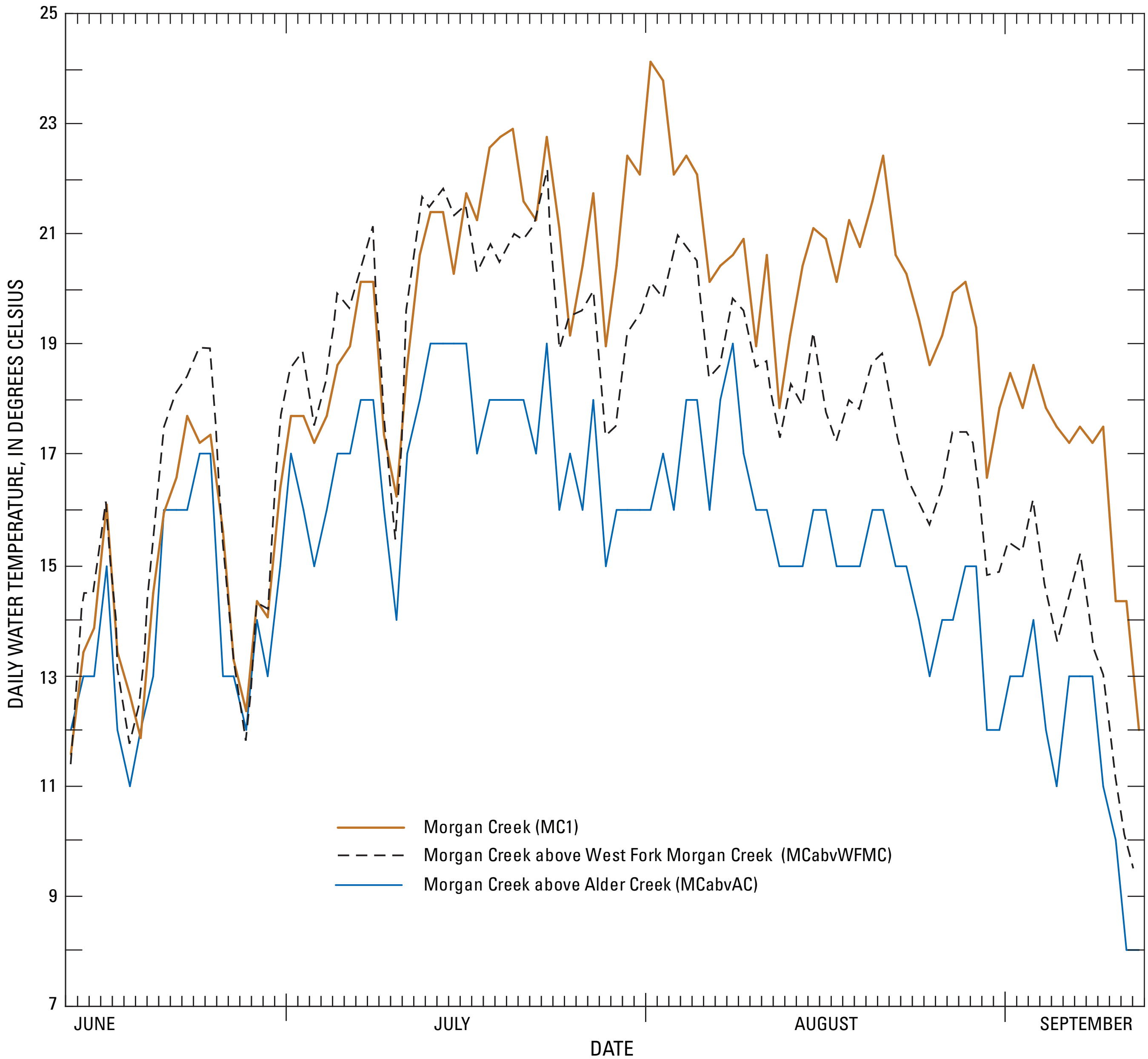



**Figure 15.** Maximum daily water temperature at Morgan Creek, upper Salmon River Basin, Idaho, June 12 through September 12, 2005.

# 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 of 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 National Oceanic and Atmospheric Administration Fisheries Biological Opinion 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 Physical Habitat Simulation System model 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.

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 2005 (WY05). Monthly snowpack levels were significantly below normal between January 1 and June 1, 2005. Average air temperature during WY05 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, as were monthly mean streamflows.

Mean air temperature at Stanley, Idaho, during WY05 was about 1.94 degrees Celsius (ºC) (35.5 degrees Fahrenheit [ºF]), slightly higher than the 30-year (1971-2000) mean of 1.78ºC (35.2ºF). Annual mean streamflows at the long-term U.S. Geological Survey streamflow-gaging stations on Valley Creek at Stanley (13295000; 65 years of record) and on the Salmon River below Yankee Fork (13296500; 75 years of record) for WY05 were about 30 percent below the long-term means.

The lower Big Boulder Creek discharges required for maximum WUA ranged from 24 to 39 cubic feet per second ($ft^3/s$) for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 24 $ft^3/s$ for Ephemeroptim, Plecoptera, and Trichoptera (EPT) taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 18 to 27 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 15 to 27 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge estimates were 32.1 $ft^3/s$ for July, 15.1 $ft^3/s$ for August, and 10.7 $ft^3/s$ for September. The mean annual discharge estimate was 15.2 $ft^3/$ s.

Analysis of the stream temperature records for the two sites on Big Boulder Creek indicated a slight warming trend downstream. Individual metric calculation results showed the maximum daily-maximum temperature (MDMT) was well below the MDMT threshold of 21.0ºC that would block adult Chinook salmon from migrating to their spawning grounds. The MDMT at the two sites on Big Boulder Creek also was below the 18.0ºC threshold that may block bull trout migration. Temperature regimes at both sites were below Idaho Department of Environmental Quality's (IDEQ) criteria of 19.0ºC maximum daily-average temperature (MDAT) and 22.0ºC MDMT.

Upper Challis Creek discharges required for maximum WUA ranged from 22 to 37 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 16 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 16 to 22 $ft^3/s$ for the depth criterion of 0.6 feet (ft) greater than 25 percent of the total channel width and 10 to 19 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge (Q.50) estimates were 17.3 $ft^3/s$ for July, 8.7 $ft^3/s$ for August, and 6.9 $ft^3/s$ for September. The mean annual discharge estimate was 17.4 $ft^3/s$.

Lower Bear Creek discharges required for maximum WUA ranged from 8 to 26 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 11 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 5 to 14 $ft^3/s$ for

the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 4 to 14 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge (Q.50) estimates were 10.1 $ft^3/s$ for July, 5.1 $ft^3/s$ for August, and 3.8 $ft^3/s$ for September. The mean annual discharge estimate was 8.9 $ft^3/s$.

Upper middle Challis Creek discharges required for maximum WUA ranged from 19 to 67 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 27 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from less than 11 to 23 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and less than 11 to 11 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge (Q.50) estimates were 47.8 $ft^3/s$ for July, 24.0 $ft^3/s$ for August, and 19.9 $ft^3/s$ for September. The mean annual discharge estimate was 46.6 $ft^3/s$.

Lower Mill Creek discharges required for maximum WUA ranged from 9 to 18 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 9 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 6 to 9 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 3 to 9 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge (Q.50) estimates were 11.7 $ft^3/s$ for July, 6.0 $ft^3/s$ for August, and 4.9 $ft^3/s$ for September. The mean annual discharge estimate was 15.4 $ft^3/s$.

Lower middle Challis Creek discharges required for maximum WUA ranged from 26 to 50 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 22 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from less than 6 to 18 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and less than 6 to 14 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge (Q.50) estimates were 59.6 $ft^3/s$ for July, 29.9 $ft^3/s$ for August, and 25.5 $ft^3/s$ for September. The mean annual discharge estimate was 64.5 $ft^3/s$.

Lower Challis Creek discharges required for maximum WUA ranged from 15 to 55 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 35 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from 15 to 19 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and 7 to 11 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge (Q.50) estimates were 59.2 $ft^3/s$ for July, 29.8 $ft^3/s$ for August, and 26.1 $ft^3/s$ for September. The mean annual discharge estimate was 74.1 $ft^3/s$.

Analysis of the stream temperature records for Challis Creek indicated a slight cooling trend downstream of upper Challis Creek to lower middle Challis Creek and then a pronounced warming trend downstream of lower middle Challis Creek to lower Challis Creek. This warming trend appears to strengthen over time and most likely is due to increasing air temperatures and the diversion of streamflow for irrigation over the course of the summer. The MDAT at upper Challis, upper middle Challis, and lower middle Challis Creek sites was below, although the MDAT at lower Challis Creek was above, the 17.8ºC MDAT upper temperature threshold that can decrease the survival rate of summer Chinook salmon juveniles in natal streams. The MDMT at all sites was very near or 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 sites exceeded the 18.0ºC threshold that may block bull trout migration. The temperature regime at all sites except lower Challis Creek was below the 19.0ºC MDAT and below the 22.0ºC MDMT IDEQ criteria, for protection of coldwater biota.

Individual metric calculation results showed that the MDAT was 11.4ºC at lower Bear Creek, well below the 17.8ºC MDAT upper temperature threshold that can decrease the survival rate of summer Chinook salmon juveniles in natal streams. The MDMT was 14.4ºC at lower Bear Creek, well below the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures. The MDMT also was below the 21.0ºC threshold that can create a thermal barrier that can possibly block adult Chinook salmon from migrating to their spawning grounds. The temperature regime at lower Bear Creek also was below the 19.0ºC MDAT and 22.0ºC MDMT IDEQ criteria for the protection of coldwater biota.

Individual metric calculation results showed that the MDAT was 18.1ºC at lower Mill Creek, slightly above the 17.8ºC MDAT upper temperature threshold that can decrease the survival rate of summer Chinook salmon juveniles in natal streams. The MDMT was 22.0ºC at lower Mill Creek, above the 18.0ºC threshold that may limit bull trout habitat and block passage as a result of high water temperatures. The MDMT at lower Mill Creek also 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. Comparison of the temperature regime at lower Mill Creek with the IDEQ criteria of 19.0ºC MDAT and 22.0ºC MDMT for the protection of coldwater biota indicates that the MDAT was below the 19.0ºC criterion while the MDMT was at the 22.0ºC MDMT criterion.

The lower Morgan Creek discharges required for maximum WUA ranged from 15 to 42 $ft^3/s$ for adult and spawning bull trout, Chinook salmon, and steelhead trout. Discharge required for maximum WUA was 30 $ft^3/s$ for EPT taxa in riffle habitat. Discharges required for adult passage over three shallow riffle habitat transects ranged from less than 11 to 15 $ft^3/s$ for the depth criterion of 0.6 ft greater than 25 percent of the total channel width and less than 11 $ft^3/s$ greater than 10 percent of the contiguous channel width, respectively. Median discharge (Q.50) estimates were 31.2 $ft^3/s$ for July, 16.4 ft$^3$/s for August, and 14.9 ft$^3$/s for September. The mean annual discharge estimate was 55.5 ft$^3$/s.

Analysis of the stream temperature records for Morgan Creek indicated a pronounced warming trend downstream of Morgan Creek above Alder Creek to lower Morgan Creek. This warming trend appears to strengthen over time and most likely is due to increasing air temperatures and the diversion of streamflow for irrigation over the course of the summer. Individual metric calculation results showed the MDAT was 14.8ºC at Morgan Creek above Alder Creek, 18.6ºC at Morgan Creek above West Fork Morgan Creek, and 19.0ºC at lower Morgan Creek. The MDAT at Morgan Creek above Alder Creek was below, while the MDAT at Morgan Creek above West Fork Morgan Creek and lower Morgan Creek was above, the 17.8ºC MDAT upper temperature threshold that can decrease the survival rate of summer Chinook salmon juveniles in natal streams. The MDMT at Morgan Creek above Alder Creek was below while the MDMT at Morgan Creek above West Fork Morgan Creek and lower Morgan Creek was 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 sites exceeded the 18.0ºC threshold that may block bull trout migration.

The temperature regime at Morgan Creek above Alder Creek was below the 19.0ºC MDAT and below the 22.0ºC MDMT IDEQ criteria, for protection of coldwater biota. The temperature regime at Morgan Creek above West Fork Morgan Creek was below the 19.0ºC MDAT but above the 22.0ºC MDMT criteria. The temperature regime at lower Morgan Creek was above the 19.0ºC MDAT and above the 22.0ºC MDMT criteria.

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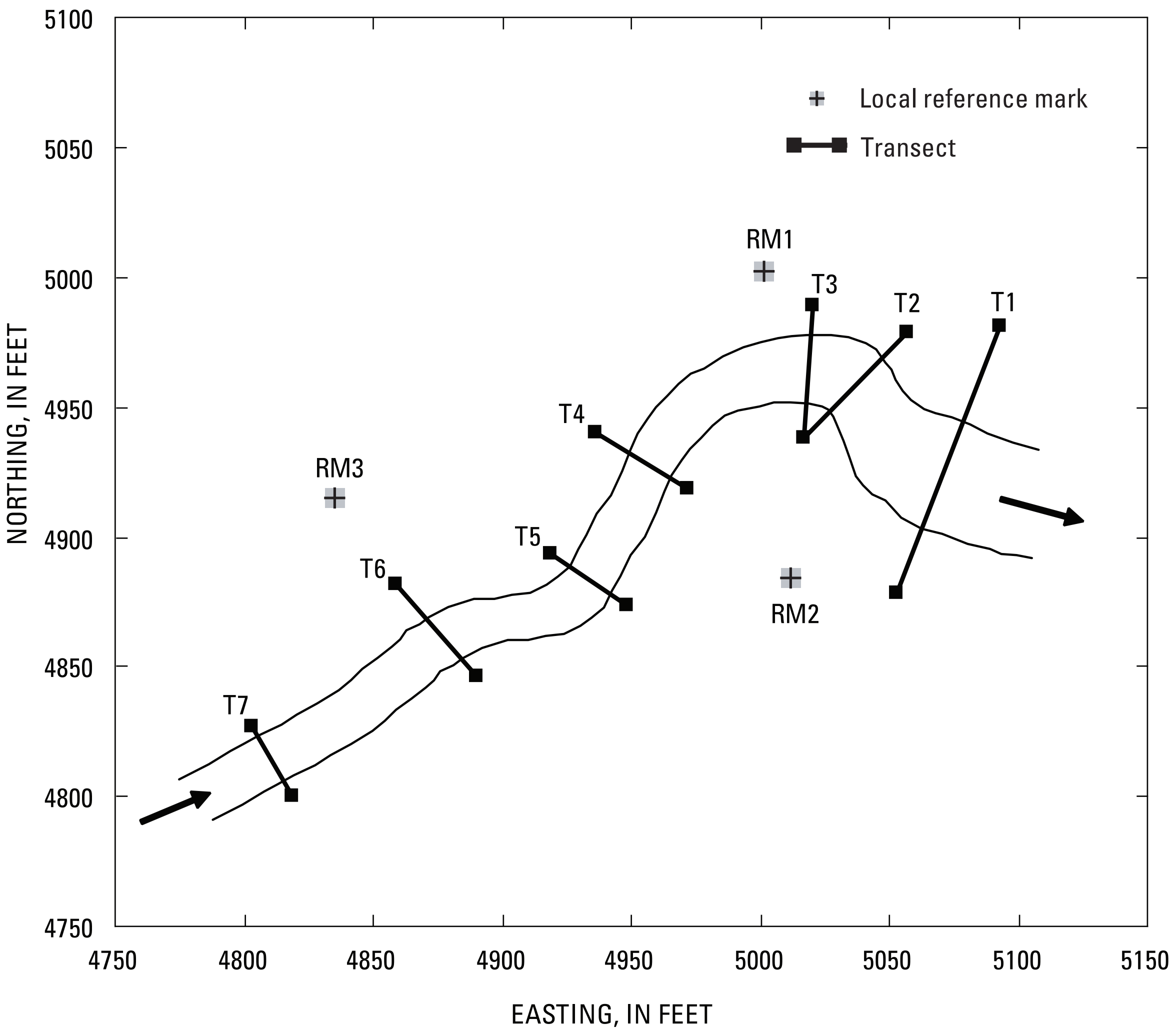
**Appendix A.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for lower Big Boulder Creek (BB1), upper Salmon River Basin, Idaho, 2005.




Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| LH1 | 44° 6' 57.48" N | 114° 26' 4.92" W |
| RH1 | 44° 6' 58.35" N | 114° 26' 3.99" W |
| LH2 | 44° 6' 58.14" N | 114° 26' 5.14" W |
| RH2 | 44° 6' 58.41" N | 114° 26' 4.45" W |
| LH3 | 44° 6' 58.14" N | 114° 26' 5.14" W |
| RH3 | 44° 6' 58.61" N | 114° 26' 4.89" W |
| LH4 | 44° 6' 58.06" N | 114° 26' 5.83" W |

Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH4 | 44° 6' 58.35" N | 114° 26' 6.21" W |
| LH5 | 44° 6' 57.7" N | 114° 26' 6.32" W |
| RH5 | 44° 6' 57.97" N | 114° 26' 6.65" W |
| LH6 | 44° 6' 57.59" N | 114° 26' 7.14" W |
| RH6 | 44° 6' 58.02" N | 114° 26' 7.45" W |
| LH7 | 44° 6' 57.37" N | 114° 26' 8.24" W |
| RH7 | 44° 6' 57.66" N | 114° 26' 8.35" W |

For reference only; stream schematic not to scale.

**Figure A1.** Plan view of lower Big Boulder Creek (BB1), upper Salmon River Basin, Idaho, 2005.

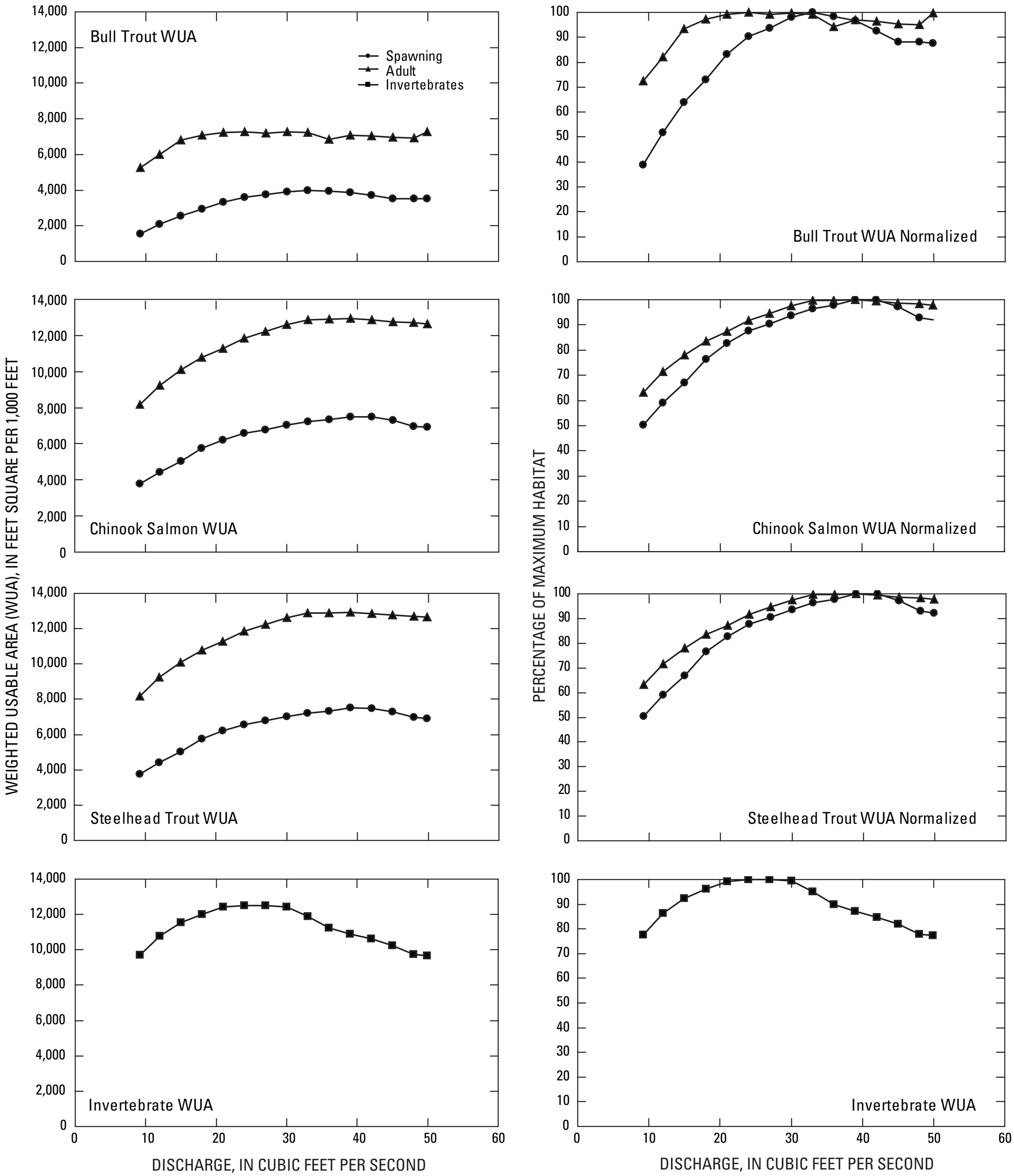



**Figure A2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, site BB1, lower Big Boulder Creek, upper Salmon River Basin, Idaho, 2005.

**Table A1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site BB1, lower Big Boulder Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 4. **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** | | | | | |
| 9.240 | 21,037 | 5,279 | 1,558 | 72.5 | 38.9 |
| 12 | 21,913 | 5,976 | 2,069 | 82.1 | 51.7 |
| 15 | 22,509 | 6,796 | 2,552 | 93.4 | 63.8 |
| 18 | 23,059 | 7,070 | 2,926 | 97.2 | 73.1 |
| 21 | 23,564 | 7,225 | 3,330 | 99.3 | 83.2 |
| 24 | 24,048 | 7,277 | 3,612 | 100.0 | 90.3 |
| 27 | 24,474 | 7,209 | 3,744 | 99.1 | 93.6 |
| 30 | 24,931 | 7,266 | 3,920 | 99.8 | 98.0 |
| 33 | 25,405 | 7,214 | 4,001 | 99.1 | 100.0 |
| 36 | 26,393 | 6,861 | 3,934 | 94.3 | 98.3 |
| 39 | 27,200 | 7,061 | 3,864 | 97.0 | 96.6 |
| 42 | 27,506 | 7,023 | 3,701 | 96.5 | 92.5 |
| 45 | 27,794 | 6,944 | 3,526 | 95.4 | 88.1 |
| 48 | 28,071 | 6,921 | 3,527 | 95.1 | 88.1 |
| 49.900 | 28,245 | 7,258 | 3,505 | 99.7 | 87.6 |
| **Chinook salmon** | | | | | |
| 9.2 | 21,037 | 8,163 | 3,777 | 63.2 | 50.4 |
| 12 | 21,913 | 9,240 | 4,424 | 71.5 | 59.0 |
| 15 | 22,509 | 10,088 | 5,021 | 78.1 | 66.9 |
| 18 | 23,059 | 10,794 | 5,738 | 83.5 | 76.5 |
| 21 | 23,564 | 11,282 | 6,196 | 87.3 | 82.6 |
| 24 | 24,048 | 11,854 | 6,577 | 91.7 | 87.7 |
| 27 | 24,474 | 12,228 | 6,790 | 94.6 | 90.5 |
| 30 | 24,931 | 12,604 | 7,025 | 97.5 | 93.7 |
| 33 | 25,405 | 12,871 | 7,229 | 99.6 | 96.4 |
| 36 | 26,393 | 12,902 | 7,337 | 99.8 | 97.8 |
| 39 | 27,200 | 12,923 | 7,501 | 100.0 | 100.0 |
| 42 | 27,506 | 12,850 | 7,492 | 99.4 | 99.9 |
| 45 | 27,794 | 12,757 | 7,292 | 98.7 | 97.2 |
| 48 | 28,071 | 12,700 | 6,971 | 98.3 | 92.9 |
| 49.900 | 28,245 | 12,645 | 6,906 | 97.9 | 92.1 |

| 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** | | | | | |
| 9.2 | 21,037 | 8,163 | 3,777 | 63.2 | 50.4 |
| 12 | 21,913 | 9,240 | 4,424 | 71.5 | 59.0 |
| 15 | 22,509 | 10,088 | 5,021 | 78.1 | 66.9 |
| 18 | 23,059 | 10,794 | 5,738 | 83.5 | 76.5 |
| 21 | 23,564 | 11,282 | 6,196 | 87.3 | 82.6 |
| 24 | 24,048 | 11,854 | 6,577 | 91.7 | 87.7 |
| 27 | 24,474 | 12,228 | 6,790 | 94.6 | 90.5 |
| 30 | 24,931 | 12,604 | 7,025 | 97.5 | 93.7 |
| 33 | 25,405 | 12,871 | 7,229 | 99.6 | 96.4 |
| 36 | 26,393 | 12,902 | 7,337 | 99.8 | 97.8 |
| 39 | 27,200 | 12,923 | 7,501 | 100.0 | 100.0 |
| 42 | 27,506 | 12,850 | 7,492 | 99.4 | 99.9 |
| 45 | 27,794 | 12,757 | 7,292 | 98.7 | 97.2 |
| 48 | 28,071 | 12,700 | 6,971 | 98.3 | 92.9 |
| 49.900 | 28,245 | 12,645 | 6,906 | 97.9 | 92.1 |

| Discharge (ft$^3$/s) | Total area (ft$^2$) | Summary of WUA (ft$^2$/1,000 ft) | Percentage of maximum habitat |
|---|---|---|---|
| **EPT Invertebrates** | | | |
| 9.240 | 21,037 | 9,709 | 77.6 |
| 12 | 21,913 | 10,797 | 86.3 |
| 15 | 22,509 | 11,536 | 92.2 |
| 18 | 23,059 | 12,019 | 96.1 |
| 21 | 23,564 | 12,410 | 99.2 |
| 24 | 24,048 | 12,508 | 100.0 |
| 27 | 24,474 | 12,506 | 100.0 |
| 30 | 24,931 | 12,437 | 99.4 |
| 33 | 25,405 | 11,908 | 95.2 |
| 36 | 26,393 | 11,250 | 89.9 |
| 39 | 27,200 | 10,912 | 87.2 |
| 42 | 27,506 | 10,606 | 84.8 |
| 45 | 27,794 | 10,237 | 81.8 |
| 48 | 28,071 | 9,730 | 77.8 |
| 49.900 | 28,245 | 9,654 | 77.2 |

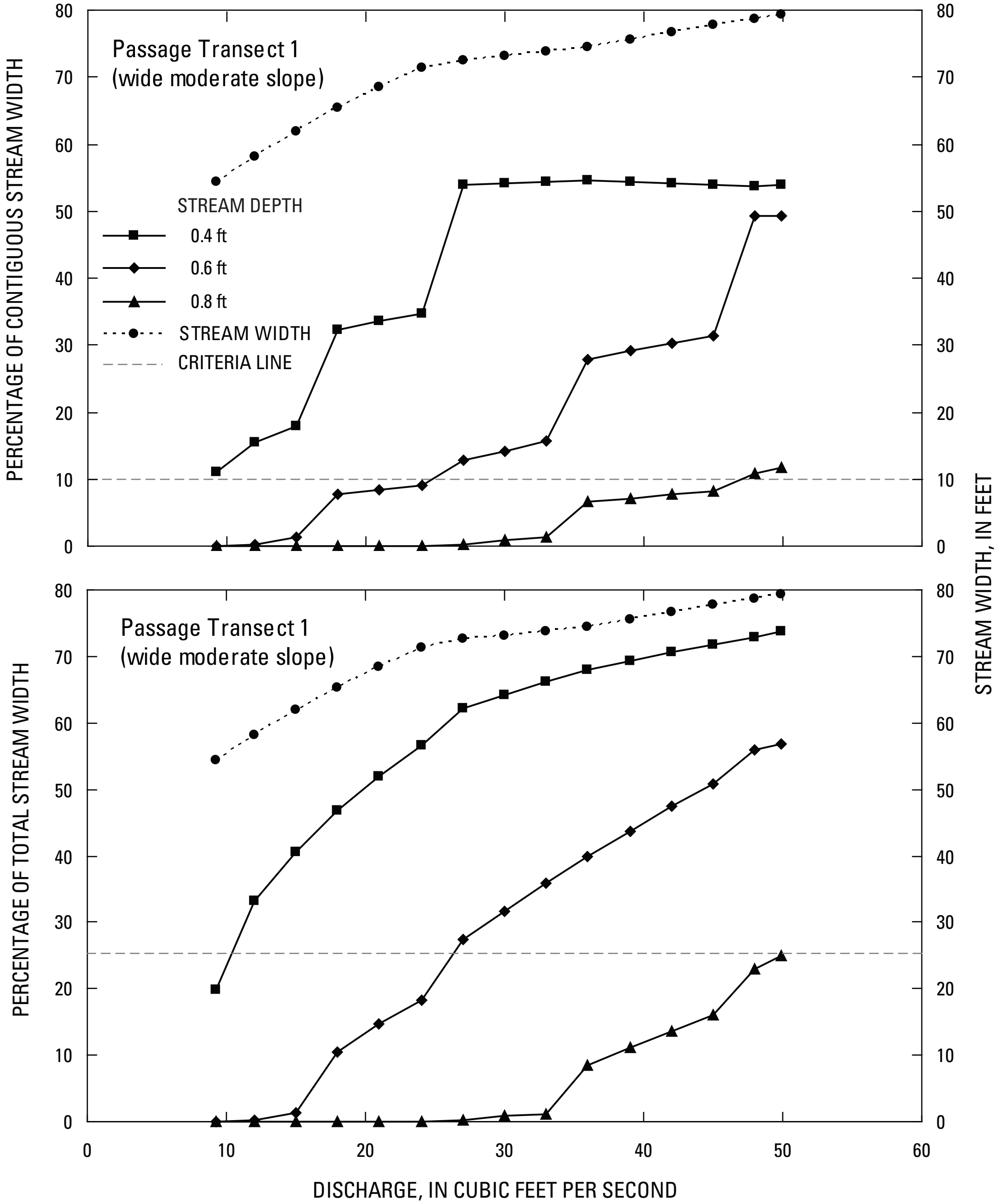



**Figure A3.** Percentages of contiguous and total stream width for passage transect 1, lower Big Boulder Creek (BB1), upper Salmon River Basin, Idaho, 2005.

**Table A2.** Passage criteria assessment for transect 1 (wide moderate slope), site BB!, lower Big Boulder Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 4. **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 | | | |
| 9.2 | 54.3 | 10.7 | 19.7 | 5.9 | 10.9 |
| 12 | 58.1 | 19.2 | 33.1 | 9.0 | 15.5 |
| 15 | 61.9 | 25.1 | 40.6 | 11.1 | 17.9 |
| 18 | 65.4 | 30.6 | 46.8 | 21.1 | 32.3 |
| 21 | 68.4 | 35.6 | 52.0 | 22.9 | 33.5 |
| 24 | 71.3 | 40.3 | 56.6 | 24.7 | 34.6 |
| 27 | 72.5 | 45.0 | 62.1 | 39.1 | 53.9 |
| 30 | 73.2 | 47.0 | 64.2 | 39.6 | 54.1 |
| 33 | 73.8 | 48.8 | 66.1 | 40.1 | 54.3 |
| 36 | 74.4 | 50.5 | 67.9 | 40.5 | 54.5 |
| 39 | 75.6 | 52.4 | 69.3 | 41.0 | 54.3 |
| 42 | 76.7 | 54.1 | 70.6 | 41.4 | 54.1 |
| 45 | 77.7 | 55.8 | 71.8 | 41.9 | 53.9 |
| 48 | 78.7 | 57.4 | 72.9 | 42.3 | 53.8 |
| 49.9 | 79.3 | 58.5 | 73.7 | 42.7 | 53.8 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 9.2 | 54.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 58.1 | 0.2 | 0.3 | 0.2 | 0.3 |
| 15 | 61.9 | 0.8 | 1.2 | 0.8 | 1.2 |
| 18 | 65.4 | 6.9 | 10.5 | 5.0 | 7.7 |
| 21 | 68.4 | 10.0 | 14.6 | 5.8 | 8.4 |
| 24 | 71.3 | 13.0 | 18.2 | 6.5 | 9.1 |
| 27 | 72.5 | 19.8 | 27.3 | 9.2 | 12.7 |
| 30 | 73.2 | 23.2 | 31.7 | 10.4 | 14.2 |
| 33 | 73.8 | 26.4 | 35.8 | 11.5 | 15.6 |
| 36 | 74.4 | 29.6 | 39.8 | 20.7 | 27.9 |
| 39 | 75.6 | 33.1 | 43.8 | 22.0 | 29.1 |
| 42 | 76.7 | 36.3 | 47.4 | 23.2 | 30.3 |
| 45 | 77.7 | 39.5 | 50.8 | 24.4 | 31.4 |
| 48 | 78.7 | 44.0 | 56.0 | 38.9 | 49.4 |
| 49.9 | 79.3 | 45.0 | 56.8 | 39.1 | 49.3 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 9.2 | 54.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 58.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 61.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 65.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 68.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | 71.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 27 | 72.5 | 0.2 | 0.3 | 0.2 | 0.3 |
| 30 | 73.2 | 0.6 | 0.8 | 0.6 | 0.8 |
| 33 | 73.8 | 0.9 | 1.2 | 0.9 | 1.2 |
| 36 | 74.4 | 6.2 | 8.4 | 4.9 | 6.5 |
| 39 | 75.6 | 8.4 | 11.2 | 5.4 | 7.1 |
| 42 | 76.7 | 10.5 | 13.7 | 5.9 | 7.7 |
| 45 | 77.7 | 12.5 | 16.0 | 6.4 | 8.2 |
| 48 | 78.7 | 18.1 | 22.9 | 8.6 | 10.9 |
| 49.9 | 79.3 | 19.8 | 25.0 | 9.2 | 11.6 |

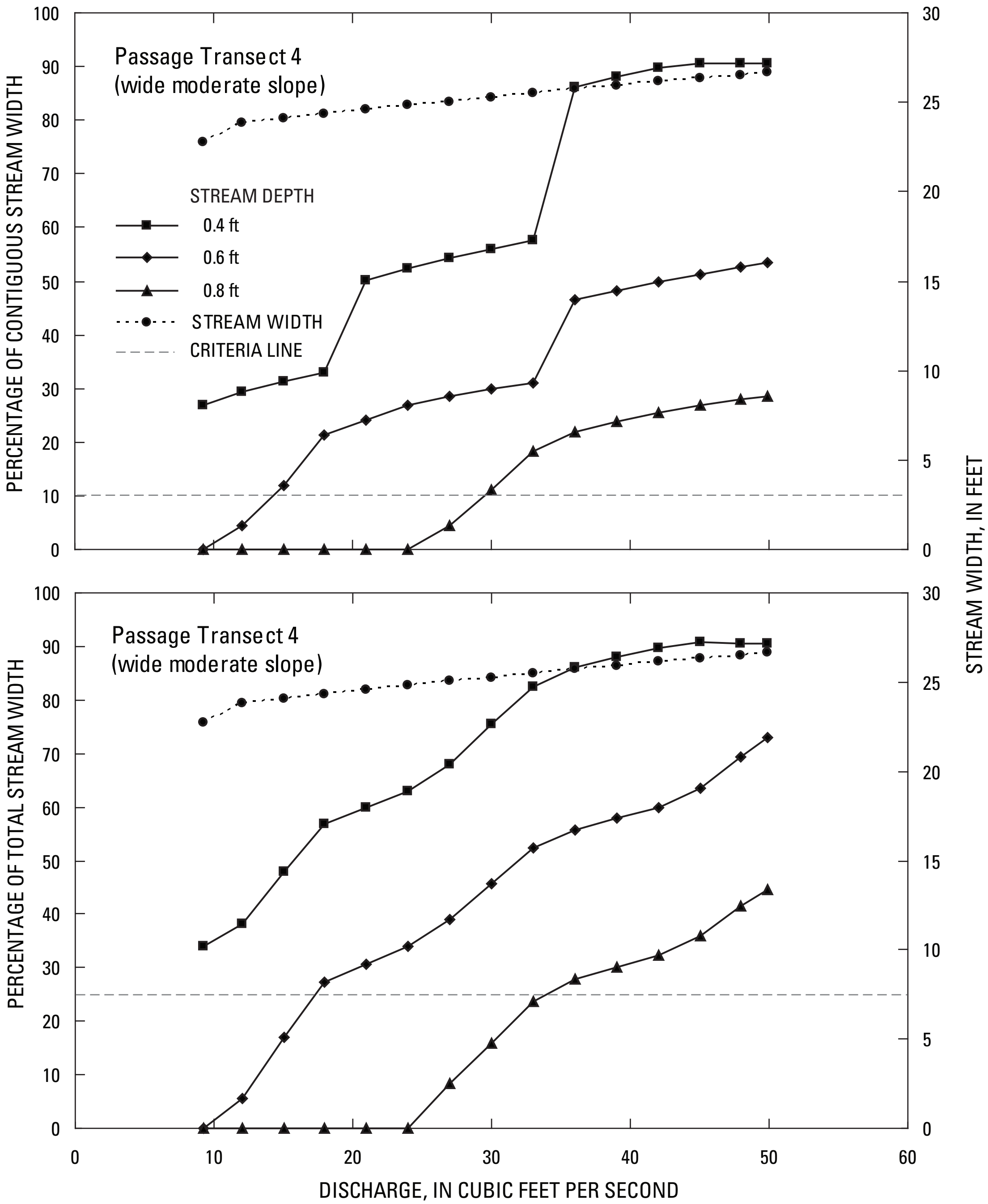



**Figure A4.** Percentages of contiguous and total stream width for passage transect 4, lower Big Boulder Creek (BB1), upper Salmon River Basin, Idaho, 2005.

**Table A3.** Passage criteria assessment for transect 4 (wide moderate slope), site BB1, lower Big Boulder Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 4. **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 | | | |
| 9.2 | 22.8 | 7.7 | 34.0 | 6.1 | 26.8 |
| 12 | 23.8 | 9.1 | 38.1 | 7.0 | 29.4 |
| 15 | 24.1 | 11.6 | 48.0 | 7.5 | 31.3 |
| 18 | 24.4 | 13.9 | 56.9 | 8.0 | 32.9 |
| 21 | 24.6 | 14.8 | 60.0 | 12.3 | 50.0 |
| 24 | 24.8 | 15.6 | 62.8 | 13.0 | 52.3 |
| 27 | 25.0 | 17.1 | 68.1 | 13.6 | 54.2 |
| 30 | 25.3 | 19.0 | 75.4 | 14.1 | 56.0 |
| 33 | 25.5 | 21.1 | 82.6 | 14.7 | 57.7 |
| 36 | 25.7 | 22.2 | 86.2 | 22.2 | 86.2 |
| 39 | 25.9 | 22.8 | 88.1 | 22.8 | 88.1 |
| 42 | 26.1 | 23.5 | 89.8 | 23.5 | 89.8 |
| 45 | 26.3 | 23.9 | 90.7 | 23.9 | 90.7 |
| 48 | 26.5 | 24.0 | 90.6 | 24.0 | 90.6 |
| 49.900 | 26.6 | 24.1 | 90.6 | 24.1 | 90.6 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 9.2 | 22.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 23.8 | 1.3 | 5.5 | 1.0 | 4.3 |
| 15 | 24.1 | 4.1 | 16.9 | 2.8 | 11.8 |
| 18 | 24.4 | 6.6 | 27.2 | 5.2 | 21.4 |
| 21 | 24.6 | 7.5 | 30.7 | 5.9 | 24.2 |
| 24 | 24.8 | 8.4 | 33.9 | 6.6 | 26.8 |
| 27 | 25.0 | 9.8 | 39.0 | 7.2 | 28.6 |
| 30 | 25.3 | 11.5 | 45.7 | 7.5 | 29.8 |
| 33 | 25.5 | 13.3 | 52.3 | 7.9 | 31.0 |
| 36 | 25.7 | 14.4 | 55.8 | 12.0 | 46.6 |
| 39 | 25.9 | 15.0 | 57.9 | 12.5 | 48.3 |
| 42 | 26.1 | 15.6 | 59.9 | 13.0 | 49.8 |
| 45 | 26.3 | 16.7 | 63.6 | 13.5 | 51.2 |
| 48 | 26.5 | 18.4 | 69.4 | 14.0 | 52.6 |
| 49.900 | 26.6 | 19.4 | 72.9 | 14.2 | 53.5 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 9.2 | 22.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 24.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 24.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 24.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | 24.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 27 | 25.0 | 2.1 | 8.3 | 1.1 | 4.3 |
| 30 | 25.3 | 4.0 | 16.0 | 2.8 | 11.2 |
| 33 | 25.5 | 6.0 | 23.7 | 4.7 | 18.3 |
| 36 | 25.7 | 7.1 | 27.8 | 5.6 | 21.9 |
| 39 | 25.9 | 7.8 | 30.2 | 6.2 | 23.8 |
| 42 | 26.1 | 8.5 | 32.4 | 6.7 | 25.6 |
| 45 | 26.3 | 9.5 | 36.1 | 7.1 | 27.0 |
| 48 | 26.5 | 11.0 | 41.4 | 7.4 | 27.9 |
| 49.900 | 26.6 | 11.9 | 44.5 | 7.6 | 28.5 |

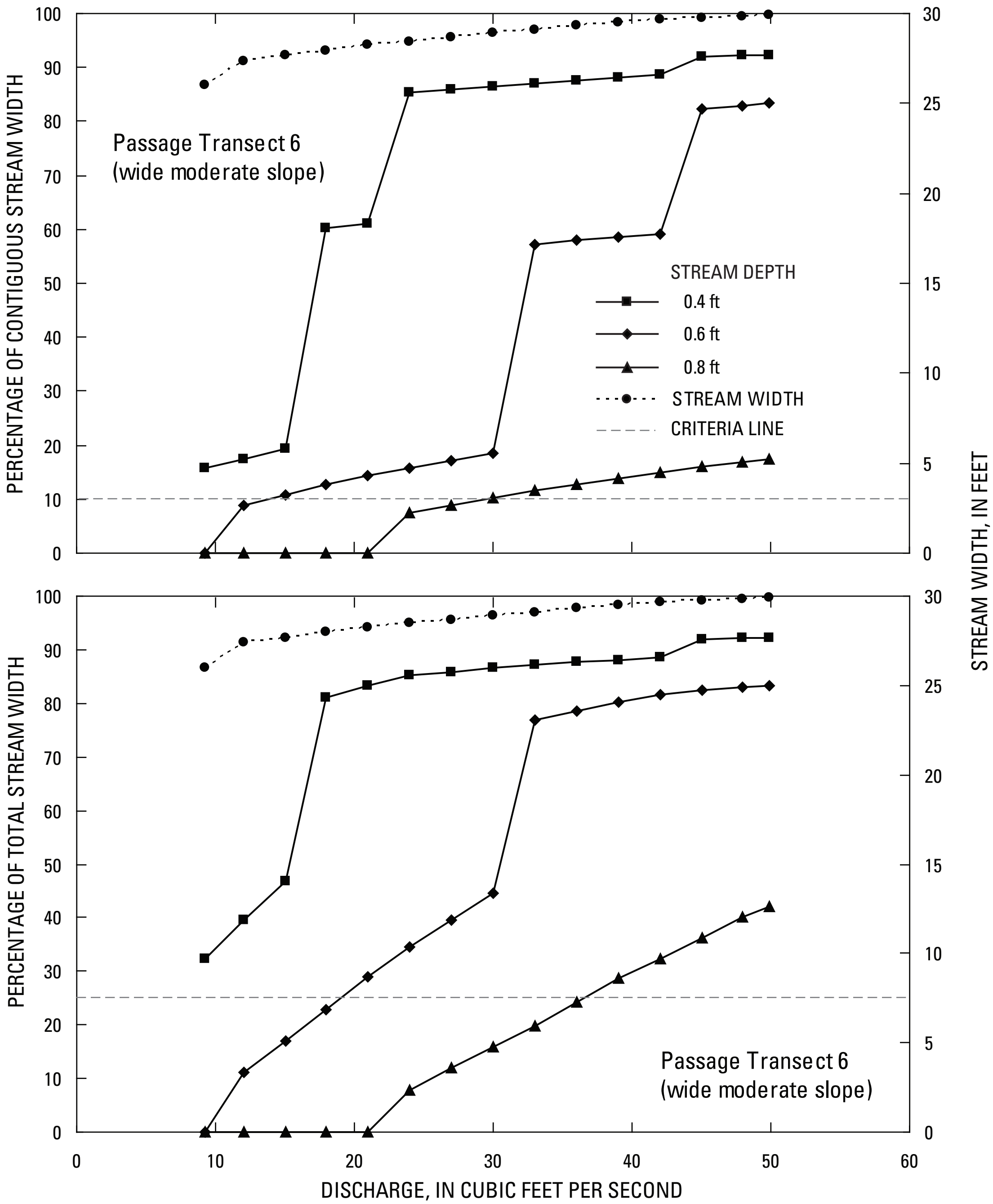


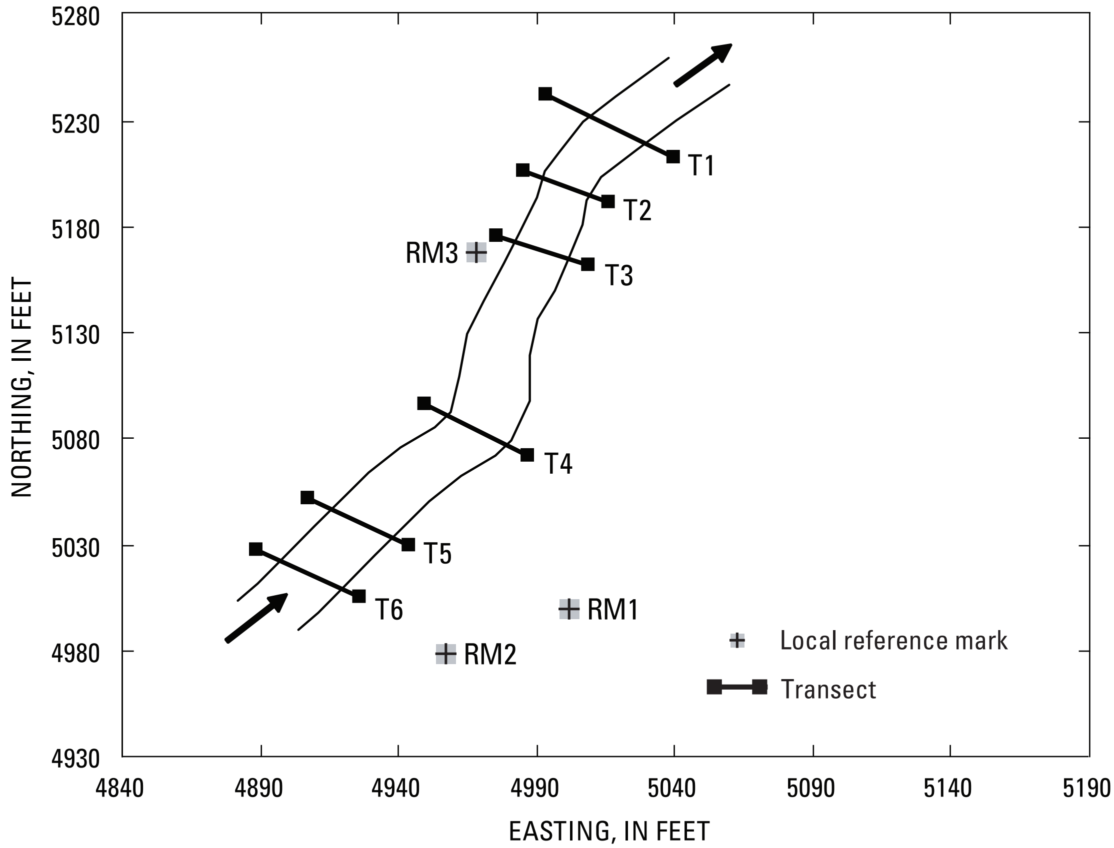

**Figure A5.** Percentages of contiguous and total stream width for passage transect 6, lower Big Boulder Creek (BB1), upper Salmon River Basin, Idaho, 2005.

**Table A4.** Passage criteria assessment for transect 6 (wide moderate slope), site BB1, lower Big Boulder Creek, upper Salmon River Basin, Idaho, 2005

[Site location shown in figure 4. **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 | | | |
| 9.2 | 22.8 | 8.4 | 32.2 | 4.1 | 15.7 |
| 12 | 23.8 | 10.8 | 39.6 | 4.8 | 17.4 |
| 15 | 24.1 | 13.0 | 46.8 | 5.3 | 19.3 |
| 18 | 24.4 | 22.7 | 81.0 | 16.8 | 60.1 |
| 21 | 24.6 | 23.5 | 83.3 | 17.2 | 61.0 |
| 24 | 24.8 | 24.3 | 85.3 | 24.3 | 85.3 |
| 27 | 25.0 | 24.6 | 85.9 | 24.6 | 85.9 |
| 30 | 25.3 | 25.0 | 86.5 | 25.0 | 86.5 |
| 33 | 25.5 | 25.4 | 87.1 | 25.4 | 87.1 |
| 36 | 25.7 | 25.7 | 87.6 | 25.7 | 87.6 |
| 39 | 25.9 | 26.0 | 88.1 | 26.0 | 88.1 |
| 42 | 26.1 | 26.3 | 88.6 | 26.3 | 88.6 |
| 45 | 26.3 | 27.4 | 91.9 | 27.4 | 91.9 |
| 48 | 26.5 | 27.5 | 92.2 | 27.5 | 92.2 |
| 49.900 | 26.6 | 27.6 | 92.3 | 27.6 | 92.3 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 9.2 | 22.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 23.8 | 3.0 | 11.0 | 2.4 | 8.9 |
| 15 | 24.1 | 4.7 | 16.9 | 3.0 | 10.9 |
| 18 | 24.4 | 6.4 | 22.8 | 3.5 | 12.6 |
| 21 | 24.6 | 8.1 | 28.8 | 4.0 | 14.2 |
| 24 | 24.8 | 9.8 | 34.4 | 4.5 | 15.7 |
| 27 | 25.0 | 11.4 | 39.6 | 4.9 | 17.1 |
| 30 | 25.3 | 12.9 | 44.6 | 5.3 | 18.4 |
| 33 | 25.5 | 22.4 | 76.8 | 16.7 | 57.3 |
| 36 | 25.7 | 23.0 | 78.6 | 17.0 | 57.9 |
| 39 | 25.9 | 23.6 | 80.2 | 17.3 | 58.5 |
| 42 | 26.1 | 24.2 | 81.6 | 17.5 | 59.1 |
| 45 | 26.3 | 24.5 | 82.3 | 24.5 | 82.3 |
| 48 | 26.5 | 24.8 | 83.0 | 24.8 | 83.0 |
| 49.900 | 26.6 | 25.0 | 83.4 | 25.0 | 83.4 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 9.2 | 22.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 23.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 24.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 24.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 24.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | 24.8 | 2.2 | 7.8 | 2.1 | 7.5 |
| 27 | 25.0 | 3.4 | 11.9 | 2.6 | 8.9 |
| 30 | 25.3 | 4.6 | 15.9 | 3.0 | 10.3 |
| 33 | 25.5 | 5.7 | 19.7 | 3.4 | 11.5 |
| 36 | 25.7 | 7.1 | 24.4 | 3.7 | 12.8 |
| 39 | 25.9 | 8.4 | 28.6 | 4.1 | 13.9 |
| 42 | 26.1 | 9.6 | 32.4 | 4.4 | 14.9 |
| 45 | 26.3 | 10.8 | 36.3 | 4.8 | 16.0 |
| 48 | 26.5 | 11.9 | 40.0 | 5.1 | 16.9 |
| 49.900 | 26.6 | 12.6 | 42.2 | 5.2 | 17.5 |

**Appendix B.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for upper Challis Creek (CH4), upper Salmon River Basin, Idaho, 2005.




Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH1 | 44° 34' 8.57" N | 114° 21' 46.74" W |
| LH1 | 44° 34' 8.17" N | 114° 21' 46.22" W |
| RH2 | 44° 34' 8.24" N | 114° 21' 46.99" W |
| LH2 | 44° 34' 8.02" N | 114° 21' 46.63" W |
| RH3 | 44° 34' 7.98" N | 114° 21' 47.21" W |
| LH3 | 44° 34' 7.76" N | 114° 21' 46.82" W |

Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH4 | 44° 34' 7.27" N | 114° 21' 47.84" W |
| LH4 | 44° 34' 6.95" N | 114° 21' 47.43" W |
| RH5 | 44° 34' 6.96" N | 114° 21' 48.55" W |
| LH5 | 44° 34' 6.66" N | 114° 21' 48.17" W |
| RH6 | 44° 34' 6.78" N | 114° 21' 48.91" W |
| LH6 | 44° 34' 6.48" N | 114° 21' 48.47" W |

For reference only; stream schematic not to scale.

**Figure B1.** Plan view of upper Challis Creek (CH4), upper Salmon River Basin, Idaho, 2005.

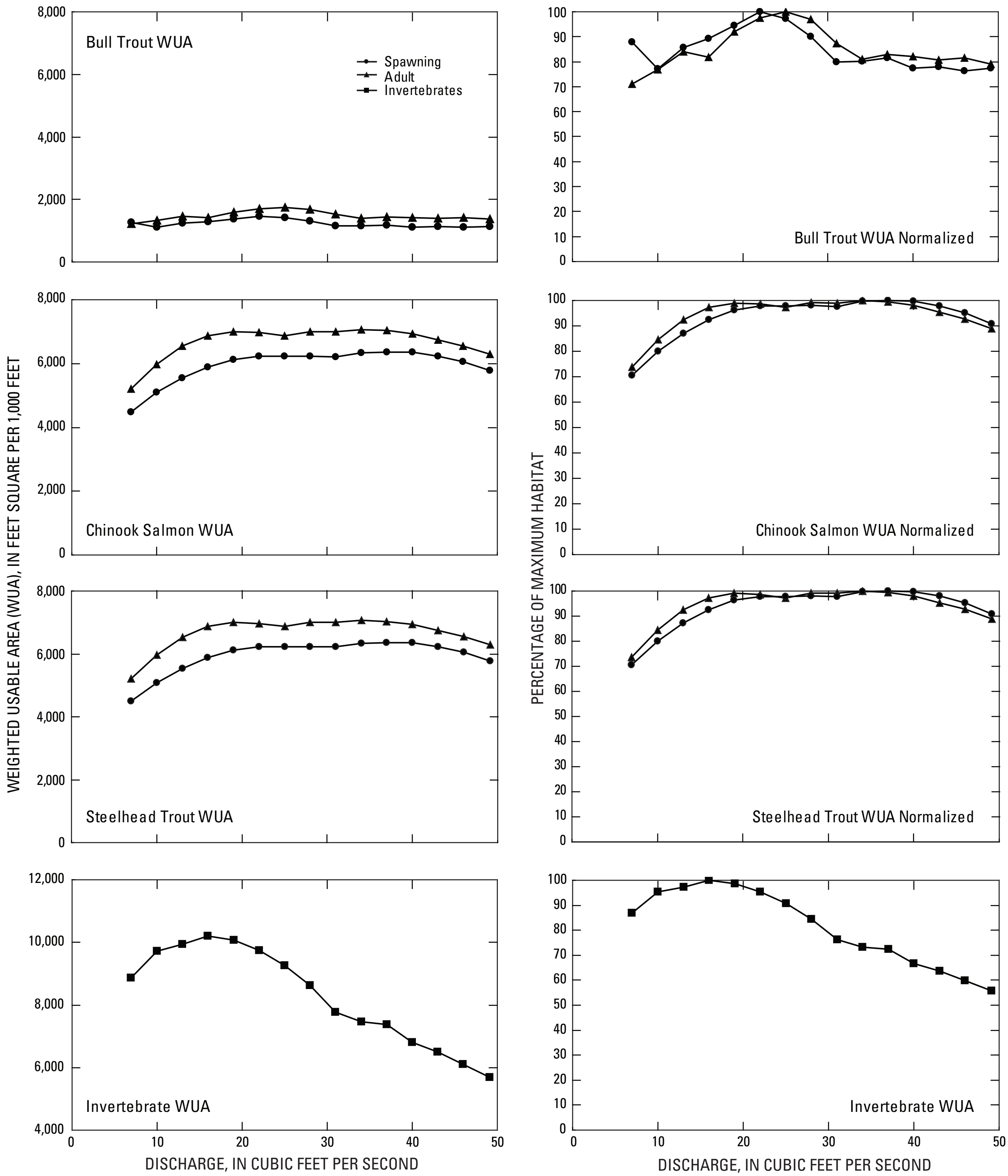



**Figure B2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, upper Challis Creek (CH4), upper Salmon River Basin, Idaho, 2005.

**Table B1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site CH4, upper Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **Abbreviations**: WUA, weighted usable area; ft³/s, cubic foot per second; ft², square foot; ft²/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** | | | | | |
| 7.0 | 15,075 | 1,231 | 1,274 | 71.0 | 87.8 |
| 10 | 15,611 | 1,333 | 1,118 | 76.8 | 77.0 |
| 13 | 16,033 | 1,460 | 1,245 | 84.1 | 85.8 |
| 16 | 16,399 | 1,419 | 1,295 | 81.8 | 89.3 |
| 19 | 16,720 | 1,595 | 1,370 | 91.9 | 94.4 |
| 22 | 17,015 | 1,692 | 1,451 | 97.5 | 100.0 |
| 25 | 17,284 | 1,735 | 1,409 | 100.0 | 97.2 |
| 28 | 17,503 | 1,680 | 1,306 | 96.9 | 90.0 |
| 31 | 17,720 | 1,516 | 1,160 | 87.4 | 79.9 |
| 34 | 18,117 | 1,404 | 1,163 | 80.9 | 80.2 |
| 37 | 18,602 | 1,439 | 1,182 | 82.9 | 81.5 |
| 40 | 19,501 | 1,424 | 1,123 | 82.1 | 77.4 |
| 43 | 19,661 | 1,399 | 1,133 | 80.6 | 78.1 |
| 46 | 19,805 | 1,416 | 1,105 | 81.6 | 76.2 |
| 49.100 | 19,947 | 1,373 | 1,124 | 79.2 | 77.5 |
| **Chinook salmon** | | | | | |
| 7.0 | 15,075 | 5,208 | 4,490 | 73.7 | 70.6 |
| 10 | 15,611 | 5,970 | 5,088 | 84.5 | 80.0 |
| 13 | 16,033 | 6,539 | 5,542 | 92.6 | 87.1 |
| 16 | 16,399 | 6,868 | 5,885 | 97.2 | 92.5 |
| 19 | 16,720 | 6,997 | 6,128 | 99.0 | 96.3 |
| 22 | 17,015 | 6,968 | 6,220 | 98.6 | 97.7 |
| 25 | 17,284 | 6,868 | 6,227 | 97.2 | 97.9 |
| 28 | 17,503 | 7,002 | 6,236 | 99.1 | 98.0 |
| 31 | 17,720 | 6,997 | 6,217 | 99.0 | 97.7 |
| 34 | 18,117 | 7,065 | 6,338 | 100.0 | 99.6 |
| 37 | 18,602 | 7,029 | 6,363 | 99.5 | 100.0 |
| 40 | 19,501 | 6,931 | 6,350 | 98.1 | 99.8 |
| 43 | 19,661 | 6,738 | 6,233 | 95.4 | 97.9 |
| 46 | 19,805 | 6,555 | 6,054 | 92.8 | 95.1 |
| 49.100 | 19,947 | 6,288 | 5,779 | 89.0 | 90.8 |
| **Steelhead trout** | | | | | |
| 7.0 | 15,075 | 5,208 | 4,490 | 73.7 | 70.6 |
| 10 | 15,611 | 5,970 | 5,088 | 84.5 | 80.0 |
| 13 | 16,033 | 6,539 | 5,542 | 92.6 | 87.1 |
| 16 | 16,399 | 6,868 | 5,885 | 97.2 | 92.5 |
| 19 | 16,720 | 6,997 | 6,128 | 99.0 | 96.3 |
| 22 | 17,015 | 6,968 | 6,220 | 98.6 | 97.7 |
| 25 | 17,284 | 6,868 | 6,227 | 97.2 | 97.9 |
| 28 | 17,503 | 7,002 | 6,236 | 99.1 | 98.0 |
| 31 | 17,720 | 6,997 | 6,217 | 99.0 | 97.7 |
| 34 | 18,117 | 7,065 | 6,338 | 100.0 | 99.6 |
| 37 | 18,602 | 7,029 | 6,363 | 99.5 | 100.0 |
| 40 | 19,501 | 6,931 | 6,350 | 98.1 | 99.8 |
| 43 | 19,661 | 6,738 | 6,233 | 95.4 | 97.9 |
| 46 | 19,805 | 6,555 | 6,054 | 92.8 | 95.1 |
| 49.100 | 19,947 | 6,288 | 5,779 | 89.0 | 90.8 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2$/1,000 ft) | Percentage of maximum habitat |
|---|---|---|---|
| **EPT Invertebrates** | | | |
| 6.970 | 15,075 | 8,873 | 86.9 |
| 10 | 15,611 | 9,729 | 95.3 |
| 13 | 16,033 | 9,941 | 97.4 |
| 16 | 16,399 | 10,207 | 100.0 |
| 19 | 16,720 | 10,062 | 98.6 |
| 22 | 17,015 | 9,737 | 95.4 |
| 25 | 17,284 | 9,270 | 90.8 |
| 28 | 17,503 | 8,631 | 84.6 |
| 31 | 17,720 | 7,774 | 76.2 |
| 34 | 18,117 | 7,460 | 73.1 |
| 37 | 18,602 | 7,380 | 72.3 |
| 40 | 19,501 | 6,812 | 66.7 |
| 43 | 19,661 | 6,503 | 63.7 |
| 46 | 19,805 | 6,108 | 59.8 |
| 49.100 | 19,947 | 5,679 | 55.6 |

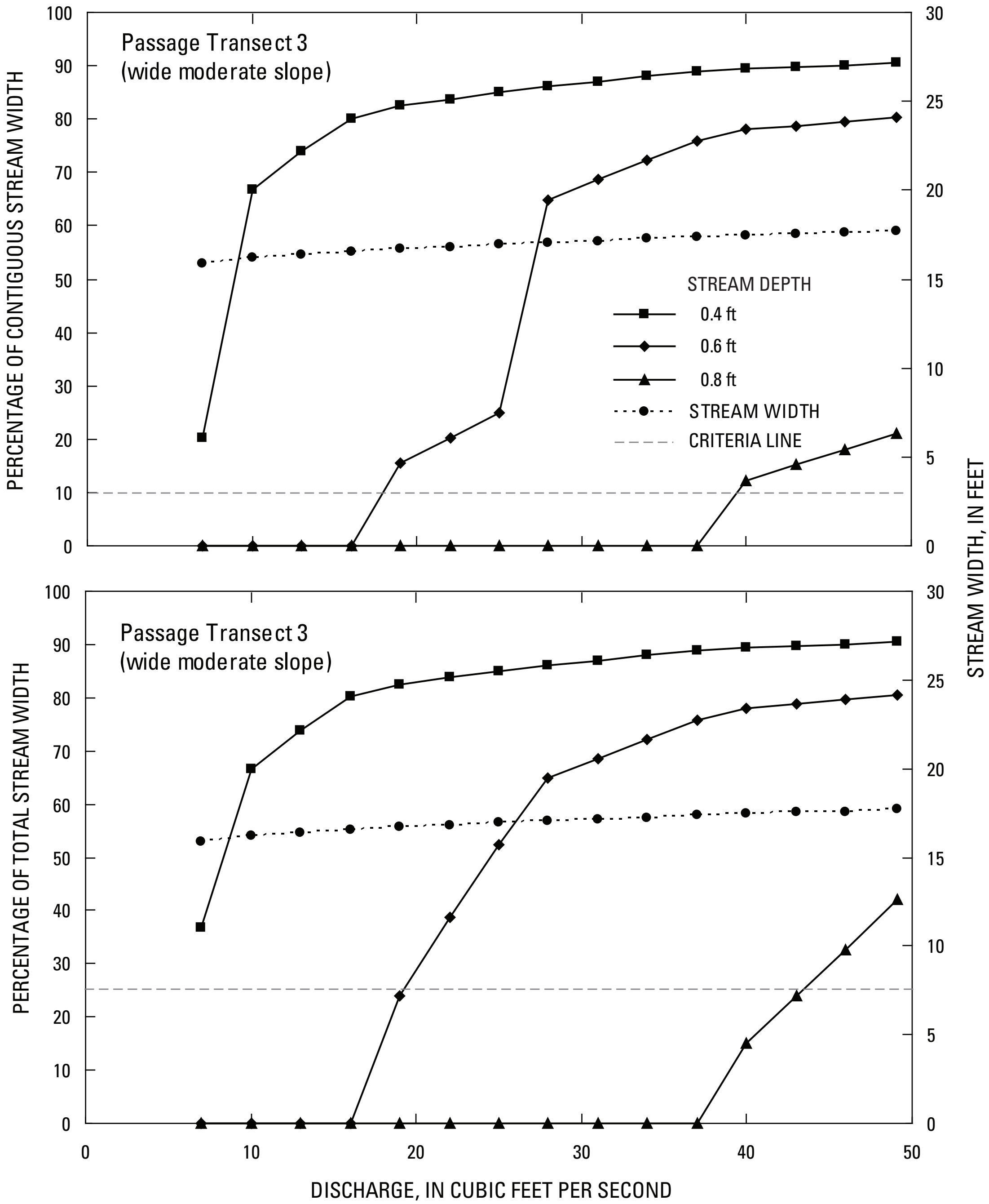



**Figure B3.** Percentages of contiguous and total stream width for passage transect 3, upper Challis Creek (CH4), upper Salmon River Basin, Idaho, 2005.

**Table B2.** Passage criteria assessment for transect 3 (wide moderate slope), site CH4, upper Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 7.0 | 15.9 | 5.9 | 36.9 | 3.2 | 20.2 | 7.0 | 15.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 16.2 | 10.8 | 66.7 | 10.8 | 66.7 | 10 | 16.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 16.4 | 12.1 | 73.9 | 12.1 | 73.9 | 13 | 16.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 16.6 | 13.3 | 80.2 | 13.3 | 80.2 | 16 | 16.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19 | 16.7 | 13.8 | 82.5 | 13.8 | 82.5 | 19 | 16.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 16.8 | 14.1 | 83.8 | 14.1 | 83.8 | 22 | 16.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | 16.9 | 14.4 | 85.0 | 14.4 | 85.0 | 25 | 16.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28 | 17.1 | 14.7 | 86.1 | 14.7 | 86.1 | 28 | 17.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31 | 17.2 | 14.9 | 87.0 | 14.9 | 87.0 | 31 | 17.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 34 | 17.2 | 15.2 | 88.0 | 15.2 | 88.0 | 34 | 17.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 37 | 17.3 | 15.4 | 88.8 | 15.4 | 88.8 | 37 | 17.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40 | 17.4 | 15.6 | 89.5 | 15.6 | 89.5 | 40 | 17.4 | 2.6 | 15.1 | 2.1 | 12.3 |
| 43 | 17.5 | 15.7 | 89.8 | 15.7 | 89.8 | 43 | 17.5 | 4.2 | 23.9 | 2.7 | 15.1 |
| 46 | 17.6 | 15.8 | 90.1 | 15.8 | 90.1 | 46 | 17.6 | 5.7 | 32.7 | 3.2 | 18.0 |
| 49.1 | 17.7 | 16.0 | 90.4 | 16.0 | 90.4 | 49.1 | 17.7 | 7.4 | 41.9 | 3.7 | 21.0 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 7.0 | 15.9 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| 10 | 16.2 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| 13 | 16.4 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| 16 | 16.6 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| 19 | 16.7 | 4.0 | 23.9 | 2.6 | 15.5 | | | | | | |
| 22 | 16.8 | 6.5 | 38.7 | 3.4 | 20.3 | | | | | | |
| 25 | 16.9 | 8.9 | 52.5 | 4.2 | 24.8 | | | | | | |
| 28 | 17.1 | 11.1 | 64.9 | 11.1 | 64.9 | | | | | | |
| 31 | 17.2 | 11.8 | 68.6 | 11.8 | 68.6 | | | | | | |
| 34 | 17.2 | 12.5 | 72.3 | 12.5 | 72.3 | | | | | | |
| 37 | 17.3 | 13.1 | 75.8 | 13.1 | 75.8 | | | | | | |
| 40 | 17.4 | 13.6 | 78.0 | 13.6 | 78.0 | | | | | | |
| 43 | 17.5 | 13.8 | 78.8 | 13.8 | 78.8 | | | | | | |
| 46 | 17.6 | 14.0 | 79.6 | 14.0 | 79.6 | | | | | | |
| 49.1 | 17.7 | 14.2 | 80.4 | 14.2 | 80.4 | | | | | | |

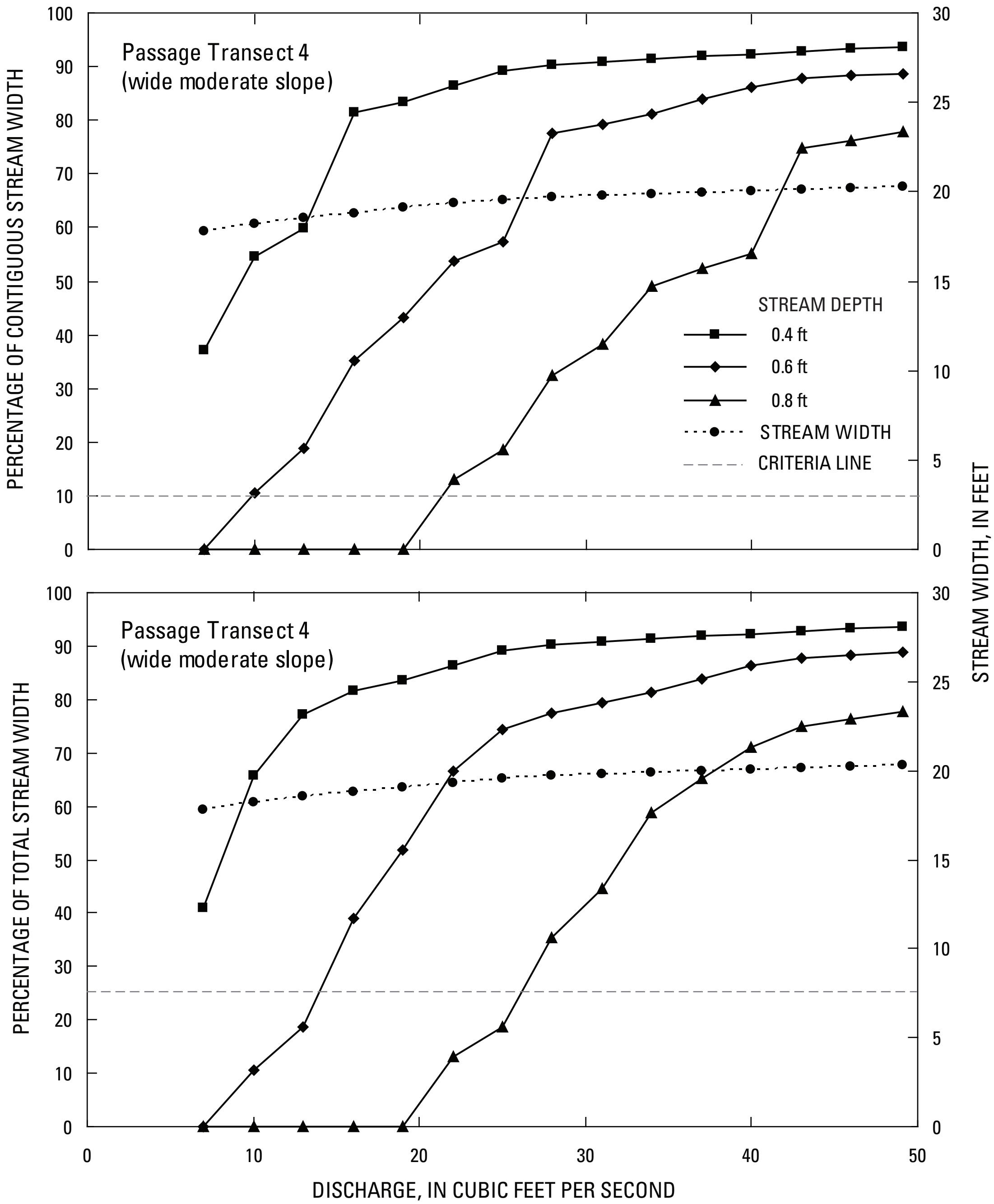



**Figure B4.** Percentages of contiguous and total stream width for passage transect 4, upper Challis Creek (CH4), upper Salmon River Basin, Idaho, 2005.

**Table B3.** Passage criteria assessment for transect 4 (wide moderate slope), site CH4, upper Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 7.0 | 17.8 | 7.3 | 41.0 | 6.6 | 37.1 | 7.0 | 17.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 18.2 | 12.0 | 65.7 | 9.9 | 54.5 | 10 | 18.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 18.5 | 14.3 | 77.1 | 11.1 | 59.9 | 13 | 18.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 18.8 | 15.3 | 81.6 | 15.3 | 81.6 | 16 | 18.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19 | 19.1 | 15.9 | 83.5 | 15.9 | 83.5 | 19 | 19.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 19.3 | 16.7 | 86.3 | 16.7 | 86.3 | 22 | 19.3 | 2.5 | 13.1 | 2.5 | 13.1 |
| 25 | 19.6 | 17.4 | 89.1 | 17.4 | 89.1 | 25 | 19.6 | 3.7 | 18.7 | 3.7 | 18.7 |
| 28 | 19.7 | 17.8 | 90.2 | 17.8 | 90.2 | 28 | 19.7 | 7.0 | 35.3 | 6.4 | 32.4 |
| 31 | 19.8 | 18.0 | 90.8 | 18.0 | 90.8 | 31 | 19.8 | 8.8 | 44.6 | 7.6 | 38.2 |
| 34 | 19.9 | 18.2 | 91.3 | 18.2 | 91.3 | 34 | 19.9 | 11.7 | 58.8 | 9.8 | 49.1 |
| 37 | 20.0 | 18.3 | 91.8 | 18.3 | 91.8 | 37 | 20.0 | 13.0 | 65.1 | 10.4 | 52.3 |
| 40 | 20.1 | 18.5 | 92.3 | 18.5 | 92.3 | 40 | 20.1 | 14.2 | 70.9 | 11.1 | 55.1 |
| 43 | 20.1 | 18.7 | 92.8 | 18.7 | 92.8 | 43 | 20.1 | 15.1 | 74.8 | 15.1 | 74.8 |
| 46 | 20.2 | 18.9 | 93.3 | 18.9 | 93.3 | 46 | 20.2 | 15.4 | 76.3 | 15.4 | 76.3 |
| 49.1 | 20.3 | 19.0 | 93.7 | 19.0 | 93.7 | 49.1 | 20.3 | 15.8 | 77.8 | 15.8 | 77.8 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 7.0 | 17.8 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| 10 | 18.2 | 1.9 | 10.5 | 1.9 | 10.5 | | | | | | |
| 13 | 18.5 | 3.5 | 18.8 | 3.5 | 18.8 | | | | | | |
| 16 | 18.8 | 7.3 | 39.0 | 6.6 | 35.2 | | | | | | |
| 19 | 19.1 | 9.9 | 51.8 | 8.2 | 43.1 | | | | | | |
| 22 | 19.3 | 12.9 | 66.6 | 10.4 | 53.7 | | | | | | |
| 25 | 19.6 | 14.5 | 74.3 | 11.2 | 57.3 | | | | | | |
| 28 | 19.7 | 15.3 | 77.5 | 15.3 | 77.5 | | | | | | |
| 31 | 19.8 | 15.7 | 79.3 | 15.7 | 79.3 | | | | | | |
| 34 | 19.9 | 16.2 | 81.2 | 16.2 | 81.2 | | | | | | |
| 37 | 20.0 | 16.7 | 83.9 | 16.7 | 83.9 | | | | | | |
| 40 | 20.1 | 17.3 | 86.3 | 17.3 | 86.3 | | | | | | |
| 43 | 20.1 | 17.7 | 87.8 | 17.7 | 87.8 | | | | | | |
| 46 | 20.2 | 17.8 | 88.3 | 17.8 | 88.3 | | | | | | |
| 49.1 | 20.3 | 18.0 | 88.7 | 18.0 | 88.7 | | | | | | |

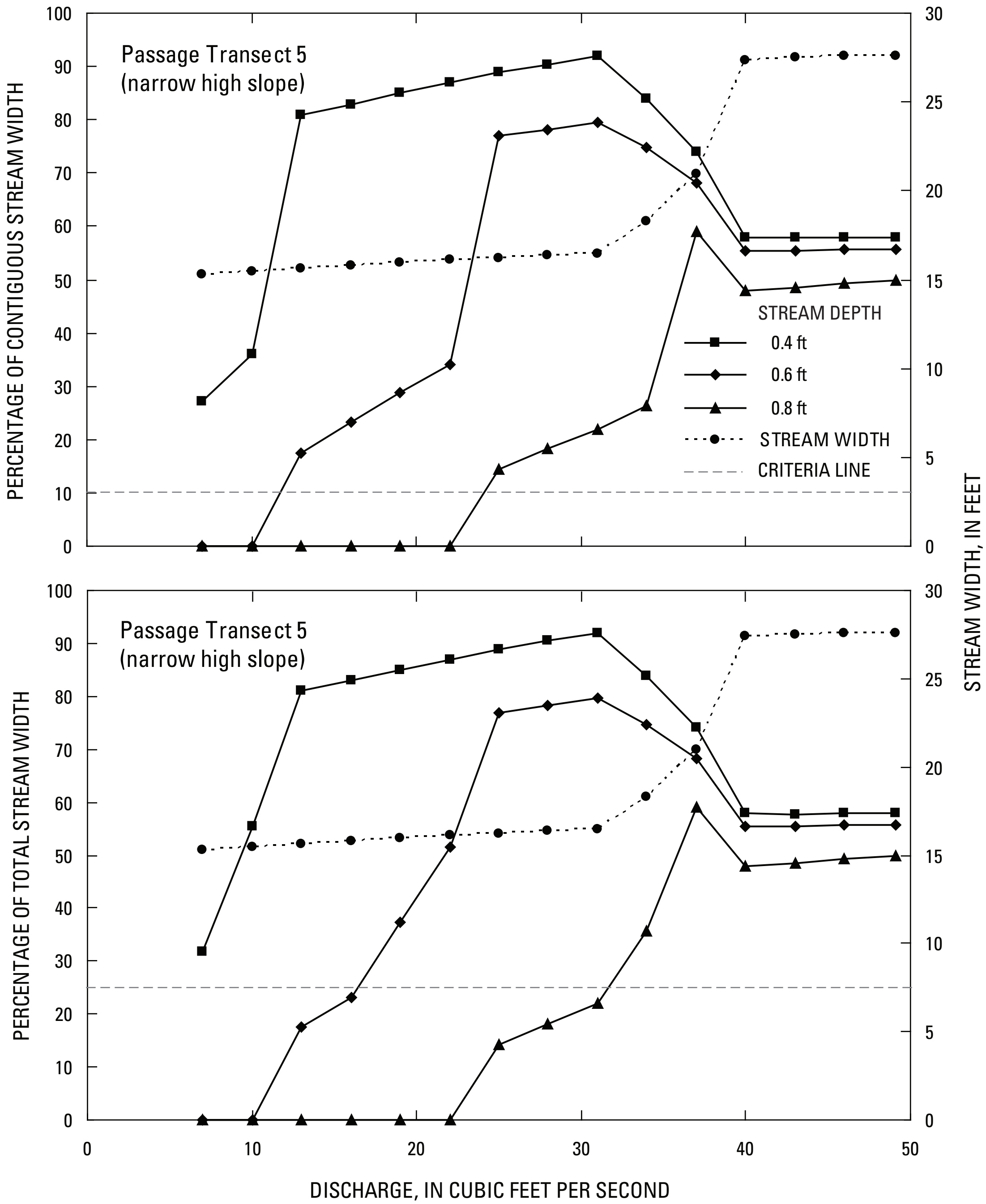


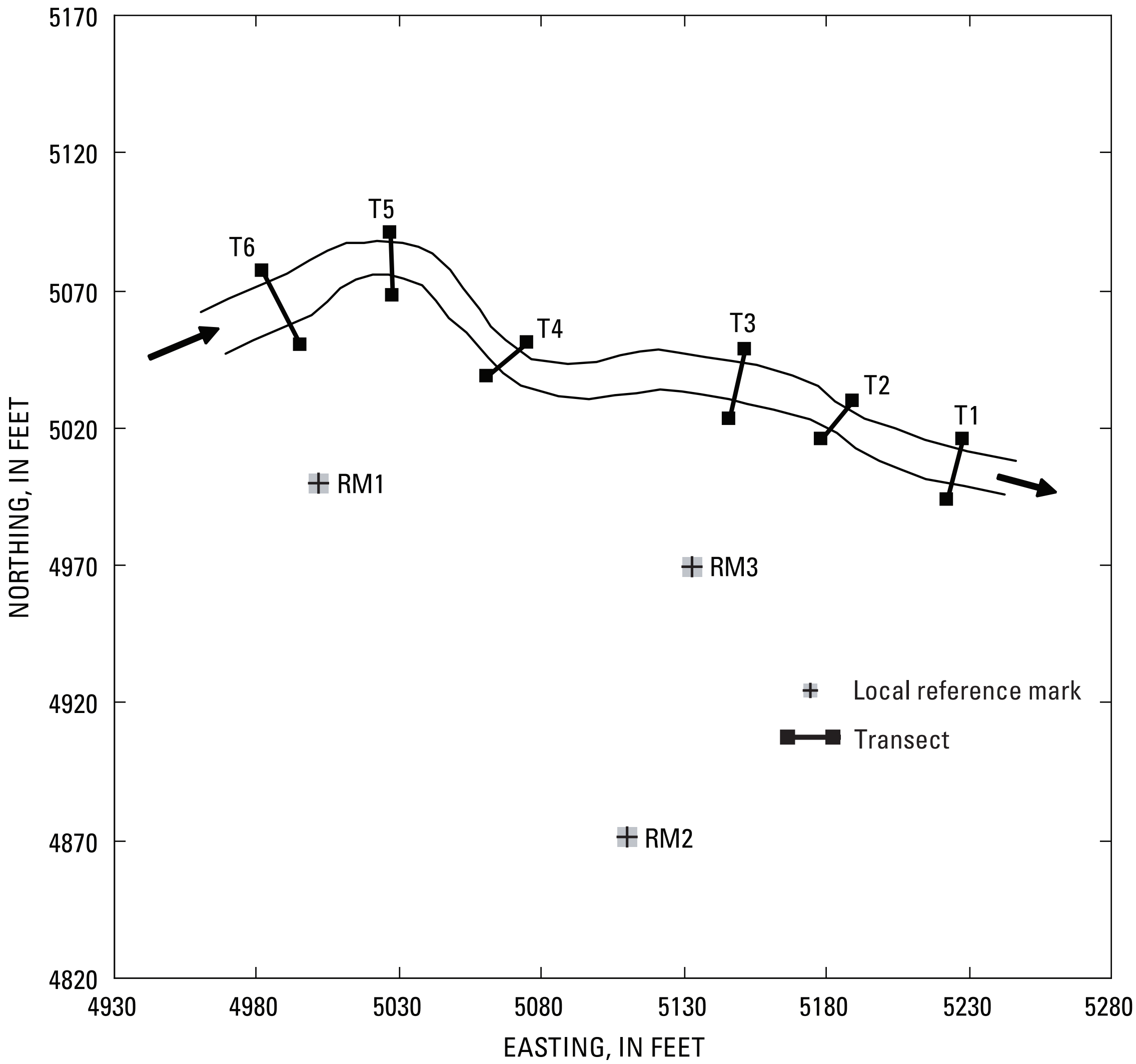

**Figure B5.** Percentages of contiguous and total stream width for passage transect 5, upper Challis Creek (CH4), upper Salmon River Basin, Idaho, 2005.

**Table B4.** Passage criteria assessment for transect 5 (narrow high slope), site CH4, upper Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 7.0 | 15.3 | 4.8 | 31.7 | 4.2 | 27.3 |
| 10 | 15.5 | 8.6 | 55.4 | 5.6 | 36.0 |
| 13 | 15.6 | 12.7 | 81.0 | 12.7 | 81.0 |
| 16 | 15.8 | 13.1 | 82.9 | 13.1 | 82.9 |
| 19 | 16.0 | 13.6 | 85.0 | 13.6 | 85.0 |
| 22 | 16.1 | 14.0 | 87.0 | 14.0 | 87.0 |
| 25 | 16.2 | 14.4 | 88.8 | 14.4 | 88.8 |
| 28 | 16.3 | 14.8 | 90.4 | 14.8 | 90.4 |
| 31 | 16.5 | 15.1 | 92.0 | 15.1 | 92.0 |
| 34 | 18.3 | 15.4 | 84.0 | 15.4 | 84.0 |
| 37 | 21.0 | 15.5 | 74.1 | 15.5 | 74.1 |
| 40 | 27.4 | 15.8 | 57.8 | 15.8 | 57.8 |
| 43 | 27.5 | 15.9 | 57.8 | 15.9 | 57.8 |
| 46 | 27.6 | 16.0 | 57.9 | 16.0 | 57.9 |
| 49.1 | 27.6 | 16.0 | 58.0 | 16.0 | 58.0 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 7.0 | 15.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 15.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 15.6 | 2.7 | 17.5 | 2.7 | 17.5 |
| 16 | 15.8 | 3.7 | 23.2 | 3.7 | 23.2 |
| 19 | 16.0 | 6.0 | 37.4 | 4.6 | 28.7 |
| 22 | 16.1 | 8.3 | 51.5 | 5.5 | 34.0 |
| 25 | 16.2 | 12.5 | 76.9 | 12.5 | 76.9 |
| 28 | 16.3 | 12.8 | 78.2 | 12.8 | 78.2 |
| 31 | 16.5 | 13.1 | 79.6 | 13.1 | 79.6 |
| 34 | 18.3 | 13.7 | 74.8 | 13.7 | 74.8 |
| 37 | 21.0 | 14.3 | 68.2 | 14.3 | 68.2 |
| 40 | 27.4 | 15.2 | 55.5 | 15.2 | 55.5 |
| 43 | 27.5 | 15.3 | 55.5 | 15.3 | 55.5 |
| 46 | 27.6 | 15.3 | 55.6 | 15.3 | 55.6 |
| 49.1 | 27.6 | 15.4 | 55.7 | 15.4 | 55.7 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 7.0 | 15.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 15.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 15.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 15.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19 | 16.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 16.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | 16.2 | 2.3 | 14.3 | 2.3 | 14.3 |
| 28 | 16.3 | 3.0 | 18.2 | 3.0 | 18.2 |
| 31 | 16.5 | 3.6 | 22.0 | 3.6 | 22.0 |
| 34 | 18.3 | 6.5 | 35.7 | 4.8 | 26.2 |
| 37 | 21.0 | 12.4 | 59.0 | 12.4 | 59.0 |
| 40 | 27.4 | 13.1 | 48.0 | 13.1 | 48.0 |
| 43 | 27.5 | 13.4 | 48.6 | 13.4 | 48.6 |
| 46 | 27.6 | 13.6 | 49.2 | 13.6 | 49.2 |
| 49.1 | 27.6 | 13.8 | 49.8 | 13.8 | 49.8 |

**Appendix C.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for lower Bear Creek, upper Salmon River Basin, Idaho, 2005.




Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH1 | 44° 34' 11.08" N | 114° 21' 49.32" W |
| LH1 | 44° 34' 10.89" N | 114° 21' 49.46" W |
| RH2 | 44° 34' 11.31" N | 114° 21' 49.76" W |
| LH2 | 44° 34' 11.2" N | 114° 21' 49.98" W |
| RH3 | 44° 34' 11.59" N | 114° 21' 50.2" W |
| LH3 | 44° 34' 11.37" N | 114° 21' 50.39" W |

Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH4 | 44° 34' 11.81" N | 114° 21' 51.22" W |
| LH4 | 44° 34' 11.72" N | 114° 21' 51.47" W |
| RH5 | 44° 34' 12.3" N | 114° 21' 51.74" W |
| LH5 | 44° 34' 12.1" N | 114° 21' 51.8" W |
| RH6 | 44° 34' 12.29" N | 114° 21' 52.37" W |
| LH6 | 44° 34' 12" N | 114° 21' 52.29" W |

For reference only; stream schematic not to scale.

**Figure C1.** Plan view of lower Bear Creek (BE1), upper Salmon River Basin, Idaho, 2005.

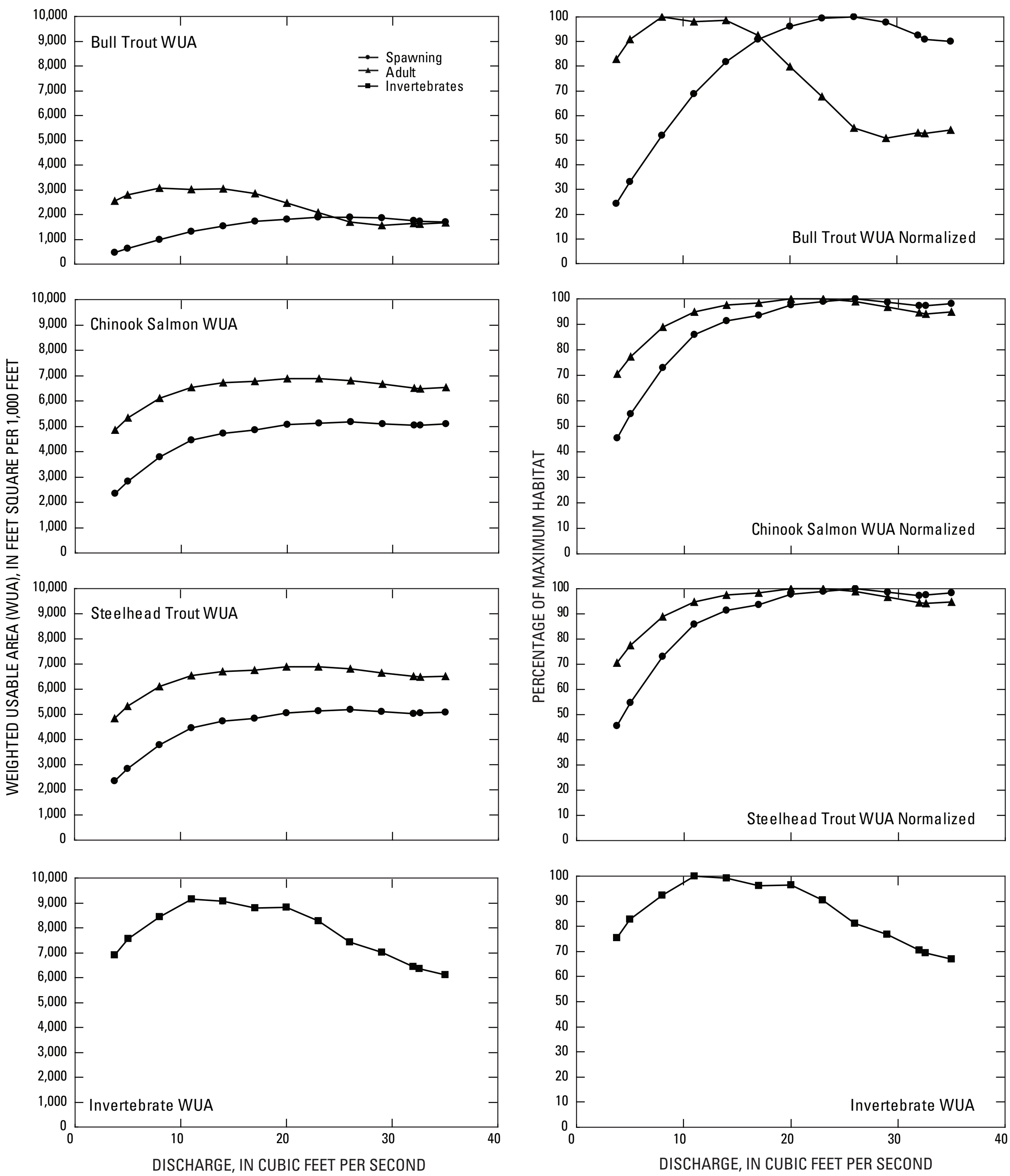



**Figure C2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, lower Bear Creek (BE1), upper Salmon River Basin, Idaho, 2005.

**Table C1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site BE1, lower Bear Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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) Adult | Summary of WUA ($ft^2/1,000$ ft) Spawning | Percentage of maximum habitat Adult | Percentage of maximum habitat Spawning |
|---|---|---|---|---|---|
| Bull trout | | | | | |
| 3.8 | 12,567 | 2,557 | 461 | 83.0 | 24.4 |
| 5 | 12,916 | 2,802 | 629 | 90.9 | 33.3 |
| 8 | 13,542 | 3,081 | 983 | 100.0 | 52.0 |
| 11 | 13,917 | 3,026 | 1,302 | 98.2 | 68.9 |
| 14 | 14,225 | 3,039 | 1,547 | 98.6 | 81.9 |
| 17 | 14,486 | 2,850 | 1,715 | 92.5 | 90.8 |
| 20 | 14,697 | 2,457 | 1,818 | 79.7 | 96.2 |
| 23 | 14,873 | 2,081 | 1,878 | 67.5 | 99.4 |
| 26 | 15,035 | 1,695 | 1,890 | 55.0 | 100.0 |
| 29 | 15,182 | 1,568 | 1,850 | 50.9 | 97.9 |
| 32 | 15,328 | 1,638 | 1,750 | 53.2 | 92.6 |
| 32.600 | 15,364 | 1,627 | 1,719 | 52.8 | 91.0 |
| 35 | 15,490 | 1,672 | 1,700 | 54.3 | 89.9 |
| Chinook salmon | | | | | |
| 3.8 | 12,567 | 4,850 | 2,357 | 70.5 | 45.5 |
| 5 | 12,916 | 5,325 | 2,839 | 77.4 | 54.8 |
| 8 | 13,542 | 6,116 | 3,776 | 88.9 | 73.0 |
| 11 | 13,917 | 6,528 | 4,450 | 94.9 | 86.0 |
| 14 | 14,225 | 6,716 | 4,730 | 97.6 | 91.4 |
| 17 | 14,486 | 6,767 | 4,843 | 98.3 | 93.6 |
| 20 | 14,697 | 6,881 | 5,054 | 100.0 | 97.6 |
| 23 | 14,873 | 6,882 | 5,125 | 100.0 | 99.0 |
| 26 | 15,035 | 6,800 | 5,176 | 98.8 | 100.0 |
| 29 | 15,182 | 6,661 | 5,105 | 96.8 | 98.6 |
| 32 | 15,328 | 6,509 | 5,036 | 94.6 | 97.3 |
| 32.600 | 15,364 | 6,482 | 5,041 | 94.2 | 97.4 |
| 35 | 15,490 | 6,523 | 5,083 | 94.8 | 98.2 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2/1,000$ ft) Adult | Summary of WUA ($ft^2/1,000$ ft) Spawning | Percentage of maximum habitat Adult | Percentage of maximum habitat Spawning |
|---|---|---|---|---|---|
| Steelhead trout | | | | | |
| 3.8 | 12,567 | 4,850 | 2,357 | 70.5 | 45.5 |
| 5 | 12,916 | 5,325 | 2,839 | 77.4 | 54.8 |
| 8 | 13,542 | 6,116 | 3,776 | 88.9 | 73.0 |
| 11 | 13,917 | 6,528 | 4,450 | 94.9 | 86.0 |
| 14 | 14,225 | 6,716 | 4,730 | 97.6 | 91.4 |
| 17 | 14,486 | 6,767 | 4,843 | 98.3 | 93.6 |
| 20 | 14,697 | 6,881 | 5,054 | 100.0 | 97.6 |
| 23 | 14,873 | 6,882 | 5,125 | 100.0 | 99.0 |
| 26 | 15,035 | 6,800 | 5,176 | 98.8 | 100.0 |
| 29 | 15,182 | 6,661 | 5,105 | 96.8 | 98.6 |
| 32 | 15,328 | 6,509 | 5,036 | 94.6 | 97.3 |
| 32.600 | 15,364 | 6,482 | 5,041 | 94.2 | 97.4 |
| 35 | 15,490 | 6,523 | 5,083 | 94.8 | 98.2 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2/1,000$ ft) | Percentage of maximum habitat |
|---|---|---|---|
| EPT Invertebrates | | | |
| 5 | 12,916 | 7,567 | 82.8 |
| 8 | 13,542 | 8,451 | 92.5 |
| 11 | 13,917 | 9,140 | 100.0 |
| 14 | 14,225 | 9,059 | 99.1 |
| 17 | 14,486 | 8,792 | 96.2 |
| 20 | 14,697 | 8,810 | 96.4 |
| 23 | 14,873 | 8,262 | 90.4 |
| 26 | 15,035 | 7,416 | 81.1 |
| 29 | 15,182 | 7,010 | 76.7 |
| 32 | 15,328 | 6,432 | 70.4 |
| 32.600 | 15,364 | 6,351 | 69.5 |
| 35 | 15,490 | 6,114 | 66.9 |

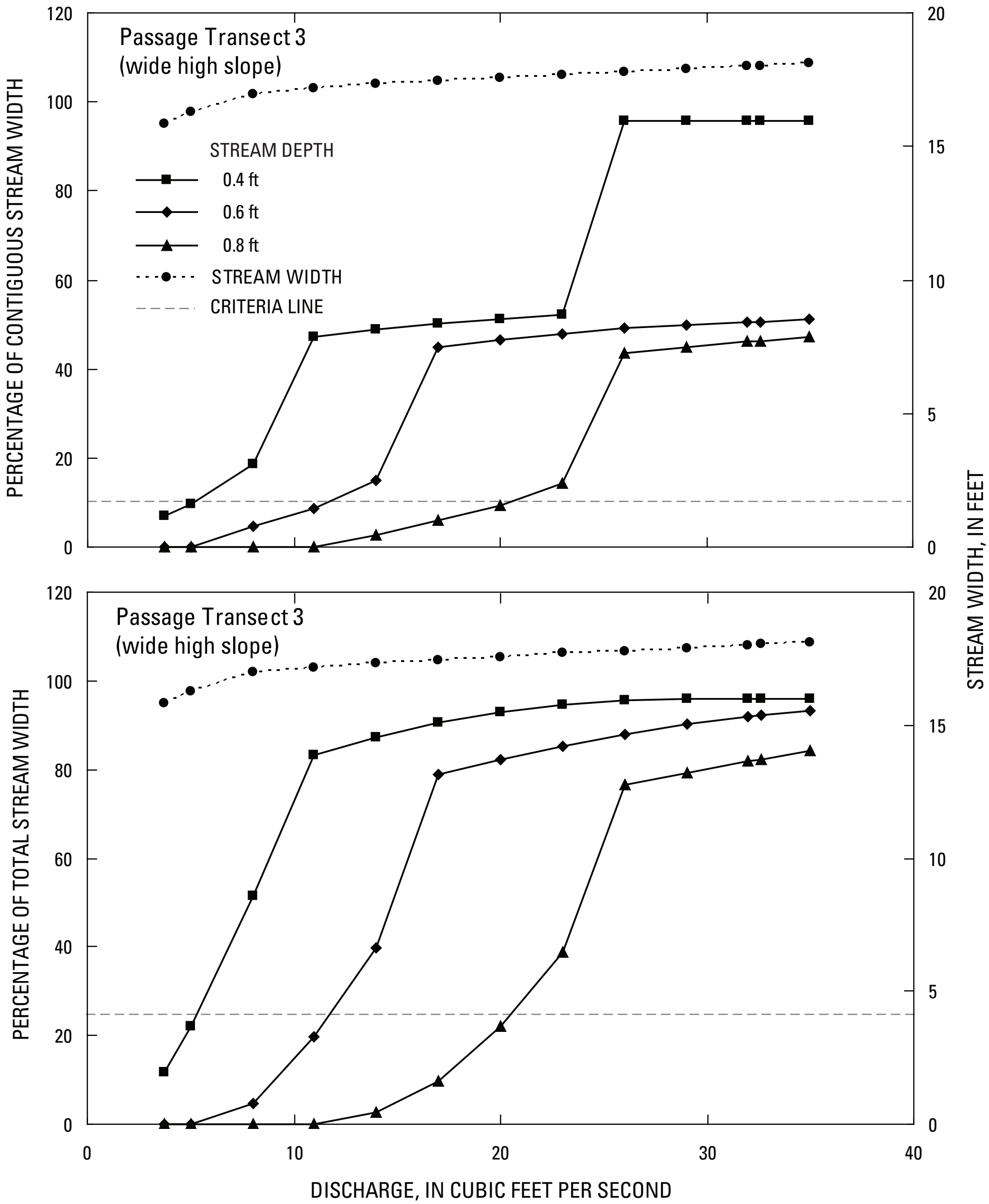



**Figure C3.** Percentages of contiguous and total stream width for passage transect 3, lower Bear Creek (BE1), upper Salmon River Basin, Idaho, 2005.

**Table C2.** Passage criteria assessment for transect 3 (wide high slope), site BE1, lower Bear Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 3.8 | 15.8 | 1.8 | 11.6 | 1.1 | 7.0 |
| 5 | 16.3 | 3.6 | 22.1 | 1.6 | 9.6 |
| 8 | 17.0 | 8.7 | 51.5 | 3.2 | 18.6 |
| 11 | 17.2 | 14.3 | 83.3 | 8.1 | 47.1 |
| 14 | 17.3 | 15.1 | 87.2 | 8.5 | 48.9 |
| 17 | 17.4 | 15.8 | 90.5 | 8.8 | 50.4 |
| 20 | 17.6 | 16.4 | 93.1 | 9.0 | 51.2 |
| 23 | 17.7 | 16.7 | 94.7 | 9.2 | 52.1 |
| 26 | 17.8 | 17.0 | 95.8 | 17.0 | 95.8 |
| 29 | 17.9 | 17.1 | 95.8 | 17.1 | 95.8 |
| 32 | 18.0 | 17.2 | 95.8 | 17.2 | 95.8 |
| 33 | 18.0 | 17.3 | 95.8 | 17.3 | 95.8 |
| 35 | 18.1 | 17.3 | 95.8 | 17.3 | 95.8 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 3.8 | 15.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 16.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 17.0 | 0.8 | 4.6 | 0.8 | 4.6 |
| 11 | 17.2 | 3.4 | 19.7 | 1.5 | 8.8 |
| 14 | 17.3 | 6.9 | 39.7 | 2.6 | 14.8 |
| 17 | 17.4 | 13.8 | 78.9 | 7.8 | 44.9 |
| 20 | 17.6 | 14.4 | 82.2 | 8.2 | 46.4 |
| 23 | 17.7 | 15.1 | 85.3 | 8.5 | 47.9 |
| 26 | 17.8 | 15.7 | 88.0 | 8.7 | 49.1 |
| 29 | 17.9 | 16.2 | 90.2 | 8.9 | 49.8 |
| 32 | 18.0 | 16.5 | 91.9 | 9.1 | 50.5 |
| 33 | 18.0 | 16.6 | 92.2 | 9.1 | 50.7 |
| 35 | 18.1 | 16.9 | 93.1 | 9.3 | 51.2 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 3.8 | 15.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 16.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 17.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 17.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14 | 17.3 | 0.5 | 2.7 | 0.5 | 2.7 |
| 17 | 17.4 | 1.7 | 9.8 | 1.1 | 6.1 |
| 20 | 17.6 | 3.8 | 21.9 | 1.6 | 9.2 |
| 23 | 17.7 | 6.9 | 38.7 | 2.6 | 14.5 |
| 26 | 17.8 | 13.6 | 76.5 | 7.8 | 43.6 |
| 29 | 17.9 | 14.2 | 79.3 | 8.0 | 44.9 |
| 32 | 18.0 | 14.7 | 81.9 | 8.3 | 46.1 |
| 33 | 18.0 | 14.8 | 82.4 | 8.3 | 46.3 |
| 35 | 18.1 | 15.3 | 84.4 | 8.6 | 47.3 |

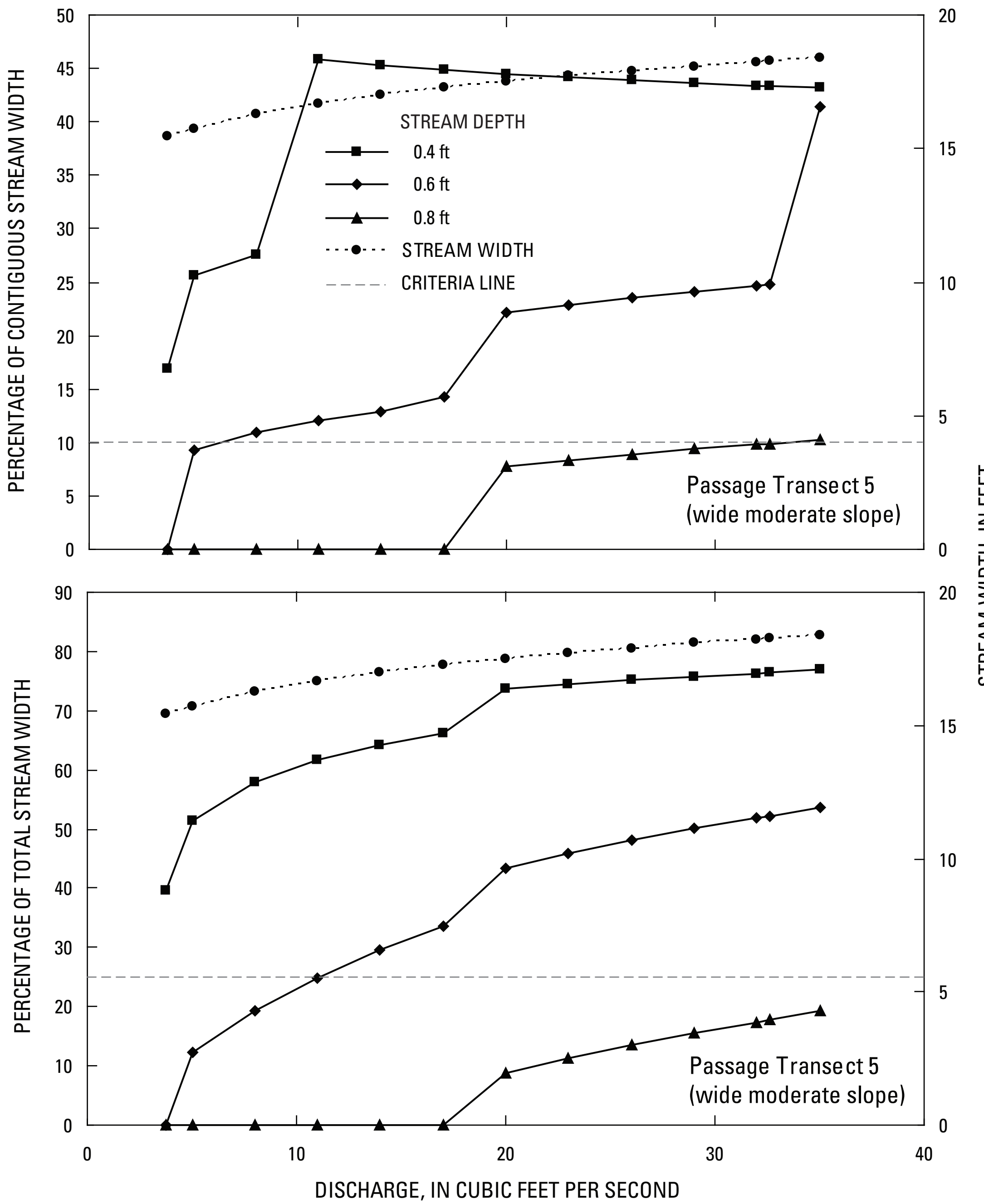



**Figure C4.** Percentages of contiguous and total stream width for passage transect 5, lower Bear Creek (BE1), upper Salmon River Basin, Idaho, 2005.

**Table C3.** Passage criteria assessment for transect 5 (wide moderate slope), site BE1, lower Bear Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 3.8 | 15.4 | 6.1 | 39.7 | 2.6 | 16.8 |
| 5 | 15.7 | 8.1 | 51.3 | 4.0 | 25.7 |
| 8 | 16.3 | 9.4 | 57.9 | 4.5 | 27.5 |
| 11 | 16.7 | 10.3 | 61.7 | 7.6 | 45.9 |
| 14 | 17.0 | 10.9 | 64.1 | 7.7 | 45.3 |
| 17 | 17.3 | 11.4 | 66.2 | 7.7 | 44.9 |
| 20 | 17.5 | 12.9 | 73.8 | 7.8 | 44.5 |
| 23 | 17.7 | 13.2 | 74.5 | 7.8 | 44.2 |
| 26 | 17.9 | 13.5 | 75.2 | 7.9 | 43.9 |
| 29 | 18.1 | 13.7 | 75.8 | 7.9 | 43.6 |
| 32 | 18.2 | 13.9 | 76.3 | 7.9 | 43.4 |
| 33 | 18.3 | 14.0 | 76.4 | 7.9 | 43.4 |
| 35 | 18.4 | 14.1 | 76.9 | 7.9 | 43.2 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 3.8 | 15.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 15.7 | 2 | 12.4 | 1.5 | 9.3 |
| 8 | 16.3 | 3 | 19.3 | 1.8 | 10.9 |
| 11 | 16.7 | 4 | 24.9 | 2.0 | 12.1 |
| 14 | 17.0 | 5 | 29.6 | 2.2 | 12.9 |
| 17 | 17.3 | 6 | 33.5 | 2.5 | 14.3 |
| 20 | 17.5 | 8 | 43.4 | 3.9 | 22.2 |
| 23 | 17.7 | 8 | 45.8 | 4.1 | 22.9 |
| 26 | 17.9 | 9 | 48.1 | 4.2 | 23.5 |
| 29 | 18.1 | 9 | 50.1 | 4.4 | 24.1 |
| 32 | 18.2 | 9 | 51.8 | 4.5 | 24.6 |
| 33 | 18.3 | 10 | 52.3 | 4.5 | 24.7 |
| 35 | 18.4 | 10 | 53.6 | 7.6 | 41.4 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 3.8 | 15.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 15.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 16.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 16.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14 | 17.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 17.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 20 | 17.5 | 1.5 | 8.8 | 1.4 | 7.8 |
| 23 | 17.7 | 2.0 | 11.2 | 1.5 | 8.4 |
| 26 | 17.9 | 2.4 | 13.5 | 1.6 | 8.9 |
| 29 | 18.1 | 2.8 | 15.5 | 1.7 | 9.4 |
| 32 | 18.2 | 3.2 | 17.3 | 1.8 | 9.8 |
| 33 | 18.3 | 3.2 | 17.8 | 1.8 | 9.9 |
| 35 | 18.4 | 3.6 | 19.3 | 1.9 | 10.2 |

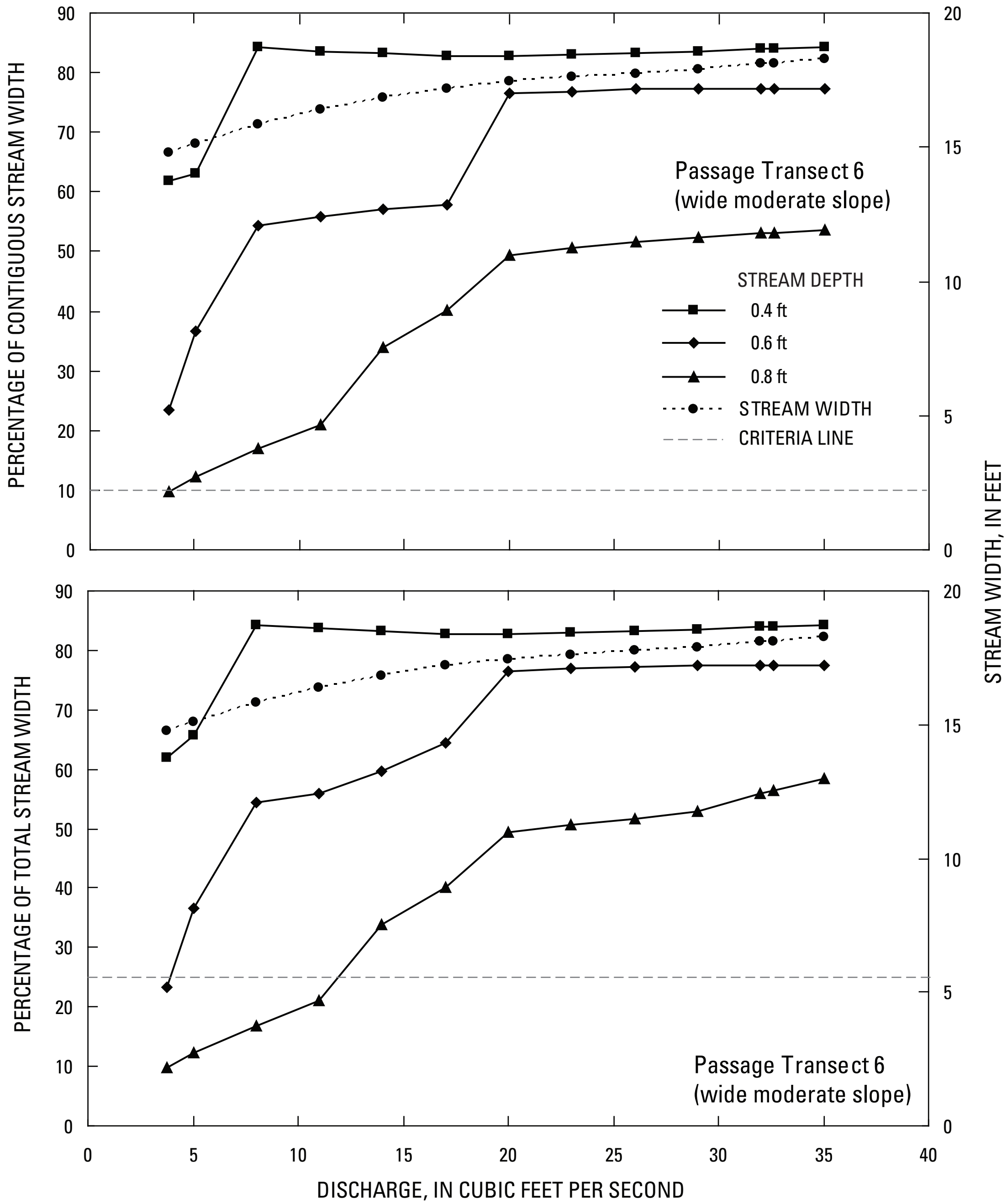


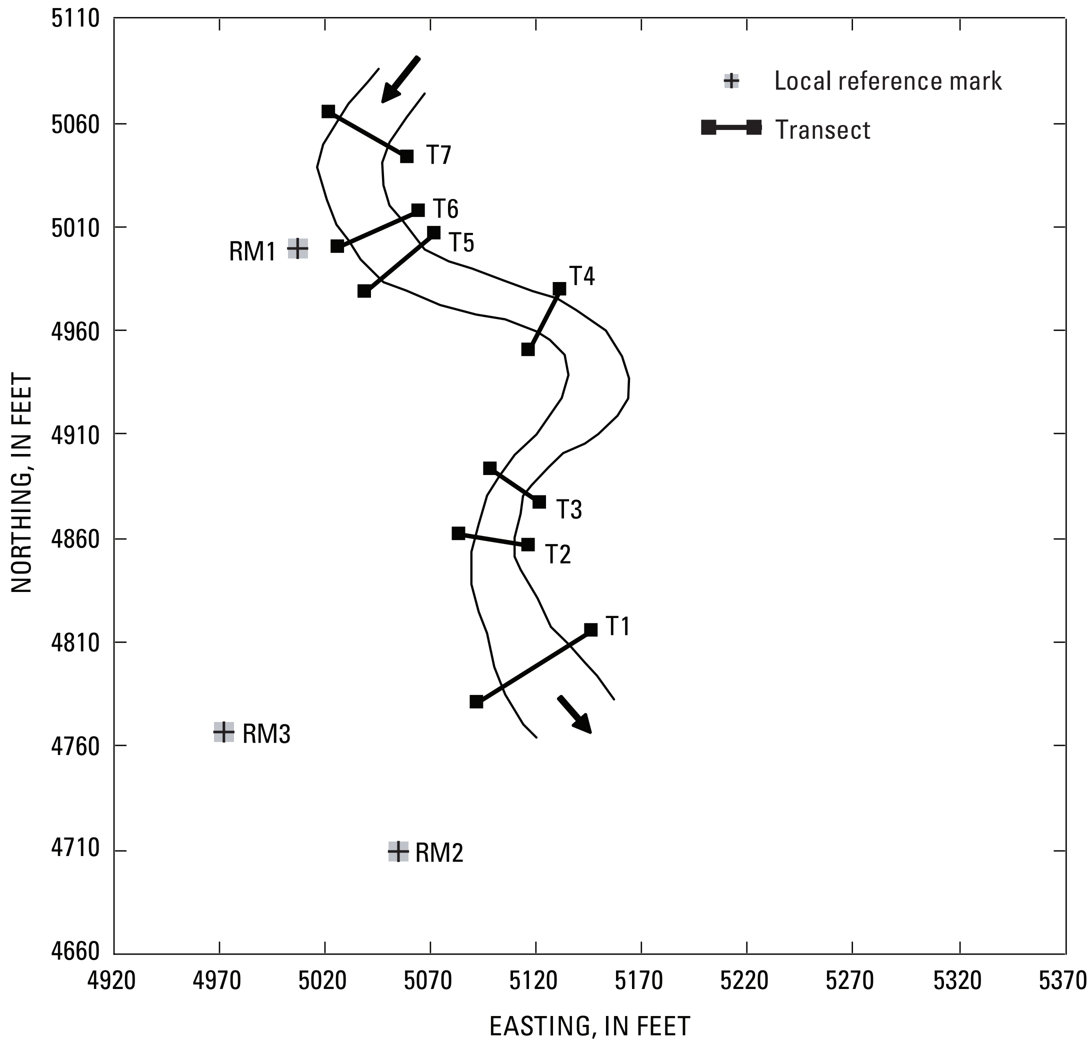

**Figure C5.** Percentages of contiguous and total stream width for passage transect 6, lower Bear Creek (BE1), upper Salmon River Basin, Idaho, 2005.

**Table C4.** Passage criteria assessment for transect 6 (wide moderate slope), site BE1, lower Bear Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 3.8 | 14.8 | 9.2 | 61.9 | 9.2 | 61.9 | 3.8 | 14.8 | 1.4 | 9.7 | 1.4 | 9.7 |
| 5 | 15.1 | 9.9 | 65.6 | 9.5 | 63.1 | 5 | 15.1 | 1.8 | 12.2 | 1.8 | 12.2 |
| 8 | 15.8 | 13.3 | 84.2 | 13.3 | 84.2 | 8 | 15.8 | 2.7 | 16.9 | 2.7 | 16.9 |
| 11 | 16.4 | 13.7 | 83.6 | 13.7 | 83.6 | 11 | 16.4 | 3.4 | 21.0 | 3.4 | 21.0 |
| 14 | 16.8 | 14.0 | 83.1 | 14.0 | 83.1 | 14 | 16.8 | 5.7 | 33.8 | 5.7 | 33.8 |
| 17 | 17.2 | 14.2 | 82.8 | 14.2 | 82.8 | 17 | 17.2 | 6.9 | 40.1 | 6.9 | 40.1 |
| 20 | 17.5 | 14.4 | 82.7 | 14.4 | 82.7 | 20 | 17.5 | 8.6 | 49.4 | 8.6 | 49.4 |
| 23 | 17.6 | 14.6 | 83.1 | 14.6 | 83.1 | 23 | 17.6 | 8.9 | 50.6 | 8.9 | 50.6 |
| 26 | 17.7 | 14.8 | 83.3 | 14.8 | 83.3 | 26 | 17.7 | 9.2 | 51.6 | 9.2 | 51.6 |
| 29 | 17.9 | 15.0 | 83.6 | 15.0 | 83.6 | 29 | 17.9 | 9.5 | 53.0 | 9.4 | 52.4 |
| 32 | 18.1 | 15.2 | 83.9 | 15.2 | 83.9 | 32 | 18.1 | 10.1 | 55.8 | 9.6 | 53.1 |
| 33 | 18.1 | 15.2 | 84.0 | 15.2 | 84.0 | 33 | 18.1 | 10.2 | 56.4 | 9.6 | 53.2 |
| 35 | 18.3 | 15.4 | 84.3 | 15.4 | 84.3 | 35 | 18.3 | 10.7 | 58.4 | 9.8 | 53.7 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 3.8 | 14.8 | 3.5 | 23.4 | 3.5 | 23.4 | | | | | | |
| 5 | 15.1 | 6 | 36.5 | 5.5 | 36.5 | | | | | | |
| 8 | 15.8 | 9 | 54.4 | 8.6 | 54.4 | | | | | | |
| 11 | 16.4 | 9 | 55.8 | 9.1 | 55.8 | | | | | | |
| 14 | 16.8 | 10 | 59.8 | 9.6 | 57.0 | | | | | | |
| 17 | 17.2 | 11 | 64.3 | 10.0 | 57.9 | | | | | | |
| 20 | 17.5 | 13 | 76.5 | 13.4 | 76.5 | | | | | | |
| 23 | 17.6 | 14 | 76.9 | 13.5 | 76.9 | | | | | | |
| 26 | 17.7 | 14 | 77.2 | 13.7 | 77.2 | | | | | | |
| 29 | 17.9 | 14 | 77.4 | 13.8 | 77.4 | | | | | | |
| 32 | 18.1 | 14 | 77.4 | 14.0 | 77.4 | | | | | | |
| 33 | 18.1 | 14 | 77.4 | 14.0 | 77.4 | | | | | | |
| 35 | 18.3 | 14 | 77.4 | 14.1 | 77.4 | | | | | | |

**Appendix D.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for upper middle Challis Creek (CH3), upper Salmon River Basin, Idaho, 2005.




Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH1 | 44° 34' 14.69" N | 114° 18' 11.52" W |
| LH1 | 44° 34' 14.33" N | 114° 18' 12.23" W |
| RH2 | 44° 34' 15.09" N | 114° 18' 11.96" W |
| LH2 | 44° 34' 15.12" N | 114° 18' 12.43" W |
| RH3 | 44° 34' 15.29" N | 114° 18' 11.9" W |
| LH3 | 44° 34' 15.45" N | 114° 18' 12.23" W |
| RH4 | 44° 34' 16.31" N | 114° 18' 11.82" W |

Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| LH4 | 44° 34' 16.02" N | 114° 18' 12.01" W |
| RH5 | 44° 34' 16.54" N | 114° 18' 12.67" W |
| LH5 | 44° 34' 16.26" N | 114° 18' 13.11" W |
| RH6 | 44° 34' 16.64" N | 114° 18' 12.78" W |
| LH6 | 44° 34' 16.46" N | 114° 18' 13.3" W |
| RH7 | 44° 34' 16.9" N | 114° 18' 12.86" W |
| LH7 | 44° 34' 17.09" N | 114° 18' 13.41" W |

For reference only; stream schematic not to scale.

**Figure D1.** Plan view of upper middle Challis Creek (CH3), upper Salmon River Basin, Idaho, 2005.

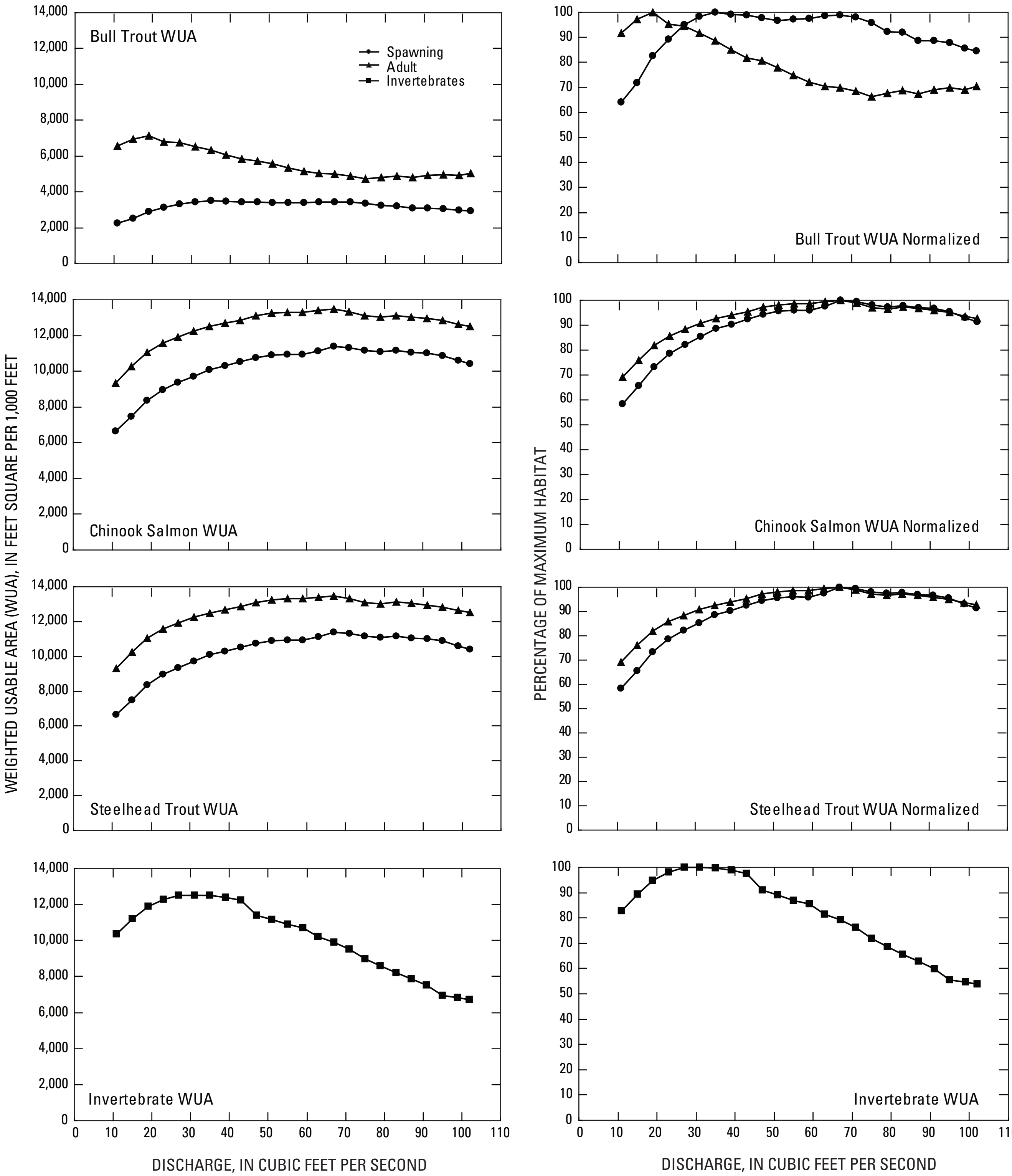



**Figure D2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, upper middle Challis Creek (CH3), upper Salmon River Basin, Idaho, 2005.

**Table D1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site CH3, upper middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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** | | | | | |
| 10.9 | 20,178 | 6,544 | 2,236 | 91.8 | 64.0 |
| 15 | 20,724 | 6,938 | 2,509 | 97.3 | 71.9 |
| 19 | 21,146 | 7,128 | 2,881 | 100.0 | 82.5 |
| 23 | 21,528 | 6,786 | 3,115 | 95.2 | 89.2 |
| 27 | 21,880 | 6,735 | 3,323 | 94.5 | 95.1 |
| 31 | 22,212 | 6,542 | 3,435 | 91.8 | 98.4 |
| 35 | 22,513 | 6,326 | 3,492 | 88.8 | 100.0 |
| 39 | 22,797 | 6,056 | 3,463 | 85.0 | 99.2 |
| 43 | 23,093 | 5,821 | 3,451 | 81.7 | 98.8 |
| 47 | 23,555 | 5,741 | 3,419 | 80.5 | 97.9 |
| 51 | 23,999 | 5,555 | 3,379 | 77.9 | 96.8 |
| 55 | 24,295 | 5,327 | 3,393 | 74.7 | 97.2 |
| 59 | 24,624 | 5,132 | 3,402 | 72.0 | 97.4 |
| 63 | 24,937 | 5,021 | 3,446 | 70.4 | 98.7 |
| 67 | 25,221 | 4,988 | 3,451 | 70.0 | 98.8 |
| 71 | 25,529 | 4,891 | 3,420 | 68.6 | 98.0 |
| 75 | 25,897 | 4,724 | 3,352 | 66.3 | 96.0 |
| 79 | 26,260 | 4,816 | 3,225 | 67.6 | 92.4 |
| 83 | 26,531 | 4,900 | 3,213 | 68.7 | 92.0 |
| 87 | 26,818 | 4,796 | 3,100 | 67.3 | 88.8 |
| 91 | 27,084 | 4,917 | 3,097 | 69.0 | 88.7 |
| 95 | 27,360 | 4,973 | 3,068 | 69.8 | 87.9 |
| 99 | 27,642 | 4,931 | 2,993 | 69.2 | 85.7 |
| 102 | 27,849 | 5,030 | 2,949 | 70.6 | 84.4 |
| **Chinook salmon** | | | | | |
| 10.9 | 20,178 | 9,322 | 6,657 | 69.1 | 58.4 |
| 15 | 20,724 | 10,254 | 7,478 | 76.0 | 65.7 |
| 19 | 21,146 | 11,042 | 8,353 | 81.9 | 73.3 |
| 23 | 21,528 | 11,567 | 8,958 | 85.8 | 78.6 |
| 27 | 21,880 | 11,916 | 9,361 | 88.3 | 82.2 |
| 31 | 22,212 | 12,246 | 9,725 | 90.8 | 85.4 |
| 35 | 22,513 | 12,493 | 10,089 | 92.6 | 88.6 |
| 39 | 22,797 | 12,677 | 10,294 | 94.0 | 90.4 |
| 43 | 23,093 | 12,858 | 10,521 | 95.3 | 92.4 |
| 47 | 23,555 | 13,110 | 10,752 | 97.2 | 94.4 |
| 51 | 23,999 | 13,243 | 10,887 | 98.2 | 95.6 |
| 55 | 24,295 | 13,308 | 10,942 | 98.7 | 96.1 |
| 59 | 24,624 | 13,301 | 10,924 | 98.6 | 95.9 |
| 63 | 24,937 | 13,401 | 11,111 | 99.4 | 97.6 |
| 67 | 25,221 | 13,489 | 11,390 | 100.0 | 100.0 |
| 71 | 25,529 | 13,337 | 11,314 | 98.9 | 99.3 |
| 75 | 25,897 | 13,104 | 11,160 | 97.1 | 98.0 |
| 79 | 26,260 | 13,027 | 11,094 | 96.6 | 97.4 |
| 83 | 26,531 | 13,117 | 11,150 | 97.2 | 97.9 |
| 87 | 26,818 | 13,042 | 11,051 | 96.7 | 97.0 |
| 91 | 27,084 | 12,937 | 11,013 | 95.9 | 96.7 |
| 95 | 27,360 | 12,828 | 10,879 | 95.1 | 95.5 |
| 99 | 27,642 | 12,620 | 10,589 | 93.6 | 93.0 |
| 102 | 27,849 | 12,513 | 10,401 | 92.8 | 91.3 |

| 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** | | | | | |
| 10.9 | 20,178 | 9,322 | 6,657 | 69.1 | 58.4 |
| 15 | 20,724 | 10,254 | 7,478 | 76.0 | 65.7 |
| 19 | 21,146 | 11,042 | 8,353 | 81.9 | 73.3 |
| 23 | 21,528 | 11,567 | 8,958 | 85.8 | 78.6 |
| 27 | 21,880 | 11,916 | 9,361 | 88.3 | 82.2 |
| 31 | 22,212 | 12,246 | 9,725 | 90.8 | 85.4 |
| 35 | 22,513 | 12,493 | 10,089 | 92.6 | 88.6 |
| 39 | 22,797 | 12,677 | 10,294 | 94.0 | 90.4 |
| 43 | 23,093 | 12,858 | 10,521 | 95.3 | 92.4 |
| 47 | 23,555 | 13,110 | 10,752 | 97.2 | 94.4 |
| 51 | 23,999 | 13,243 | 10,887 | 98.2 | 95.6 |
| 55 | 24,295 | 13,308 | 10,942 | 98.7 | 96.1 |
| 59 | 24,624 | 13,301 | 10,924 | 98.6 | 95.9 |
| 63 | 24,937 | 13,401 | 11,111 | 99.4 | 97.6 |
| 67 | 25,221 | 13,489 | 11,390 | 100.0 | 100.0 |
| 71 | 25,529 | 13,337 | 11,314 | 98.9 | 99.3 |
| 75 | 25,897 | 13,104 | 11,160 | 97.1 | 98.0 |
| 79 | 26,260 | 13,027 | 11,094 | 96.6 | 97.4 |
| 83 | 26,531 | 13,117 | 11,150 | 97.2 | 97.9 |
| 87 | 26,818 | 13,042 | 11,051 | 96.7 | 97.0 |
| 91 | 27,084 | 12,937 | 11,013 | 95.9 | 96.7 |
| 95 | 27,360 | 12,828 | 10,879 | 95.1 | 95.5 |
| 99 | 27,642 | 12,620 | 10,589 | 93.6 | 93.0 |
| 102 | 27,849 | 12,513 | 10,401 | 92.8 | 91.3 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2/1,000$ ft) | Percentage of maximum habitat |
|---|---|---|---|
| **EPT Invertebrates** | | | |
| 10.9 | 20,178 | 10,366 | 82.8 |
| 15 | 20,724 | 11,185 | 89.3 |
| 19 | 21,146 | 11,873 | 94.8 |
| 23 | 21,528 | 12,292 | 98.2 |
| 27 | 21,880 | 12,519 | 100.0 |
| 31 | 22,212 | 12,517 | 100.0 |
| 35 | 22,513 | 12,496 | 99.8 |
| 39 | 22,797 | 12,375 | 98.8 |
| 43 | 23,093 | 12,226 | 97.7 |
| 47 | 23,555 | 11,378 | 90.9 |
| 51 | 23,999 | 11,157 | 89.1 |
| 55 | 24,295 | 10,880 | 86.9 |
| 59 | 24,624 | 10,691 | 85.4 |
| 63 | 24,937 | 10,187 | 81.4 |
| 67 | 25,221 | 9,910 | 79.2 |
| 71 | 25,529 | 9,528 | 76.1 |
| 75 | 25,897 | 8,986 | 71.8 |
| 79 | 26,260 | 8,598 | 68.7 |
| 83 | 26,531 | 8,211 | 65.6 |
| 87 | 26,818 | 7,863 | 62.8 |
| 91 | 27,084 | 7,503 | 59.9 |
| 95 | 27,360 | 6,937 | 55.4 |
| 99 | 27,642 | 6,828 | 54.5 |
| 102 | 27,849 | 6,722 | 53.7 |

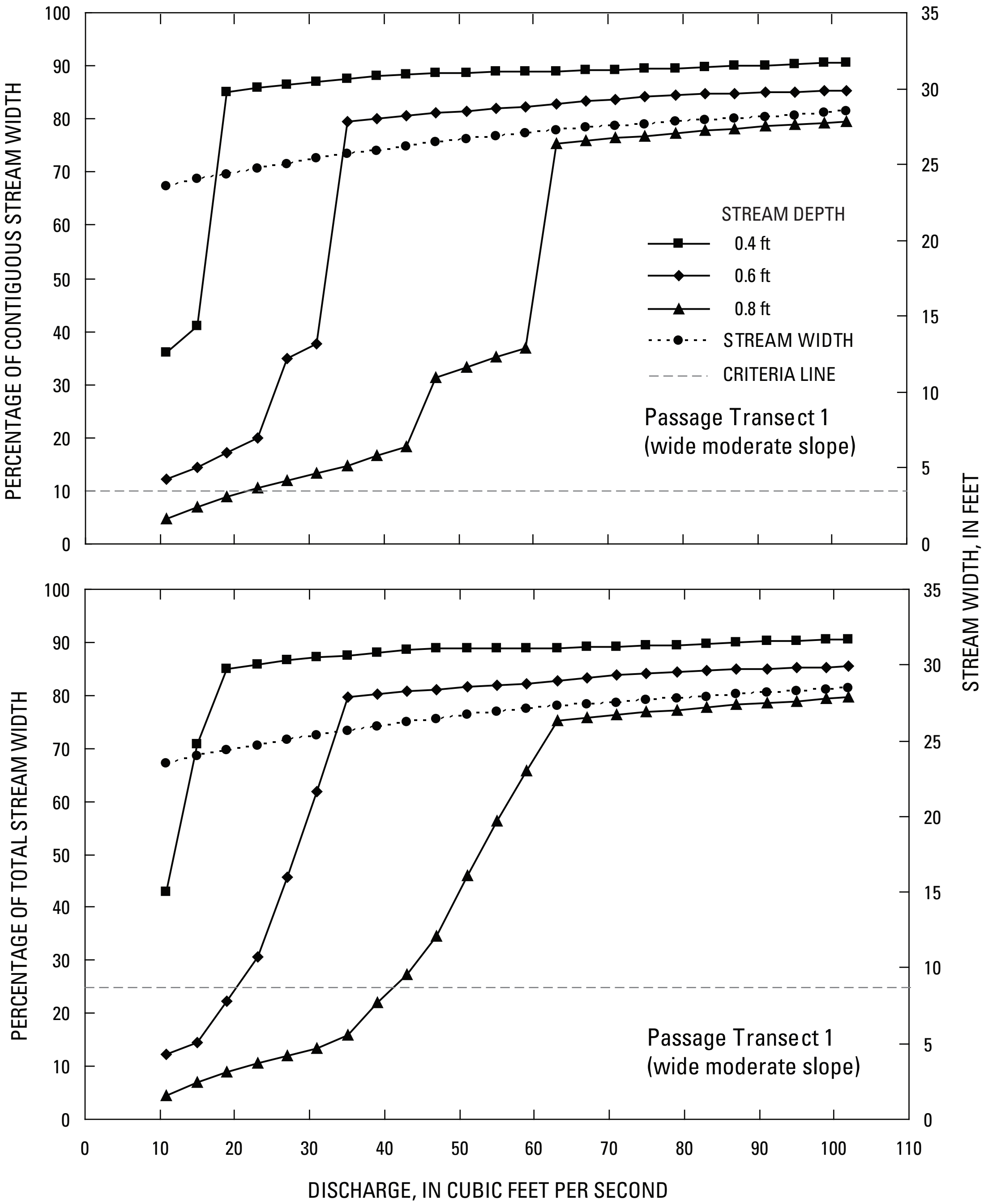



**Figure D3.** Percentages of contiguous and total stream width for passage transect 1, upper middle Challis Creek (CH3), upper Salmon River Basin, Idaho, 2005.

**Table D2.** Passage criteria assessment for transect 1 (wide moderate slope), site CH3, upper middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 10.9 | 23.5 | 10.1 | 42.9 | 8.5 | 36.0 |
| 15 | 24.0 | 17.0 | 70.7 | 9.8 | 41.0 |
| 19 | 24.4 | 20.7 | 85.0 | 20.7 | 85.0 |
| 23 | 24.7 | 21.2 | 85.9 | 21.2 | 85.9 |
| 27 | 25.0 | 21.7 | 86.5 | 21.7 | 86.5 |
| 31 | 25.4 | 22.1 | 87.1 | 22.1 | 87.1 |
| 35 | 25.6 | 22.5 | 87.6 | 22.5 | 87.6 |
| 39 | 25.9 | 22.8 | 88.1 | 22.8 | 88.1 |
| 43 | 26.2 | 23.2 | 88.5 | 23.2 | 88.5 |
| 47 | 26.4 | 23.5 | 88.7 | 23.5 | 88.7 |
| 51 | 26.7 | 23.7 | 88.8 | 23.7 | 88.8 |
| 55 | 26.9 | 23.9 | 88.8 | 23.9 | 88.8 |
| 59 | 27.1 | 24.1 | 88.8 | 24.1 | 88.8 |
| 63 | 27.3 | 24.2 | 89.0 | 24.2 | 89.0 |
| 67 | 27.4 | 24.4 | 89.1 | 24.4 | 89.1 |
| 71 | 27.5 | 24.6 | 89.2 | 24.6 | 89.2 |
| 75 | 27.7 | 24.7 | 89.4 | 24.7 | 89.4 |
| 79 | 27.8 | 24.9 | 89.6 | 24.9 | 89.6 |
| 83 | 27.9 | 25.1 | 89.8 | 25.1 | 89.8 |
| 87 | 28.0 | 25.2 | 90.0 | 25.2 | 90.0 |
| 91 | 28.2 | 25.4 | 90.2 | 25.4 | 90.2 |
| 95 | 28.3 | 25.5 | 90.3 | 25.5 | 90.3 |
| 99 | 28.4 | 25.7 | 90.5 | 25.7 | 90.5 |
| 102 | 28.5 | 25.8 | 90.7 | 25.8 | 90.7 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 10.9 | 23.5 | 2.9 | 12.2 | 2.9 | 12.2 |
| 15 | 24.0 | 3.5 | 14.5 | 3.5 | 14.5 |
| 19 | 24.4 | 5.4 | 22.2 | 4.2 | 17.2 |
| 23 | 24.7 | 7.6 | 30.7 | 4.9 | 19.8 |
| 27 | 25.0 | 11.4 | 45.6 | 8.7 | 34.8 |
| 31 | 25.4 | 15.7 | 61.9 | 9.6 | 37.8 |
| 35 | 25.6 | 20.4 | 79.6 | 20.4 | 79.6 |
| 39 | 25.9 | 20.8 | 80.2 | 20.8 | 80.2 |
| 43 | 26.2 | 21.1 | 80.6 | 21.1 | 80.6 |
| 47 | 26.4 | 21.4 | 81.1 | 21.4 | 81.1 |
| 51 | 26.7 | 21.7 | 81.5 | 21.7 | 81.5 |
| 55 | 26.9 | 22.0 | 81.9 | 22.0 | 81.9 |
| 59 | 27.1 | 22.3 | 82.3 | 22.3 | 82.3 |
| 63 | 27.3 | 22.6 | 82.8 | 22.6 | 82.8 |
| 67 | 27.4 | 22.8 | 83.3 | 22.8 | 83.3 |
| 71 | 27.5 | 23.1 | 83.8 | 23.1 | 83.8 |
| 75 | 27.7 | 23.3 | 84.2 | 23.3 | 84.2 |
| 79 | 27.8 | 23.5 | 84.5 | 23.5 | 84.5 |
| 83 | 27.9 | 23.6 | 84.7 | 23.6 | 84.7 |
| 87 | 28.0 | 23.8 | 84.8 | 23.8 | 84.8 |
| 91 | 28.2 | 23.9 | 85.0 | 23.9 | 85.0 |
| 95 | 28.3 | 24.1 | 85.2 | 24.1 | 85.2 |
| 99 | 28.4 | 24.2 | 85.3 | 24.2 | 85.3 |
| 102 | 28.5 | 24.3 | 85.4 | 24.3 | 85.4 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 10.9 | 23.5 | 1.1 | 4.6 | 1.1 | 4.6 |
| 15 | 24.0 | 1.7 | 7.0 | 1.7 | 7.0 |
| 19 | 24.4 | 2.2 | 8.9 | 2.2 | 8.9 |
| 23 | 24.7 | 2.6 | 10.6 | 2.6 | 10.6 |
| 27 | 25.0 | 3.0 | 12.0 | 3.0 | 12.0 |
| 31 | 25.4 | 3.4 | 13.3 | 3.4 | 13.3 |
| 35 | 25.6 | 4.1 | 16.0 | 3.8 | 14.7 |
| 39 | 25.9 | 5.7 | 22.0 | 4.3 | 16.5 |
| 43 | 26.2 | 7.2 | 27.3 | 4.8 | 18.2 |
| 47 | 26.4 | 9.1 | 34.5 | 8.3 | 31.3 |
| 51 | 26.7 | 12.2 | 45.9 | 8.9 | 33.3 |
| 55 | 26.9 | 15.1 | 56.2 | 9.5 | 35.2 |
| 59 | 27.1 | 17.8 | 65.6 | 10.0 | 36.9 |
| 63 | 27.3 | 20.5 | 75.3 | 20.5 | 75.3 |
| 67 | 27.4 | 20.8 | 75.8 | 20.8 | 75.8 |
| 71 | 27.5 | 21.0 | 76.3 | 21.0 | 76.3 |
| 75 | 27.7 | 21.2 | 76.8 | 21.2 | 76.8 |
| 79 | 27.8 | 21.5 | 77.3 | 21.5 | 77.3 |
| 83 | 27.9 | 21.7 | 77.7 | 21.7 | 77.7 |
| 87 | 28.0 | 21.9 | 78.1 | 21.9 | 78.1 |
| 91 | 28.2 | 22.1 | 78.6 | 22.1 | 78.6 |
| 95 | 28.3 | 22.3 | 78.9 | 22.3 | 78.9 |
| 99 | 28.4 | 22.5 | 79.3 | 22.5 | 79.3 |
| 102 | 28.5 | 22.7 | 79.6 | 22.7 | 79.6 |

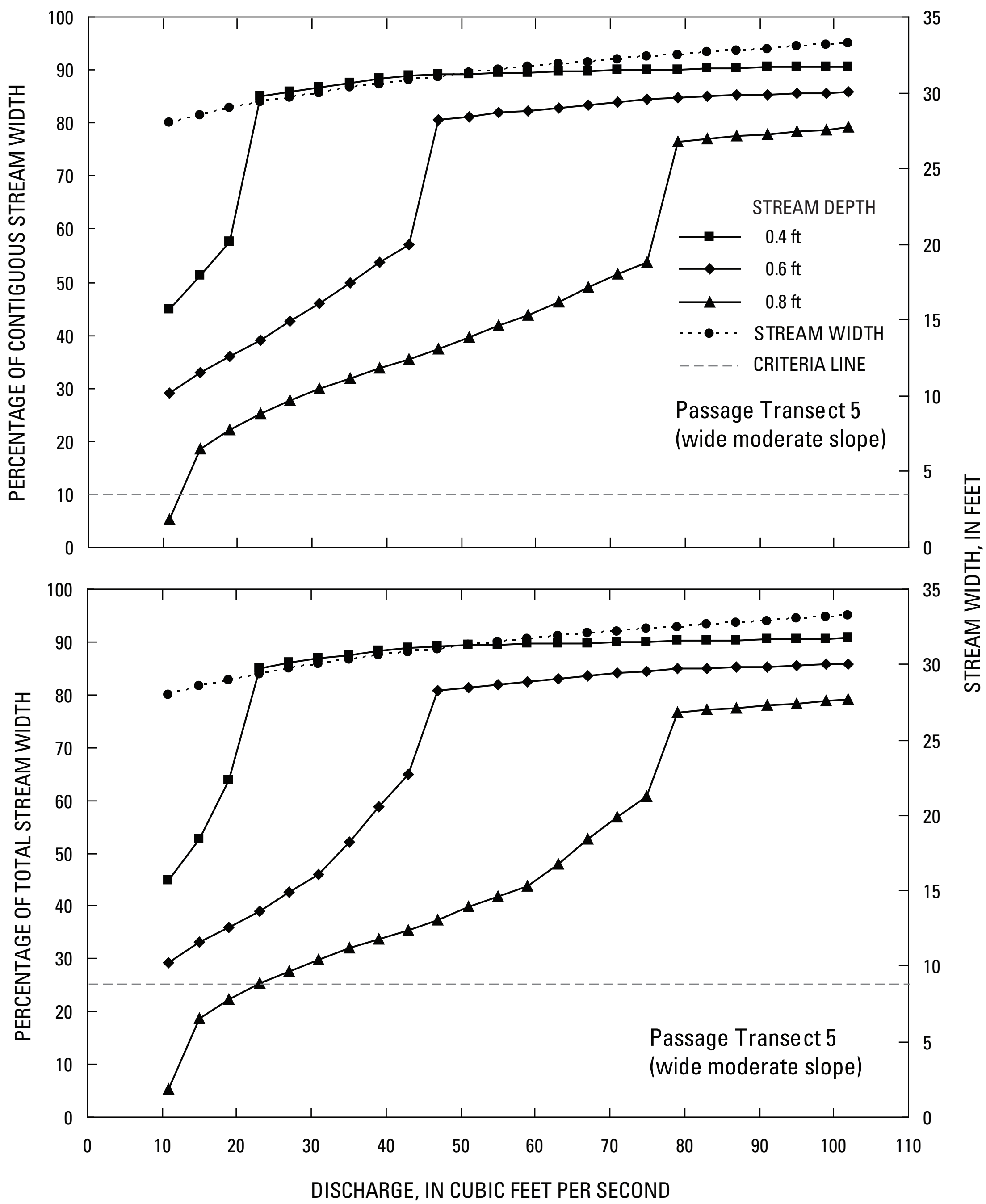



**Figure D4.** Percentages of contiguous and total stream width for passage transect 5, upper middle Challis Creek (CH3), upper Salmon River Basin, Idaho, 2005.

**Table D3.** Passage criteria assessment for transect 5 (wide moderate slope), site CH3, upper middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 10.9 | 28.0 | 12.6 | 44.9 | 12.6 | 44.9 |
| 15 | 28.5 | 15.0 | 52.5 | 14.6 | 51.1 |
| 19 | 29.0 | 18.5 | 63.7 | 16.7 | 57.5 |
| 23 | 29.4 | 25.0 | 85.1 | 25.0 | 85.1 |
| 27 | 29.7 | 25.5 | 86.0 | 25.5 | 86.0 |
| 31 | 30.0 | 26.1 | 86.8 | 26.1 | 86.8 |
| 35 | 30.3 | 26.5 | 87.6 | 26.5 | 87.6 |
| 39 | 30.6 | 27.0 | 88.3 | 27.0 | 88.3 |
| 43 | 30.8 | 27.4 | 88.9 | 27.4 | 88.9 |
| 47 | 31.0 | 27.7 | 89.2 | 27.7 | 89.2 |
| 51 | 31.3 | 27.9 | 89.3 | 27.9 | 89.3 |
| 55 | 31.5 | 28.2 | 89.5 | 28.2 | 89.5 |
| 59 | 31.7 | 28.4 | 89.6 | 28.4 | 89.6 |
| 63 | 31.9 | 28.6 | 89.7 | 28.6 | 89.7 |
| 67 | 32.0 | 28.8 | 89.8 | 28.8 | 89.8 |
| 71 | 32.2 | 29.0 | 89.9 | 29.0 | 89.9 |
| 75 | 32.3 | 29.1 | 90.1 | 29.1 | 90.1 |
| 79 | 32.5 | 29.3 | 90.2 | 29.3 | 90.2 |
| 83 | 32.6 | 29.5 | 90.3 | 29.5 | 90.3 |
| 87 | 32.8 | 29.6 | 90.4 | 29.6 | 90.4 |
| 91 | 32.9 | 29.8 | 90.5 | 29.8 | 90.5 |
| 95 | 33.0 | 29.9 | 90.6 | 29.9 | 90.6 |
| 99 | 33.2 | 30.0 | 90.6 | 30.0 | 90.6 |
| 102 | 33.2 | 30.2 | 90.7 | 30.2 | 90.7 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 10.9 | 28.0 | 8.2 | 29.1 | 8.2 | 29.1 |
| 15 | 28.5 | 9.4 | 33.1 | 9.4 | 33.1 |
| 19 | 29.0 | 10.4 | 36.1 | 10.4 | 36.1 |
| 23 | 29.4 | 11.5 | 39.1 | 11.5 | 39.1 |
| 27 | 29.7 | 12.7 | 42.6 | 12.7 | 42.6 |
| 31 | 30.0 | 13.8 | 45.9 | 13.8 | 45.9 |
| 35 | 30.3 | 15.8 | 52.2 | 15.1 | 49.8 |
| 39 | 30.6 | 18.0 | 58.9 | 16.4 | 53.6 |
| 43 | 30.8 | 20.0 | 64.9 | 17.6 | 57.0 |
| 47 | 31.0 | 25.0 | 80.7 | 25.0 | 80.7 |
| 51 | 31.3 | 25.4 | 81.3 | 25.4 | 81.3 |
| 55 | 31.5 | 25.8 | 81.9 | 25.8 | 81.9 |
| 59 | 31.7 | 26.1 | 82.4 | 26.1 | 82.4 |
| 63 | 31.9 | 26.4 | 83.0 | 26.4 | 83.0 |
| 67 | 32.0 | 26.7 | 83.5 | 26.7 | 83.5 |
| 71 | 32.2 | 27.0 | 84.0 | 27.0 | 84.0 |
| 75 | 32.3 | 27.3 | 84.5 | 27.3 | 84.5 |
| 79 | 32.5 | 27.6 | 84.9 | 27.6 | 84.9 |
| 83 | 32.6 | 27.8 | 85.1 | 27.8 | 85.1 |
| 87 | 32.8 | 27.9 | 85.2 | 27.9 | 85.2 |
| 91 | 32.9 | 28.1 | 85.4 | 28.1 | 85.4 |
| 95 | 33.0 | 28.2 | 85.5 | 28.2 | 85.5 |
| 99 | 33.2 | 28.4 | 85.7 | 28.4 | 85.7 |
| 102 | 33.2 | 28.5 | 85.7 | 28.5 | 85.7 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 10.9 | 28.0 | 1.5 | 5.4 | 1.5 | 5.4 |
| 15 | 28.5 | 5.3 | 18.6 | 5.3 | 18.6 |
| 19 | 29.0 | 6.4 | 22.2 | 6.4 | 22.2 |
| 23 | 29.4 | 7.4 | 25.2 | 7.4 | 25.2 |
| 27 | 29.7 | 8.2 | 27.7 | 8.2 | 27.7 |
| 31 | 30.0 | 9.0 | 29.9 | 9.0 | 29.9 |
| 35 | 30.3 | 9.7 | 31.9 | 9.7 | 31.9 |
| 39 | 30.6 | 10.3 | 33.7 | 10.3 | 33.7 |
| 43 | 30.8 | 10.9 | 35.3 | 10.9 | 35.3 |
| 47 | 31.0 | 11.6 | 37.4 | 11.6 | 37.4 |
| 51 | 31.3 | 12.4 | 39.7 | 12.4 | 39.7 |
| 55 | 31.5 | 13.2 | 41.8 | 13.2 | 41.8 |
| 59 | 31.7 | 13.9 | 43.8 | 13.9 | 43.8 |
| 63 | 31.9 | 15.3 | 48.0 | 14.8 | 46.4 |
| 67 | 32.0 | 16.9 | 52.6 | 15.7 | 49.0 |
| 71 | 32.2 | 18.3 | 56.9 | 16.6 | 51.5 |
| 75 | 32.3 | 19.7 | 60.9 | 17.4 | 53.8 |
| 79 | 32.5 | 24.9 | 76.5 | 24.9 | 76.5 |
| 83 | 32.6 | 25.1 | 77.0 | 25.1 | 77.0 |
| 87 | 32.8 | 25.4 | 77.5 | 25.4 | 77.5 |
| 91 | 32.9 | 25.7 | 78.0 | 25.7 | 78.0 |
| 95 | 33.0 | 25.9 | 78.4 | 25.9 | 78.4 |
| 99 | 33.2 | 26.1 | 78.8 | 26.1 | 78.8 |
| 102 | 33.2 | 26.3 | 79.1 | 26.3 | 79.1 |

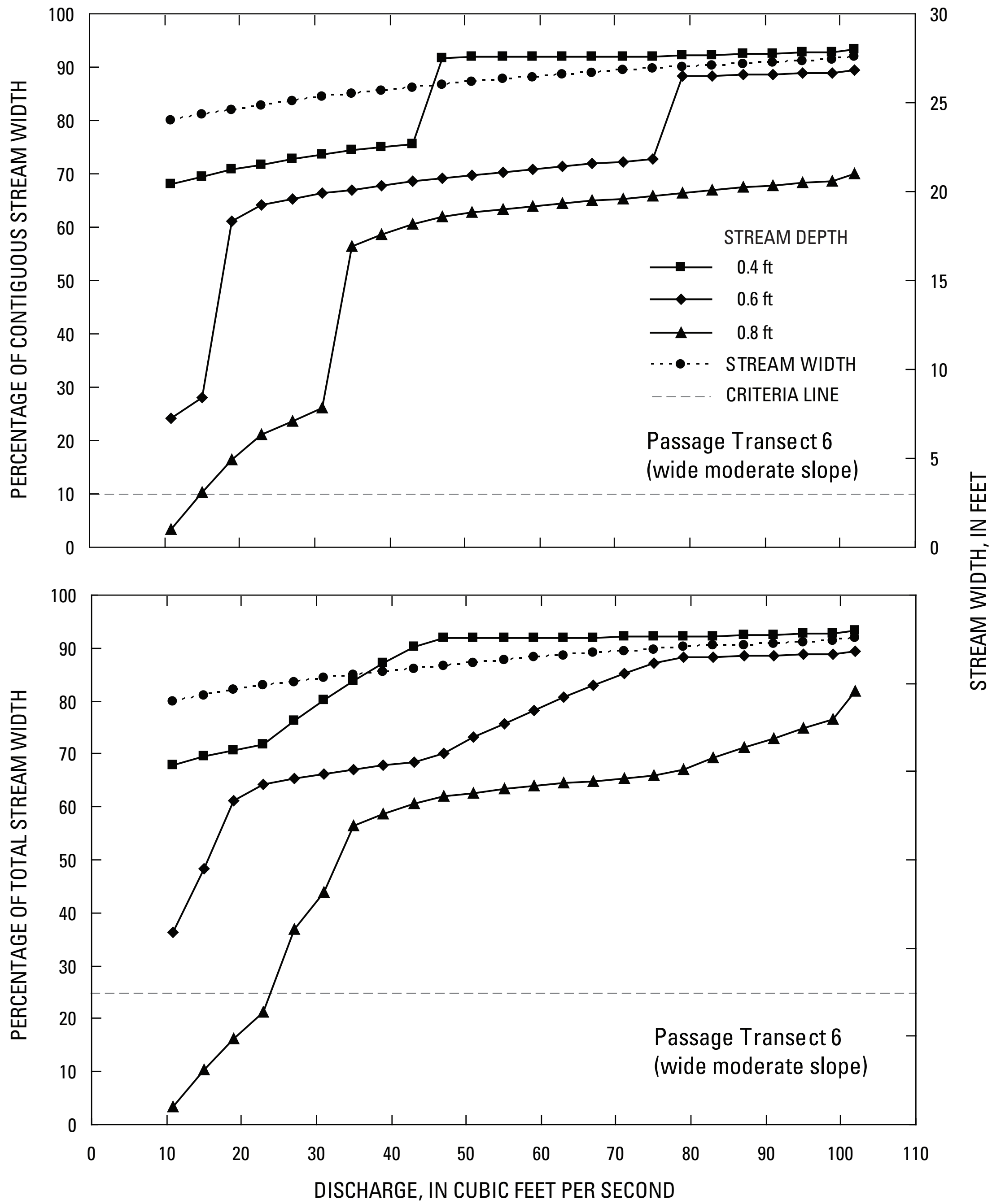


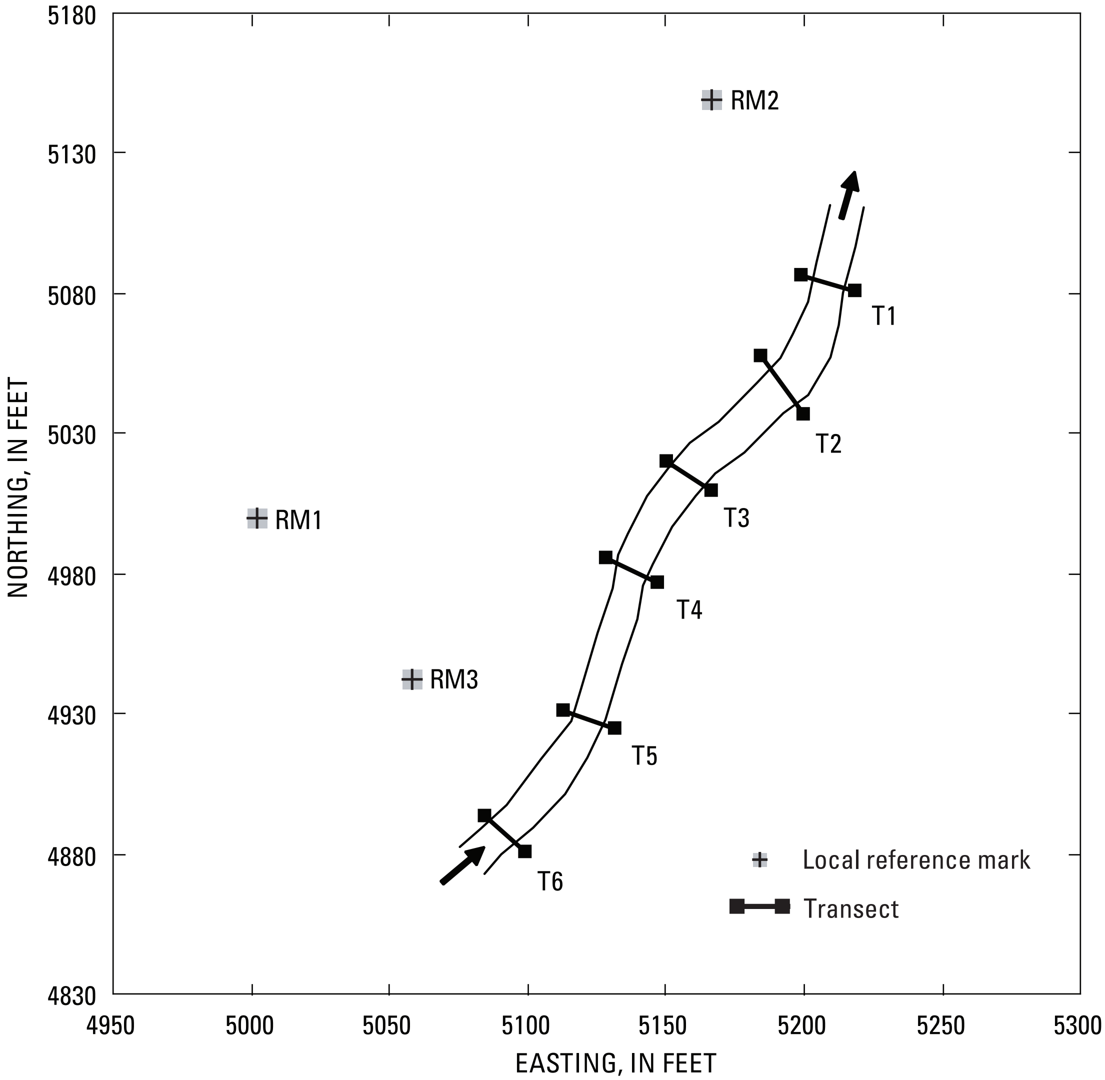

**Figure D5.** Percentages of contiguous and total stream width for passage transect 6, upper middle Challis Creek (CH3), upper Salmon River Basin, Idaho, 2005.

**Table D4.** Passage criteria assessment for transect 6 (wide moderate slope), site CH3, upper middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 10.9 | 24.0 | 16.3 | 67.9 | 16.3 | 67.9 |
| 15 | 24.3 | 16.9 | 69.5 | 16.9 | 69.5 |
| 19 | 24.6 | 17.4 | 70.7 | 17.4 | 70.7 |
| 23 | 24.9 | 17.8 | 71.8 | 17.8 | 71.8 |
| 27 | 25.1 | 19.1 | 76.1 | 18.2 | 72.7 |
| 31 | 25.3 | 20.3 | 80.3 | 18.6 | 73.6 |
| 35 | 25.5 | 21.4 | 83.9 | 19.0 | 74.3 |
| 39 | 25.7 | 22.4 | 87.2 | 19.3 | 75.0 |
| 43 | 25.8 | 23.3 | 90.2 | 19.6 | 75.6 |
| 47 | 26.0 | 23.9 | 91.8 | 23.9 | 91.8 |
| 51 | 26.2 | 24.0 | 91.8 | 24.0 | 91.8 |
| 55 | 26.3 | 24.2 | 91.9 | 24.2 | 91.9 |
| 59 | 26.4 | 24.3 | 91.9 | 24.3 | 91.9 |
| 63 | 26.6 | 24.4 | 92.0 | 24.4 | 92.0 |
| 67 | 26.7 | 24.6 | 92.0 | 24.6 | 92.0 |
| 71 | 26.8 | 24.7 | 92.0 | 24.7 | 92.0 |
| 75 | 26.9 | 24.8 | 92.1 | 24.8 | 92.1 |
| 79 | 27.0 | 24.9 | 92.2 | 24.9 | 92.2 |
| 83 | 27.1 | 25.0 | 92.3 | 25.0 | 92.3 |
| 87 | 27.2 | 25.1 | 92.5 | 25.1 | 92.5 |
| 91 | 27.3 | 25.2 | 92.6 | 25.2 | 92.6 |
| 95 | 27.3 | 25.3 | 92.7 | 25.3 | 92.7 |
| 99 | 27.4 | 25.4 | 92.8 | 25.4 | 92.8 |
| 102 | 27.6 | 25.7 | 93.2 | 25.7 | 93.2 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 10.9 | 24.0 | 8.7 | 36.2 | 5.8 | 24.1 |
| 15 | 24.3 | 11.8 | 48.4 | 6.8 | 28.0 |
| 19 | 24.6 | 15.0 | 61.1 | 15.0 | 61.1 |
| 23 | 24.9 | 16.0 | 64.3 | 16.0 | 64.3 |
| 27 | 25.1 | 16.4 | 65.3 | 16.4 | 65.3 |
| 31 | 25.3 | 16.8 | 66.3 | 16.8 | 66.3 |
| 35 | 25.5 | 17.1 | 67.1 | 17.1 | 67.1 |
| 39 | 25.7 | 17.4 | 67.8 | 17.4 | 67.8 |
| 43 | 25.8 | 17.7 | 68.5 | 17.7 | 68.5 |
| 47 | 26.0 | 18.3 | 70.2 | 18.0 | 69.1 |
| 51 | 26.2 | 19.1 | 73.1 | 18.2 | 69.7 |
| 55 | 26.3 | 19.9 | 75.8 | 18.5 | 70.3 |
| 59 | 26.4 | 20.7 | 78.2 | 18.7 | 70.8 |
| 63 | 26.6 | 21.4 | 80.6 | 19.0 | 71.3 |
| 67 | 26.7 | 22.1 | 82.9 | 19.2 | 71.8 |
| 71 | 26.8 | 22.8 | 85.1 | 19.4 | 72.3 |
| 75 | 26.9 | 23.4 | 87.0 | 19.6 | 72.7 |
| 79 | 27.0 | 23.8 | 88.2 | 23.8 | 88.2 |
| 83 | 27.1 | 24.0 | 88.4 | 24.0 | 88.4 |
| 87 | 27.2 | 24.1 | 88.5 | 24.1 | 88.5 |
| 91 | 27.3 | 24.2 | 88.7 | 24.2 | 88.7 |
| 95 | 27.3 | 24.3 | 88.8 | 24.3 | 88.8 |
| 99 | 27.4 | 24.4 | 89.0 | 24.4 | 89.0 |
| 102 | 27.6 | 24.7 | 89.4 | 24.7 | 89.4 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 10.9 | 24.0 | 0.8 | 3.3 | 0.8 | 3.3 |
| 15 | 24.3 | 2.5 | 10.4 | 2.5 | 10.4 |
| 19 | 24.6 | 4.0 | 16.3 | 4.0 | 16.3 |
| 23 | 24.9 | 5.3 | 21.2 | 5.3 | 21.2 |
| 27 | 25.1 | 9.2 | 36.8 | 6.0 | 23.7 |
| 31 | 25.3 | 11.1 | 43.9 | 6.6 | 26.0 |
| 35 | 25.5 | 14.4 | 56.4 | 14.4 | 56.4 |
| 39 | 25.7 | 15.1 | 58.6 | 15.1 | 58.6 |
| 43 | 25.8 | 15.7 | 60.7 | 15.7 | 60.7 |
| 47 | 26.0 | 16.1 | 62.0 | 16.1 | 62.0 |
| 51 | 26.2 | 16.4 | 62.7 | 16.4 | 62.7 |
| 55 | 26.3 | 16.6 | 63.3 | 16.6 | 63.3 |
| 59 | 26.4 | 16.9 | 63.8 | 16.9 | 63.8 |
| 63 | 26.6 | 17.1 | 64.4 | 17.1 | 64.4 |
| 67 | 26.7 | 17.3 | 64.9 | 17.3 | 64.9 |
| 71 | 26.8 | 17.5 | 65.4 | 17.5 | 65.4 |
| 75 | 26.9 | 17.7 | 65.9 | 17.7 | 65.9 |
| 79 | 27.0 | 18.1 | 67.0 | 17.9 | 66.3 |
| 83 | 27.1 | 18.7 | 69.1 | 18.1 | 66.9 |
| 87 | 27.2 | 19.3 | 71.1 | 18.3 | 67.4 |
| 91 | 27.3 | 19.9 | 73.0 | 18.5 | 67.8 |
| 95 | 27.3 | 20.4 | 74.8 | 18.7 | 68.3 |
| 99 | 27.4 | 21.0 | 76.6 | 18.8 | 68.7 |
| 102 | 27.6 | 22.6 | 82.0 | 19.3 | 70.1 |

**Appendix E.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for lower Mill Creek (ML1), upper Salmon River Basin, Idaho, 2005.




Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH1 | 44° 33' 36.5" N | 114° 16' 30.86" W |
| LH1 | 44° 33' 36.46" N | 114° 16' 30.58" W |
| RH2 | 44° 33' 36.2" N | 114° 16' 31.05" W |
| LH2 | 44° 33' 36.02" N | 114° 16' 30.8" W |
| RH3 | 44° 33' 35.81" N | 114° 16' 31.46" W |
| LH3 | 44° 33' 35.72" N | 114° 16' 31.21" W |

Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| LH4 | 44° 33' 35.39" N | 114° 16' 31.46" W |
| RH5 | 44° 33' 34.91" N | 114° 16' 31.87" W |
| LH5 | 44° 33' 34.85" N | 114° 16' 31.6" W |
| RH6 | 44° 33' 34.51" N | 114° 16' 32.23" W |
| LH6 | 44° 33' 34.4" N | 114° 16' 32.01" W |

For reference only; stream schematic not to scale.

**Figure E1.** Plan view of upper lower Mill Creek (ML1), upper Salmon River Basin, Idaho, 2005.

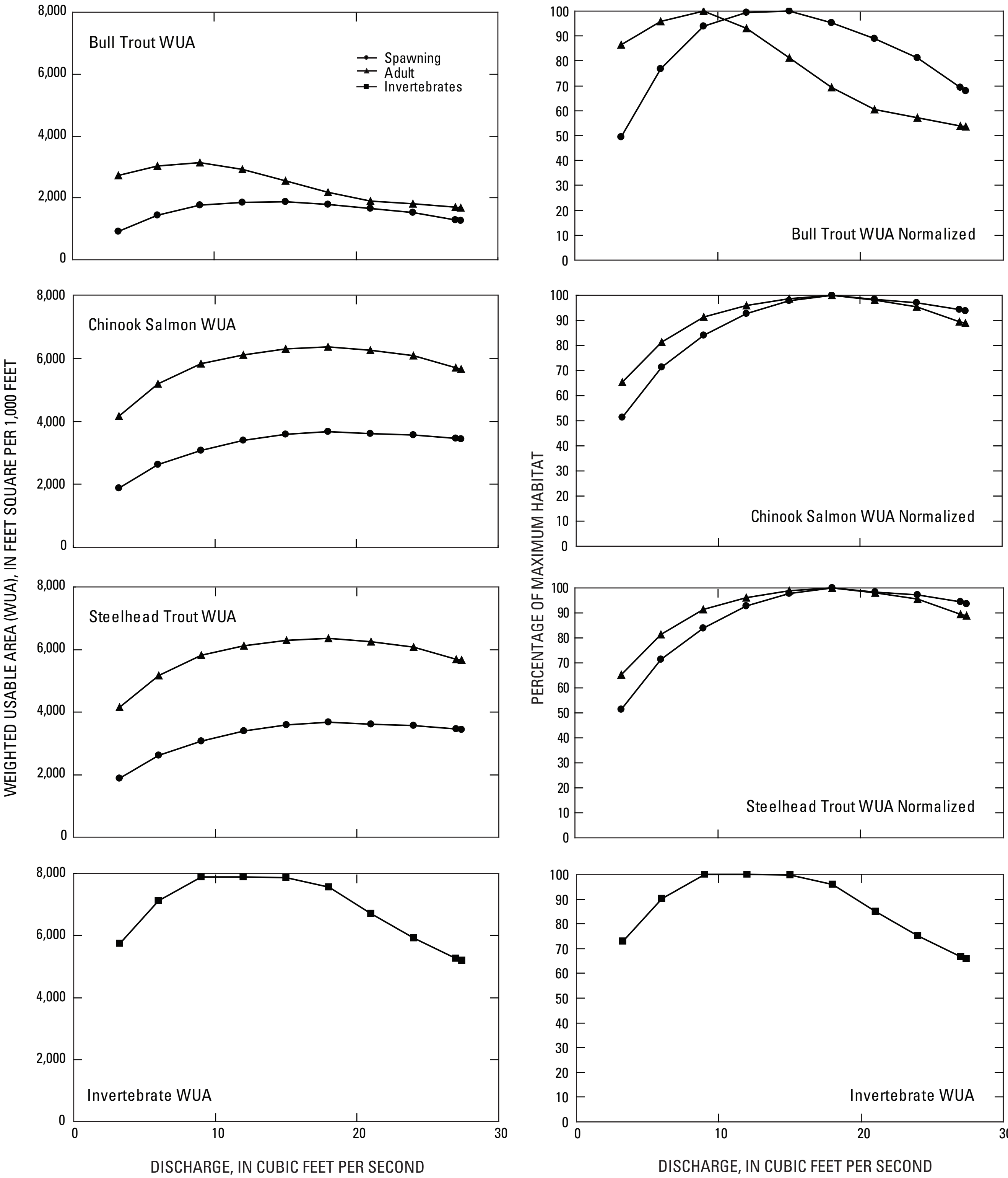



**Figure E2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, lower Mill Creek (ML1), upper Salmon River Basin, Idaho, 2005.

**Table E1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site ML1, lower Mill Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | 11,523 | 2,725 | 924 | 86.6 | 49.5 |
| 6 | 11,902 | 3,020 | 1,435 | 96.0 | 76.9 |
| 9 | 12,149 | 3,147 | 1,756 | 100.0 | 94.0 |
| 12 | 12,328 | 2,926 | 1,857 | 93.0 | 99.4 |
| 15 | 12,479 | 2,559 | 1,867 | 81.3 | 100.0 |
| 18 | 12,613 | 2,181 | 1,780 | 69.3 | 95.3 |
| 21 | 12,732 | 1,901 | 1,661 | 60.4 | 89.0 |
| 24 | 12,839 | 1,799 | 1,519 | 57.2 | 81.3 |
| 27 | 12,937 | 1,696 | 1,293 | 53.9 | 69.3 |
| 27.400 | 12,951 | 1,683 | 1,268 | 53.5 | 67.9 |
| **Chinook salmon** | | | | | |
| 3.3 | 11,523 | 4,159 | 1,886 | 65.4 | 51.4 |
| 6 | 11,902 | 5,178 | 2,617 | 81.4 | 71.4 |
| 9 | 12,149 | 5,814 | 3,079 | 91.4 | 83.9 |
| 12 | 12,328 | 6,110 | 3,402 | 96.0 | 92.8 |
| 15 | 12,479 | 6,284 | 3,589 | 98.8 | 97.9 |
| 18 | 12,613 | 6,362 | 3,667 | 100.0 | 100.0 |
| 21 | 12,732 | 6,247 | 3,606 | 98.2 | 98.3 |
| 24 | 12,839 | 6,077 | 3,562 | 95.5 | 97.1 |
| 27 | 12,937 | 5,692 | 3,459 | 89.5 | 94.3 |
| 27.400 | 12,951 | 5,657 | 3,437 | 88.9 | 93.7 |

| 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** | | | | | |
| 3.3 | 11,523 | 4,159 | 1,886 | 65.4 | 51.4 |
| 6 | 11,902 | 5,178 | 2,617 | 81.4 | 71.4 |
| 9 | 12,149 | 5,814 | 3,079 | 91.4 | 83.9 |
| 12 | 12,328 | 6,110 | 3,402 | 96.0 | 92.8 |
| 15 | 12,479 | 6,284 | 3,589 | 98.8 | 97.9 |
| 18 | 12,613 | 6,362 | 3,667 | 100.0 | 100.0 |
| 21 | 12,732 | 6,247 | 3,606 | 98.2 | 98.3 |
| 24 | 12,839 | 6,077 | 3,562 | 95.5 | 97.1 |
| 27 | 12,937 | 5,692 | 3,459 | 89.5 | 94.3 |
| 27.400 | 12,951 | 5,657 | 3,437 | 88.9 | 93.7 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2/1,000$ ft) | Percentage of maximum habitat |
|---|---|---|---|
| **EPT Invertebrates** | | | |
| 3.25 | 11,523 | 5,753 | 72.9 |
| 6 | 11,902 | 7,123 | 90.3 |
| 9 | 12,149 | 7,890 | 100.0 |
| 12 | 12,328 | 7,883 | 99.9 |
| 15 | 12,479 | 7,865 | 99.7 |
| 18 | 12,613 | 7,565 | 95.9 |
| 21 | 12,732 | 6,706 | 85.0 |
| 24 | 12,839 | 5,927 | 75.1 |
| 27 | 12,937 | 5,266 | 66.7 |
| 27.400 | 12,951 | 5,198 | 65.9 |

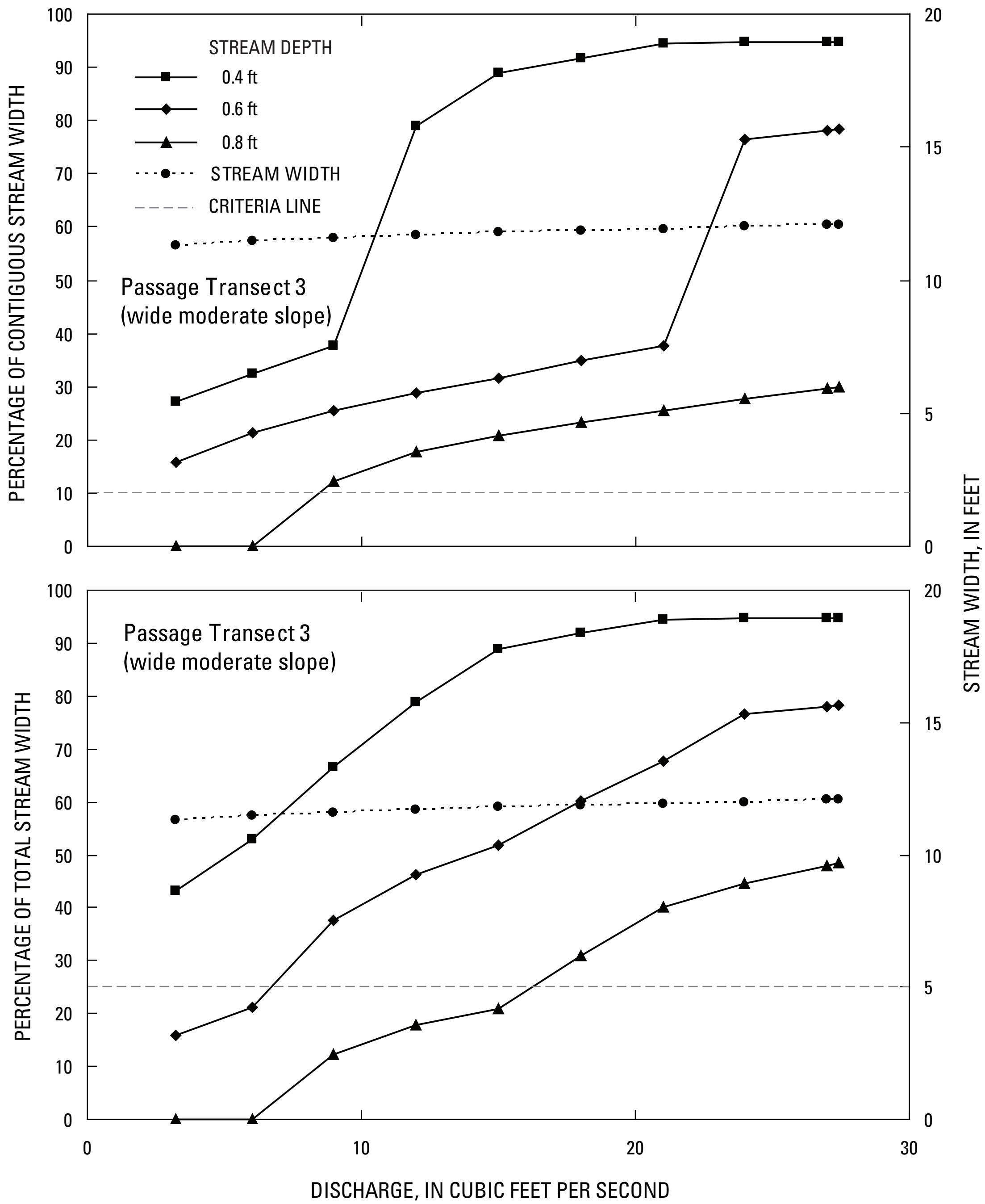



**Figure E3.** Percentages of contiguous and total stream width for passage transect 3, lower Mill Creek (ML1), upper Salmon River Basin, Idaho, 2005.

**Table E2.** Passage criteria assessment for transect 3 (wide moderate slope), site ML1, lower Mill Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 3.3 | 11.3 | 4.9 | 43.2 | 3.1 | 27.2 | 3.3 | 11.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 11.5 | 6.1 | 52.9 | 3.7 | 32.4 | 6 | 11.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 11.6 | 7.7 | 66.6 | 4.4 | 37.7 | 9 | 11.6 | 1.4 | 12.3 | 1.4 | 12.3 |
| 12 | 11.7 | 9.2 | 78.9 | 9.2 | 78.9 | 12 | 11.7 | 2.1 | 17.8 | 2.1 | 17.8 |
| 15 | 11.8 | 10.5 | 88.8 | 10.5 | 88.8 | 15 | 11.8 | 2.5 | 20.9 | 2.4 | 20.7 |
| 18 | 11.9 | 10.9 | 91.8 | 10.9 | 91.8 | 18 | 11.9 | 3.7 | 30.9 | 2.8 | 23.3 |
| 21 | 11.9 | 11.3 | 94.5 | 11.3 | 94.5 | 21 | 11.9 | 4.8 | 40.0 | 3.1 | 25.6 |
| 24 | 12.0 | 11.4 | 94.8 | 11.4 | 94.8 | 24 | 12.0 | 5.3 | 44.4 | 3.3 | 27.7 |
| 27 | 12.1 | 11.4 | 94.8 | 11.4 | 94.8 | 27 | 12.1 | 5.8 | 48.0 | 3.6 | 29.6 |
| 27 | 12.1 | 11.4 | 94.8 | 11.4 | 94.8 | 27 | 12.1 | 5.8 | 48.4 | 3.6 | 29.8 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 3.3 | 11.3 | 1.8 | 15.9 | 1.8 | 15.9 | | | | | | |
| 6 | 11.5 | 2.4 | 21.2 | 2.4 | 21.2 | | | | | | |
| 9 | 11.6 | 4.4 | 37.7 | 3.0 | 25.4 | | | | | | |
| 12 | 11.7 | 5.4 | 46.3 | 3.4 | 28.8 | | | | | | |
| 15 | 11.8 | 6.1 | 51.7 | 3.7 | 31.6 | | | | | | |
| 18 | 11.9 | 7.1 | 60.0 | 4.1 | 34.9 | | | | | | |
| 21 | 11.9 | 8.1 | 67.6 | 4.5 | 37.8 | | | | | | |
| 24 | 12.0 | 9.2 | 76.6 | 9.2 | 76.6 | | | | | | |
| 27 | 12.1 | 9.4 | 78.1 | 9.4 | 78.1 | | | | | | |
| 27 | 12.1 | 9.4 | 78.3 | 9.4 | 78.3 | | | | | | |

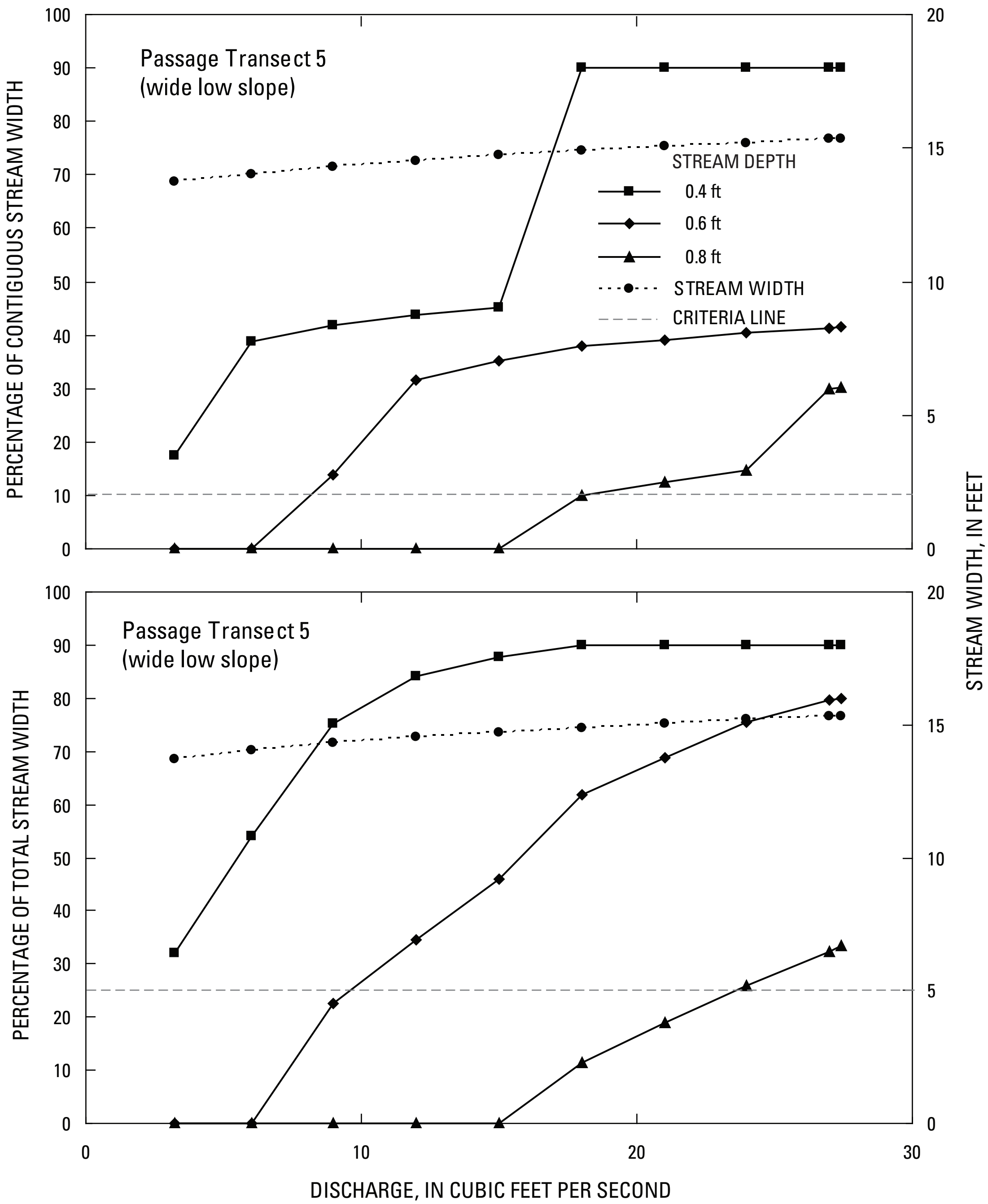



**Figure E4.** Percentages of contiguous and total stream width for passage transect 5, lower Mill Creek (ML1), upper Salmon River Basin, Idaho, 2005.

**Table E3.** Passage criteria assessment for transect 5 (wide low slope), site ML1 lower Mill Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 3.3 | 13.7 | 4.4 | 32.0 | 2.4 | 17.4 | 3.3 | 13.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 14.0 | 7.6 | 54.1 | 5.5 | 38.9 | 6 | 14.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 14.3 | 10.8 | 75.2 | 6.0 | 41.8 | 9 | 14.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 14.5 | 12.2 | 84.1 | 6.3 | 43.7 | 12 | 14.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 14.7 | 12.9 | 87.7 | 6.7 | 45.2 | 15 | 14.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 14.9 | 13.4 | 90.0 | 13.4 | 90.0 | 18 | 14.9 | 1.7 | 11.4 | 1.5 | 10.1 |
| 21 | 15.1 | 13.5 | 90.0 | 13.5 | 90.0 | 21 | 15.1 | 2.8 | 18.8 | 1.9 | 12.5 |
| 24 | 15.2 | 13.7 | 90.0 | 13.7 | 90.0 | 24 | 15.2 | 3.9 | 25.8 | 2.2 | 14.7 |
| 27 | 15.3 | 13.8 | 90.0 | 13.8 | 90.0 | 27 | 15.3 | 5.0 | 32.4 | 4.6 | 29.9 |
| 27 | 15.3 | 13.8 | 90.0 | 13.8 | 90.0 | 27 | 15.3 | 5.1 | 33.3 | 4.6 | 30.2 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 3.3 | 13.7 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| 6 | 14.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | |
| 9 | 14.3 | 3.2 | 22.4 | 2.0 | 14.0 | | | | | | |
| 12 | 14.5 | 5.0 | 34.6 | 4.6 | 31.7 | | | | | | |
| 15 | 14.7 | 6.8 | 46.1 | 5.2 | 35.2 | | | | | | |
| 18 | 14.9 | 9.2 | 61.7 | 5.7 | 38.0 | | | | | | |
| 21 | 15.1 | 10.4 | 68.9 | 5.9 | 39.2 | | | | | | |
| 24 | 15.2 | 11.5 | 75.6 | 6.1 | 40.4 | | | | | | |
| 27 | 15.3 | 12.2 | 79.7 | 6.3 | 41.4 | | | | | | |
| 27 | 15.3 | 12.3 | 80.0 | 6.4 | 41.5 | | | | | | |

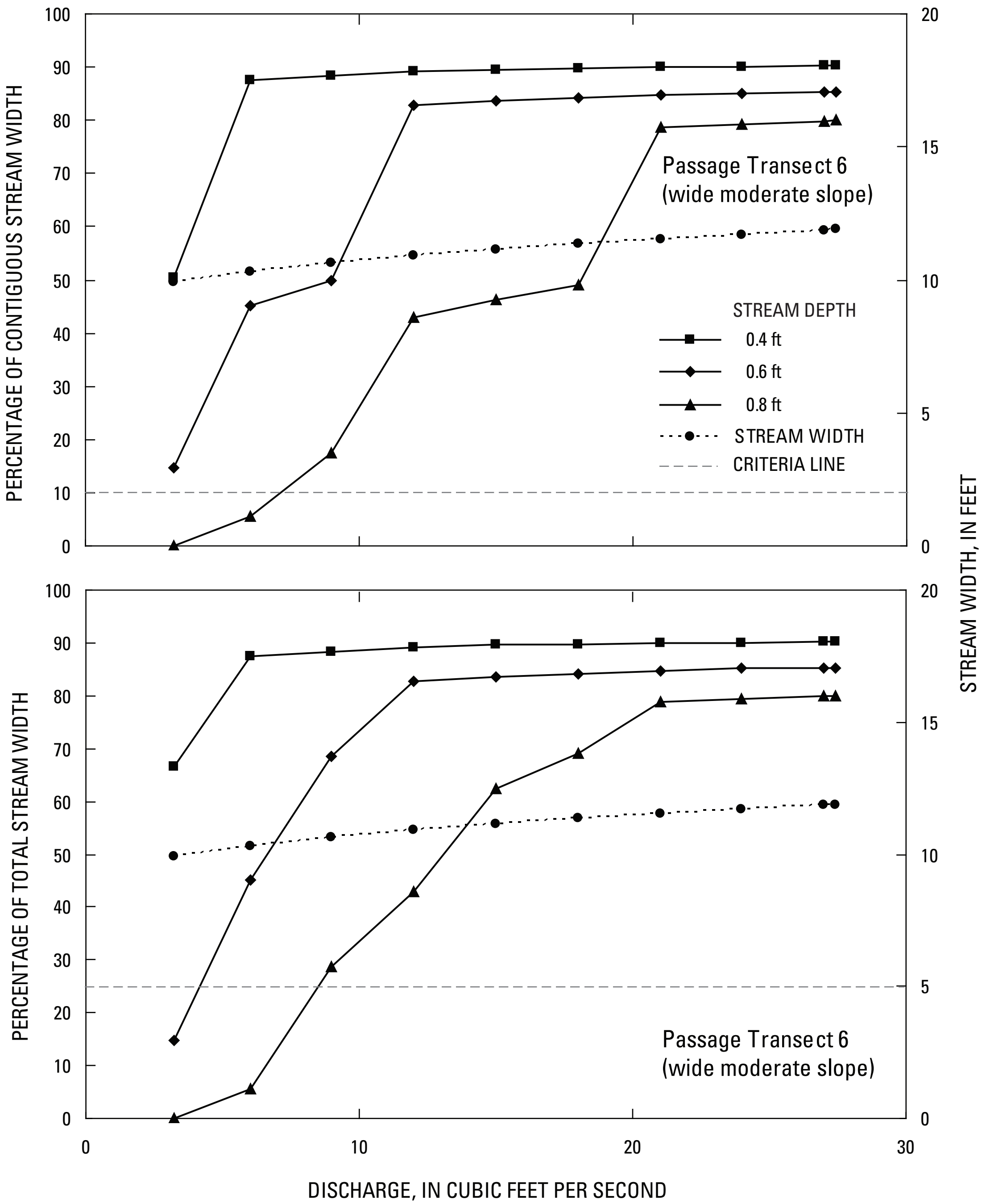


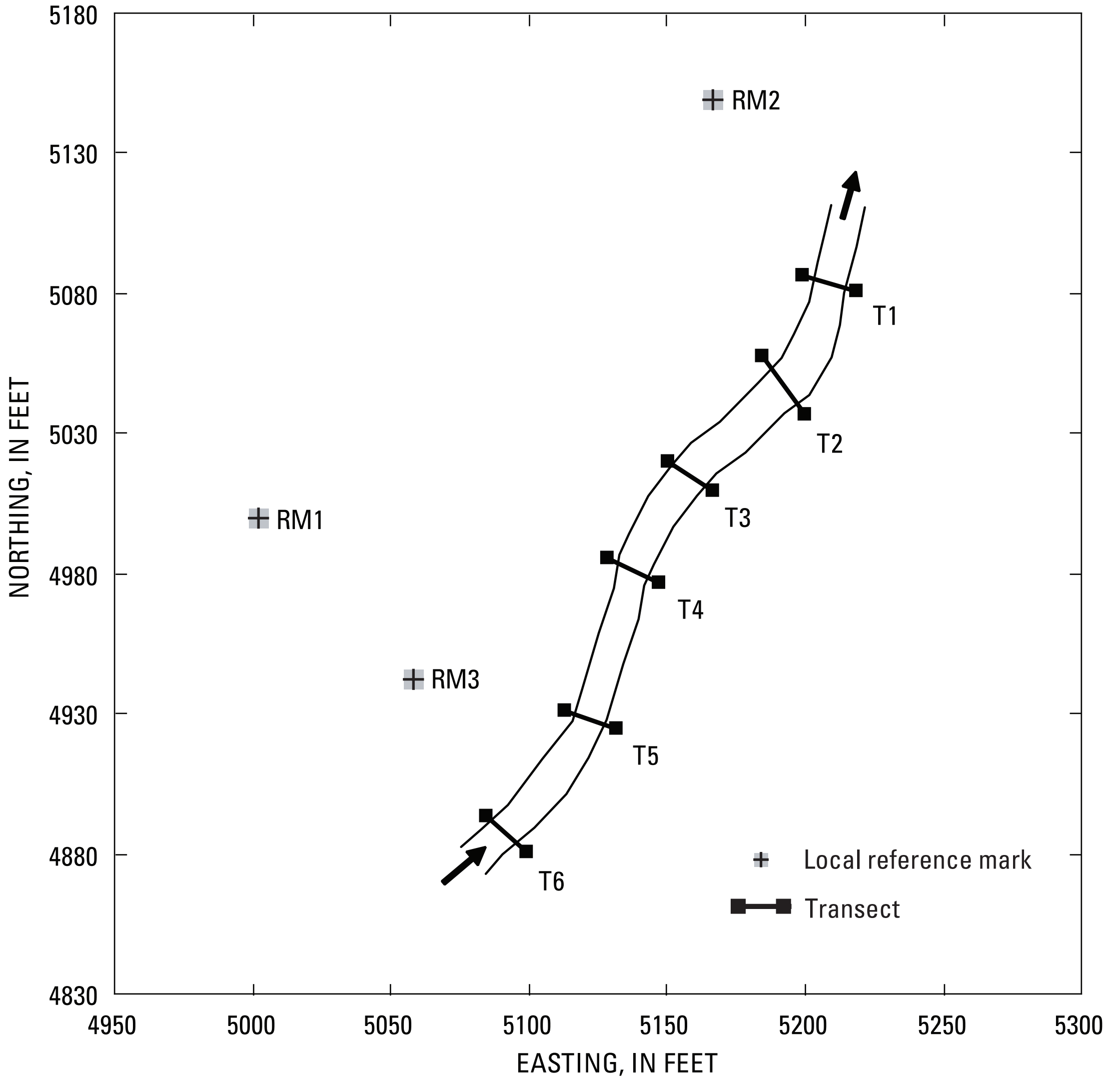

**Figure E5.** Percentages of contiguous and total stream width for passage transect 6, lower Mill Creek (ML1), upper Salmon River Basin, Idaho, 2005.

**Table E4.** Passage criteria assessment for transect 6 (wide moderate slope), site ML1 lower Mill Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 3.3 | 9.9 | 6.6 | 66.7 | 5.0 | 50.5 | 3.3 | 9.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 10.3 | 9.0 | 87.4 | 9.0 | 87.4 | 6 | 10.3 | .6 | 5.6 | .6 | 5.6 |
| 9 | 10.6 | 9.4 | 88.4 | 9.4 | 88.4 | 9 | 10.6 | 3.0 | 28.6 | 1.9 | 17.5 |
| 12 | 10.9 | 9.7 | 89.1 | 9.7 | 89.1 | 12 | 10.9 | 4.7 | 43.0 | 4.7 | 43.0 |
| 15 | 11.2 | 10.0 | 89.6 | 10.0 | 89.6 | 15 | 11.2 | 6.9 | 62.3 | 5.2 | 46.3 |
| 18 | 11.4 | 10.2 | 89.8 | 10.2 | 89.8 | 18 | 11.4 | 7.8 | 69.0 | 5.6 | 49.0 |
| 21 | 11.5 | 10.4 | 89.9 | 10.4 | 89.9 | 21 | 11.5 | 9.1 | 78.8 | 9.1 | 78.8 |
| 24 | 11.7 | 10.5 | 90.1 | 10.5 | 90.1 | 24 | 11.7 | 9.3 | 79.3 | 9.3 | 79.3 |
| 27 | 11.9 | 10.7 | 90.2 | 10.7 | 90.2 | 27 | 11.9 | 9.5 | 79.9 | 9.5 | 79.9 |
| 27 | 11.9 | 10.7 | 90.2 | 10.7 | 90.2 | 27 | 11.9 | 9.5 | 79.9 | 9.5 | 79.9 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 3.3 | 9.9 | 1.5 | 14.7 | 1.5 | 14.6 | | | | | | |
| 6 | 10.3 | 4.7 | 45.2 | 4.7 | 45.2 | | | | | | |
| 9 | 10.6 | 7.3 | 68.4 | 5.3 | 49.9 | | | | | | |
| 12 | 10.9 | 9.0 | 82.8 | 9.0 | 82.8 | | | | | | |
| 15 | 11.2 | 9.3 | 83.6 | 9.3 | 83.6 | | | | | | |
| 18 | 11.4 | 9.6 | 84.2 | 9.6 | 84.2 | | | | | | |
| 21 | 11.5 | 9.8 | 84.7 | 9.8 | 84.7 | | | | | | |
| 24 | 11.7 | 10.0 | 85.1 | 10.0 | 85.1 | | | | | | |
| 27 | 11.9 | 10.1 | 85.3 | 10.1 | 85.3 | | | | | | |
| 27 | 11.9 | 10.1 | 85.3 | 10.1 | 85.3 | | | | | | |

**Appendix F.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for lower middle Challis Creek (CH2), upper Salmon River Basin, Idaho, 2005.




Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH1 | 44° 33' 36.5" N | 114° 16' 30.86" W |
| LH1 | 44° 33' 36.46" N | 114° 16' 30.58" W |
| RH2 | 44° 33' 36.2" N | 114° 16' 31.05" W |
| LH2 | 44° 33' 36.02" N | 114° 16' 30.8" W |
| RH3 | 44° 33' 35.81" N | 114° 16' 31.46" W |
| LH3 | 44° 33' 35.72" N | 114° 16' 31.21" W |

Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| LH4 | 44° 33' 35.39" N | 114° 16' 31.46" W |
| RH5 | 44° 33' 34.91" N | 114° 16' 31.87" W |
| LH5 | 44° 33' 34.85" N | 114° 16' 31.6" W |
| RH6 | 44° 33' 34.51" N | 114° 16' 32.23" W |
| LH6 | 44° 33' 34.4" N | 114° 16' 32.01" W |

For reference only; stream schematic not to scale.

**Figure F1.** Plan view of upper lower middle Challis Creek (CH2), upper Salmon River Basin, Idaho, 2005.

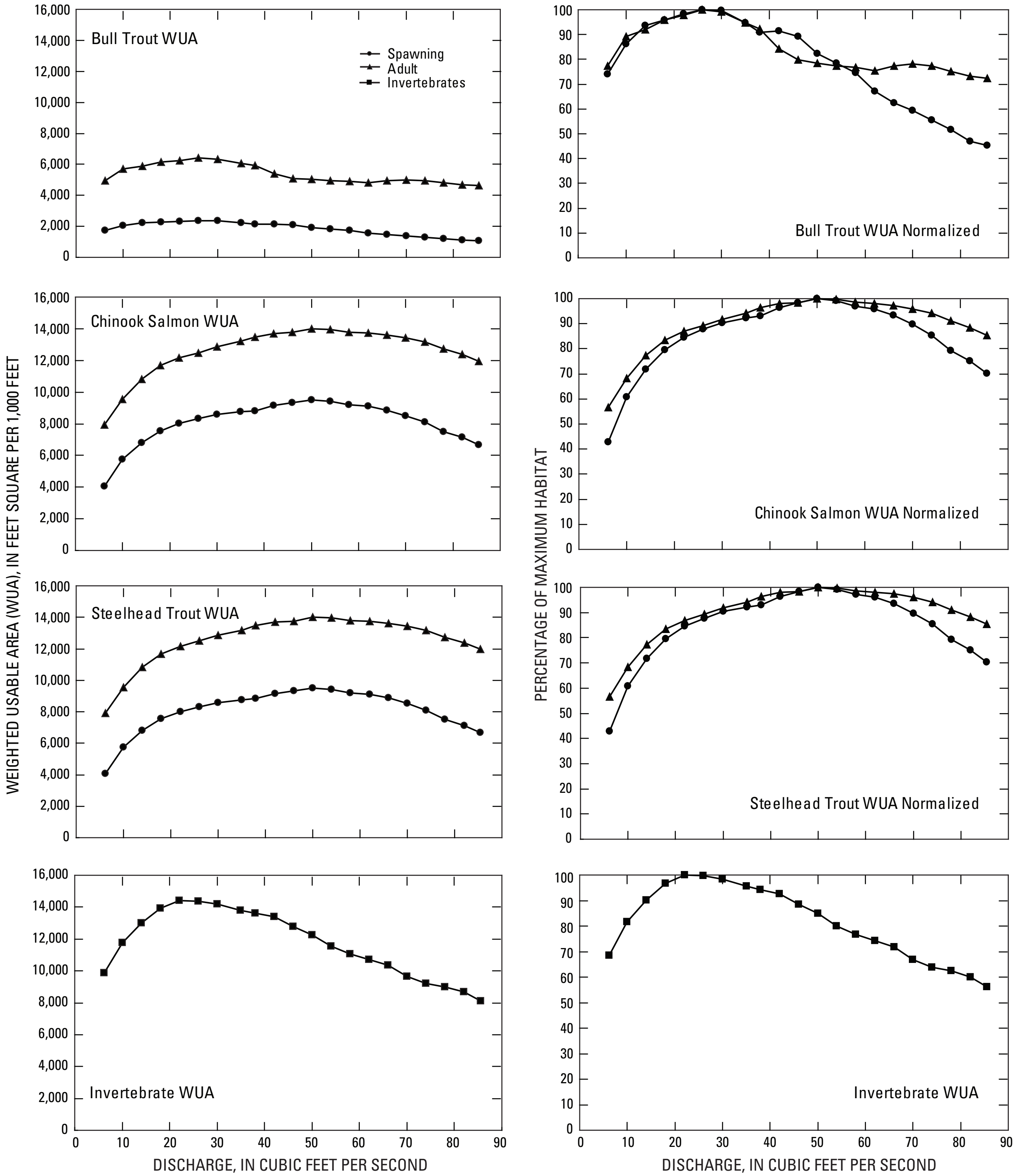



**Figure F2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, lower middle Challis Creek (CH2), upper Salmon River Basin, Idaho, 2005.

**Table F1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site CH2, lower middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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** | | | | | |
| 6.2 | 22,307 | 4,947 | 1,744 | 77.3 | 74.0 |
| 10 | 23,494 | 5,706 | 2,033 | 89.2 | 86.2 |
| 14 | 24,052 | 5,886 | 2,210 | 92.0 | 93.7 |
| 18 | 24,516 | 6,140 | 2,260 | 96.0 | 95.9 |
| 22 | 24,920 | 6,258 | 2,318 | 97.8 | 98.3 |
| 26 | 25,286 | 6,399 | 2,358 | 100.0 | 100.0 |
| 30 | 26,497 | 6,348 | 2,349 | 99.2 | 99.6 |
| 35 | 26,839 | 6,055 | 2,231 | 94.6 | 94.6 |
| 38 | 27,157 | 5,910 | 2,140 | 92.4 | 90.8 |
| 42 | 27,448 | 5,399 | 2,156 | 84.4 | 91.4 |
| 46 | 27,717 | 5,102 | 2,105 | 79.7 | 89.3 |
| 50 | 28,306 | 5,017 | 1,938 | 78.4 | 82.2 |
| 54 | 28,924 | 4,958 | 1,849 | 77.5 | 78.4 |
| 58 | 29,616 | 4,912 | 1,760 | 76.8 | 74.6 |
| 62 | 31,557 | 4,824 | 1,580 | 75.4 | 67.0 |
| 66 | 33,641 | 4,953 | 1,473 | 77.4 | 62.5 |
| 70 | 34,339 | 4,996 | 1,398 | 78.1 | 59.3 |
| 74 | 34,613 | 4,941 | 1,312 | 77.2 | 55.6 |
| 78 | 34,871 | 4,813 | 1,221 | 75.2 | 51.8 |
| 82 | 35,127 | 4,693 | 1,109 | 73.3 | 47.0 |
| 85.5 | 35,363 | 4,638 | 1,066 | 72.5 | 45.2 |
| **Chinook salmon** | | | | | |
| 6.2 | 22,307 | 7,925 | 4,064 | 56.6 | 42.8 |
| 10 | 23,494 | 9,561 | 5,752 | 68.3 | 60.7 |
| 14 | 24,052 | 10,816 | 6,811 | 77.3 | 71.8 |
| 18 | 24,516 | 11,681 | 7,548 | 83.5 | 79.6 |
| 22 | 24,920 | 12,164 | 8,015 | 86.9 | 84.5 |
| 26 | 25,286 | 12,487 | 8,325 | 89.2 | 87.8 |
| 30 | 26,497 | 12,850 | 8,571 | 91.8 | 90.4 |
| 35 | 26,839 | 13,190 | 8,747 | 94.3 | 92.2 |
| 38 | 27,157 | 13,493 | 8,823 | 96.4 | 93.0 |
| 42 | 27,448 | 13,709 | 9,141 | 98.0 | 96.4 |
| 46 | 27,717 | 13,765 | 9,318 | 98.4 | 98.2 |
| 50 | 28,306 | 13,995 | 9,484 | 100.0 | 100.0 |
| 54 | 28,924 | 13,951 | 9,416 | 99.7 | 99.3 |
| 58 | 29,616 | 13,798 | 9,207 | 98.6 | 97.1 |
| 62 | 31,557 | 13,735 | 9,100 | 98.1 | 95.9 |
| 66 | 33,641 | 13,623 | 8,862 | 97.3 | 93.4 |
| 70 | 34,339 | 13,429 | 8,512 | 96.0 | 89.7 |
| 74 | 34,613 | 13,175 | 8,105 | 94.1 | 85.5 |
| 78 | 34,871 | 12,750 | 7,511 | 91.1 | 79.2 |
| 82 | 35,127 | 12,361 | 7,128 | 88.3 | 75.2 |
| 85.5 | 35,363 | 11,962 | 6,659 | 85.5 | 70.2 |
| **Steelhead trout** | | | | | |
| 6.2 | 22,307 | 7,925 | 4,064 | 56.6 | 42.8 |
| 10 | 23,494 | 9,561 | 5,752 | 68.3 | 60.7 |
| 14 | 24,052 | 10,816 | 6,811 | 77.3 | 71.8 |
| 18 | 24,516 | 11,681 | 7,548 | 83.5 | 79.6 |
| 22 | 24,920 | 12,164 | 8,015 | 86.9 | 84.5 |
| 26 | 25,286 | 12,487 | 8,325 | 89.2 | 87.8 |
| 30 | 26,497 | 12,850 | 8,571 | 91.8 | 90.4 |
| 35 | 26,839 | 13,190 | 8,747 | 94.3 | 92.2 |
| 38 | 27,157 | 13,493 | 8,823 | 96.4 | 93.0 |
| 42 | 27,448 | 13,709 | 9,141 | 98.0 | 96.4 |
| 46 | 27,717 | 13,765 | 9,318 | 98.4 | 98.2 |
| 50 | 28,306 | 13,995 | 9,484 | 100.0 | 100.0 |
| 54 | 28,924 | 13,951 | 9,416 | 99.7 | 99.3 |
| 58 | 29,616 | 13,798 | 9,207 | 98.6 | 97.1 |
| 62 | 31,557 | 13,735 | 9,100 | 98.1 | 95.9 |
| 66 | 33,641 | 13,623 | 8,862 | 97.3 | 93.4 |
| 70 | 34,339 | 13,429 | 8,512 | 96.0 | 89.7 |
| 74 | 34,613 | 13,175 | 8,105 | 94.1 | 85.5 |
| 78 | 34,871 | 12,750 | 7,511 | 91.1 | 79.2 |
| 82 | 35,127 | 12,361 | 7,128 | 88.3 | 75.2 |
| 85.5 | 35,363 | 11,962 | 6,659 | 85.5 | 70.2 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2/1,000$ ft) | Percentage of maximum habitat |
|---|---|---|---|
| **EPT Invertebrates** | | | |
| 6.180 | 22,307 | 9,886 | 68.5 |
| 10 | 23,494 | 11,769 | 81.5 |
| 14 | 24,052 | 12,998 | 90.1 |
| 18 | 24,516 | 13,940 | 96.6 |
| 22 | 24,920 | 14,433 | 100.0 |
| 26 | 25,286 | 14,386 | 99.7 |
| 30 | 26,497 | 14,195 | 98.4 |
| 35 | 26,839 | 13,798 | 95.6 |
| 38 | 27,157 | 13,615 | 94.3 |
| 42 | 27,448 | 13,382 | 92.7 |
| 46 | 27,717 | 12,761 | 88.4 |
| 50 | 28,306 | 12,252 | 84.9 |
| 54 | 28,924 | 11,538 | 79.9 |
| 58 | 29,616 | 11,068 | 76.7 |
| 62 | 31,557 | 10,704 | 74.2 |
| 66 | 33,641 | 10,354 | 71.7 |
| 70 | 34,339 | 9,631 | 66.7 |
| 74 | 34,613 | 9,226 | 63.9 |
| 78 | 34,871 | 9,009 | 62.4 |
| 82 | 35,127 | 8,679 | 60.1 |
| 85.5 | 35,363 | 8,126 | 56.3 |

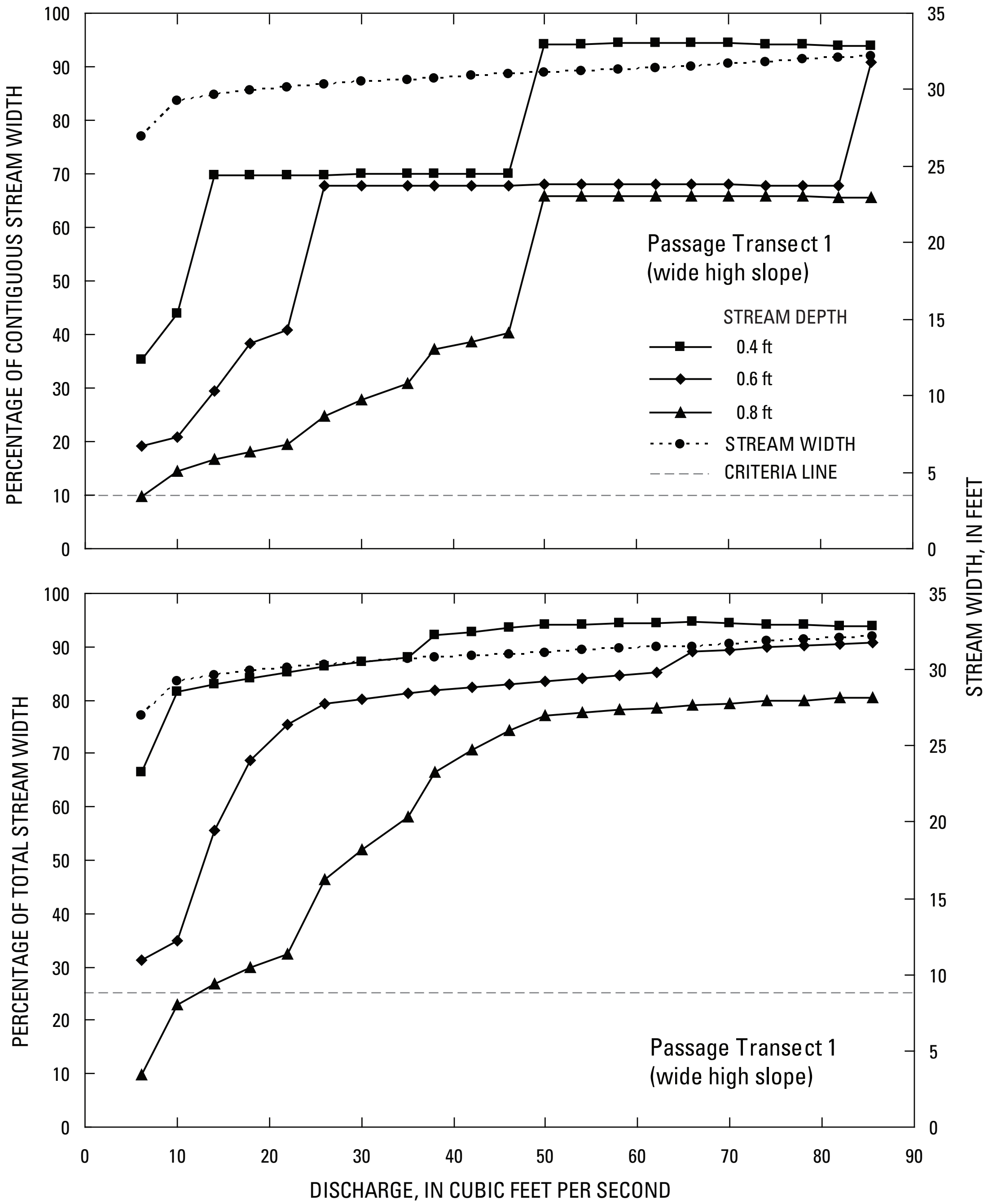



**Figure F3.** Percentages of contiguous and total stream width for passage transect 1, lower middle Challis Creek (CH2), upper Salmon River Basin, Idaho, 2005.

**Table F2.** Passage criteria assessment for transect 1 (wide high slope), site CH2, lower middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 6.2 | 27.0 | 17.9 | 66.4 | 9.5 | 35.2 |
| 10 | 29.2 | 23.9 | 81.7 | 12.8 | 43.8 |
| 14 | 29.6 | 24.6 | 83.0 | 20.7 | 69.8 |
| 18 | 29.9 | 25.2 | 84.2 | 20.9 | 69.8 |
| 22 | 30.1 | 25.7 | 85.3 | 21.0 | 69.8 |
| 26 | 30.3 | 26.1 | 86.2 | 21.2 | 69.9 |
| 30 | 30.5 | 26.5 | 87.0 | 21.3 | 69.9 |
| 35 | 30.7 | 27.0 | 87.9 | 21.4 | 69.9 |
| 38 | 30.8 | 28.3 | 92.1 | 21.5 | 70.0 |
| 42 | 30.9 | 28.7 | 92.9 | 21.6 | 70.0 |
| 46 | 31.0 | 29.0 | 93.5 | 21.7 | 70.0 |
| 50 | 31.1 | 29.3 | 94.0 | 29.3 | 94.0 |
| 54 | 31.2 | 29.4 | 94.2 | 29.4 | 94.2 |
| 58 | 31.3 | 29.6 | 94.3 | 29.6 | 94.3 |
| 62 | 31.4 | 29.7 | 94.5 | 29.7 | 94.5 |
| 66 | 31.5 | 29.8 | 94.6 | 29.8 | 94.6 |
| 70 | 31.7 | 29.9 | 94.4 | 29.9 | 94.4 |
| 74 | 31.8 | 30.0 | 94.3 | 30.0 | 94.3 |
| 78 | 32.0 | 30.1 | 94.1 | 30.1 | 94.1 |
| 82 | 32.1 | 30.2 | 94.0 | 30.2 | 94.0 |
| 85.5 | 32.2 | 30.2 | 93.9 | 30.2 | 93.9 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 6.2 | 27.0 | 8.5 | 31.4 | 5.2 | 19.2 |
| 10 | 29.2 | 10.2 | 35.0 | 6.1 | 20.9 |
| 14 | 29.6 | 16.5 | 55.6 | 8.8 | 29.6 |
| 18 | 29.9 | 20.6 | 68.8 | 11.5 | 38.3 |
| 22 | 30.1 | 22.7 | 75.5 | 12.3 | 40.9 |
| 26 | 30.3 | 24.1 | 79.4 | 20.5 | 67.7 |
| 30 | 30.5 | 24.5 | 80.3 | 20.6 | 67.7 |
| 35 | 30.7 | 24.9 | 81.2 | 20.8 | 67.8 |
| 38 | 30.8 | 25.2 | 81.8 | 20.9 | 67.8 |
| 42 | 30.9 | 25.5 | 82.4 | 21.0 | 67.9 |
| 46 | 31.0 | 25.8 | 83.0 | 21.1 | 67.9 |
| 50 | 31.1 | 26.0 | 83.6 | 21.1 | 67.9 |
| 54 | 31.2 | 26.3 | 84.2 | 21.2 | 68.0 |
| 58 | 31.3 | 26.5 | 84.7 | 21.3 | 68.0 |
| 62 | 31.4 | 26.8 | 85.2 | 21.4 | 68.0 |
| 66 | 31.5 | 28.1 | 89.1 | 21.5 | 68.1 |
| 70 | 31.7 | 28.4 | 89.5 | 21.5 | 68.0 |
| 74 | 31.8 | 28.6 | 89.8 | 21.6 | 67.9 |
| 78 | 32.0 | 28.8 | 90.1 | 21.7 | 67.8 |
| 82 | 32.1 | 29.0 | 90.5 | 21.7 | 67.7 |
| 85.5 | 32.2 | 29.2 | 90.7 | 29.2 | 90.7 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 6.2 | 27.0 | 2.6 | 9.8 | 2.6 | 9.8 |
| 10 | 29.2 | 6.7 | 22.9 | 4.3 | 14.6 |
| 14 | 29.6 | 7.9 | 26.7 | 4.9 | 16.5 |
| 18 | 29.9 | 8.9 | 29.8 | 5.4 | 18.1 |
| 22 | 30.1 | 9.8 | 32.4 | 5.9 | 19.5 |
| 26 | 30.3 | 14.0 | 46.3 | 7.5 | 24.9 |
| 30 | 30.5 | 15.9 | 52.1 | 8.5 | 27.7 |
| 35 | 30.7 | 17.8 | 58.2 | 9.5 | 30.8 |
| 38 | 30.8 | 20.5 | 66.5 | 11.4 | 37.1 |
| 42 | 30.9 | 21.8 | 70.6 | 12.0 | 38.7 |
| 46 | 31.0 | 23.1 | 74.3 | 12.5 | 40.2 |
| 50 | 31.1 | 24.0 | 77.0 | 20.5 | 65.8 |
| 54 | 31.2 | 24.2 | 77.6 | 20.6 | 65.8 |
| 58 | 31.3 | 24.5 | 78.1 | 20.6 | 65.9 |
| 62 | 31.4 | 24.7 | 78.6 | 20.7 | 65.9 |
| 66 | 31.5 | 24.9 | 79.1 | 20.8 | 66.0 |
| 70 | 31.7 | 25.2 | 79.4 | 20.9 | 65.9 |
| 74 | 31.8 | 25.4 | 79.8 | 20.9 | 65.8 |
| 78 | 32.0 | 25.6 | 80.0 | 21.0 | 65.7 |
| 82 | 32.1 | 25.8 | 80.3 | 21.1 | 65.6 |
| 85.5 | 32.2 | 26.0 | 80.6 | 21.1 | 65.6 |

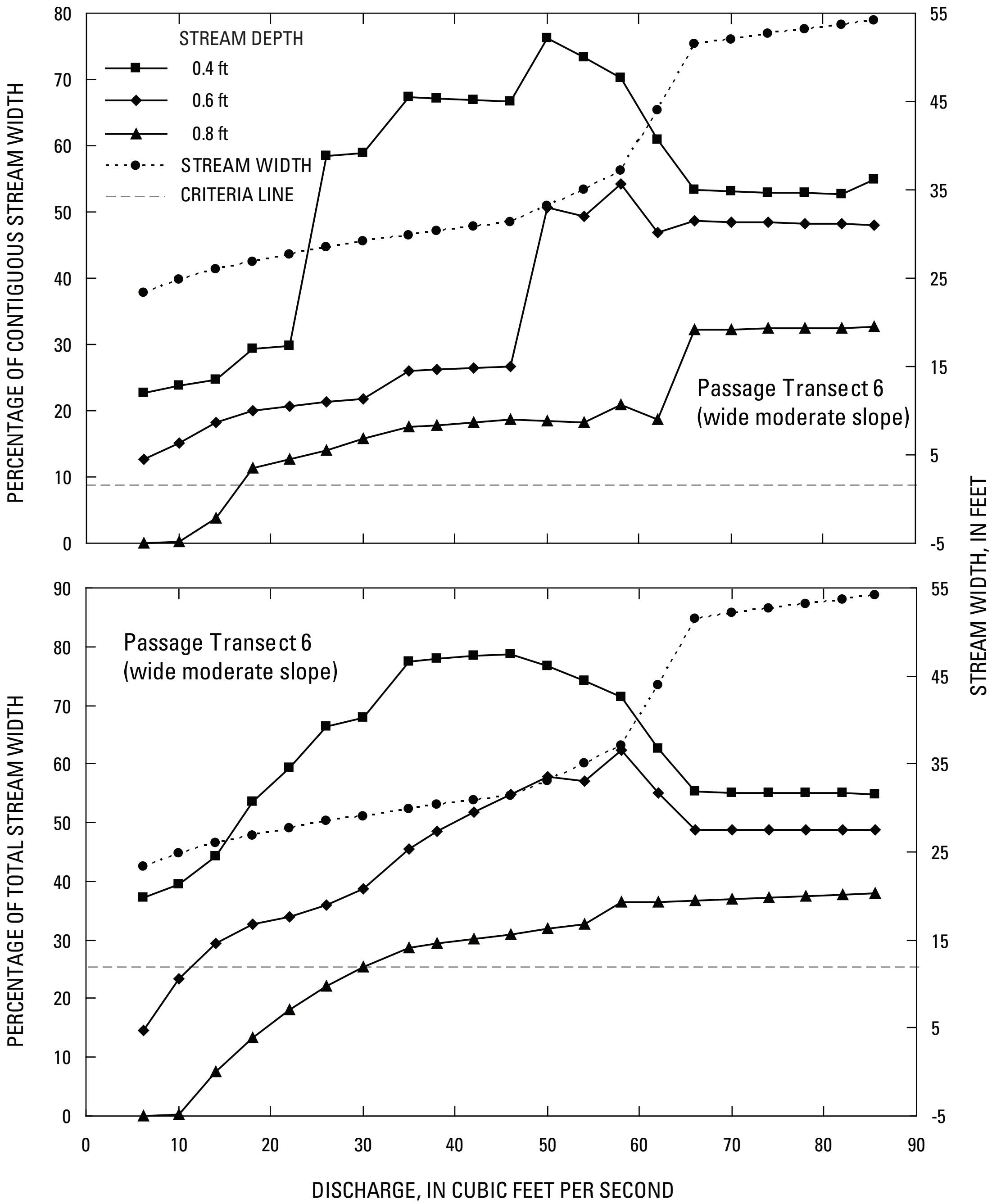



**Figure F4.** Percentages of contiguous and total stream width for passage transect 6, lower middle Challis Creek (CH2), upper Salmon River Basin, Idaho, 2005.

**Table F3.** Passage criteria assessment for transect 6 (wide moderate slope), site CH2, lower middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 6.2 | 23.4 | 8.7 | 37.3 | 5.3 | 22.7 |
| 10 | 24.9 | 9.8 | 39.4 | 5.9 | 23.8 |
| 14 | 26.0 | 11.5 | 44.2 | 6.4 | 24.7 |
| 18 | 26.9 | 14.4 | 53.6 | 7.9 | 29.4 |
| 22 | 27.7 | 16.4 | 59.3 | 8.3 | 29.8 |
| 26 | 28.5 | 18.9 | 66.4 | 16.6 | 58.4 |
| 30 | 29.1 | 19.7 | 67.9 | 17.1 | 58.9 |
| 35 | 29.9 | 23.1 | 77.5 | 20.1 | 67.4 |
| 38 | 30.3 | 23.6 | 77.9 | 20.4 | 67.2 |
| 42 | 30.9 | 24.2 | 78.4 | 20.7 | 66.9 |
| 46 | 31.4 | 24.7 | 78.8 | 20.9 | 66.7 |
| 50 | 33.1 | 25.3 | 76.6 | 25.2 | 76.1 |
| 54 | 35.0 | 26.0 | 74.2 | 25.7 | 73.3 |
| 58 | 37.1 | 26.5 | 71.5 | 26.1 | 70.3 |
| 62 | 44.0 | 27.6 | 62.6 | 26.8 | 61.0 |
| 66 | 51.5 | 28.4 | 55.2 | 27.5 | 53.4 |
| 70 | 52.1 | 28.7 | 55.1 | 27.7 | 53.2 |
| 74 | 52.6 | 29.0 | 55.1 | 27.9 | 53.0 |
| 78 | 53.2 | 29.3 | 55.0 | 28.1 | 52.8 |
| 82 | 53.7 | 29.5 | 55.0 | 28.3 | 52.7 |
| 85.5 | 54.2 | 29.8 | 54.9 | 29.8 | 54.9 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 6.2 | 23.4 | 3.4 | 14.5 | 3.0 | 12.8 |
| 10 | 24.9 | 5.8 | 23.4 | 3.7 | 15.0 |
| 14 | 26.0 | 7.6 | 29.4 | 4.7 | 18.2 |
| 18 | 26.9 | 8.8 | 32.7 | 5.4 | 19.9 |
| 22 | 27.7 | 9.4 | 34.0 | 5.7 | 20.7 |
| 26 | 28.5 | 10.3 | 36.1 | 6.1 | 21.3 |
| 30 | 29.1 | 11.2 | 38.7 | 6.3 | 21.8 |
| 35 | 29.9 | 13.6 | 45.6 | 7.8 | 26.0 |
| 38 | 30.3 | 14.7 | 48.5 | 8.0 | 26.3 |
| 42 | 30.9 | 16.0 | 51.9 | 8.2 | 26.5 |
| 46 | 31.4 | 17.2 | 54.9 | 8.4 | 26.8 |
| 50 | 33.1 | 19.1 | 57.8 | 16.8 | 50.6 |
| 54 | 35.0 | 19.9 | 57.0 | 17.3 | 49.3 |
| 58 | 37.1 | 23.1 | 62.2 | 20.1 | 54.2 |
| 62 | 44.0 | 24.2 | 55.0 | 20.7 | 47.0 |
| 66 | 51.5 | 25.1 | 48.8 | 25.0 | 48.7 |
| 70 | 52.1 | 25.4 | 48.8 | 25.3 | 48.5 |
| 74 | 52.6 | 25.7 | 48.8 | 25.5 | 48.4 |
| 78 | 53.2 | 26.0 | 48.8 | 25.7 | 48.3 |
| 82 | 53.7 | 26.2 | 48.8 | 25.9 | 48.1 |
| 85.5 | 54.2 | 26.5 | 48.8 | 26.0 | 48.0 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 6.2 | 23.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 24.9 | 0.1 | 0.3 | 0.0 | 0.1 |
| 14 | 26.0 | 2.0 | 7.5 | 1.0 | 3.8 |
| 18 | 26.9 | 3.6 | 13.3 | 3.0 | 11.3 |
| 22 | 27.7 | 5.0 | 18.2 | 3.5 | 12.6 |
| 26 | 28.5 | 6.3 | 22.2 | 4.0 | 14.1 |
| 30 | 29.1 | 7.4 | 25.4 | 4.6 | 15.7 |
| 35 | 29.9 | 8.5 | 28.6 | 5.2 | 17.5 |
| 38 | 30.3 | 8.9 | 29.3 | 5.4 | 17.8 |
| 42 | 30.9 | 9.3 | 30.1 | 5.6 | 18.3 |
| 46 | 31.4 | 9.7 | 30.8 | 5.9 | 18.7 |
| 50 | 33.1 | 10.5 | 31.9 | 6.1 | 18.5 |
| 54 | 35.0 | 11.5 | 32.8 | 6.4 | 18.3 |
| 58 | 37.1 | 13.6 | 36.5 | 7.8 | 20.9 |
| 62 | 44.0 | 16.1 | 36.5 | 8.2 | 18.6 |
| 66 | 51.5 | 18.8 | 36.6 | 16.6 | 32.2 |
| 70 | 52.1 | 19.2 | 36.9 | 16.8 | 32.3 |
| 74 | 52.6 | 19.6 | 37.2 | 17.1 | 32.4 |
| 78 | 53.2 | 20.0 | 37.5 | 17.3 | 32.5 |
| 82 | 53.7 | 20.3 | 37.8 | 17.5 | 32.5 |
| 85.5 | 54.2 | 20.6 | 38.0 | 17.7 | 32.6 |

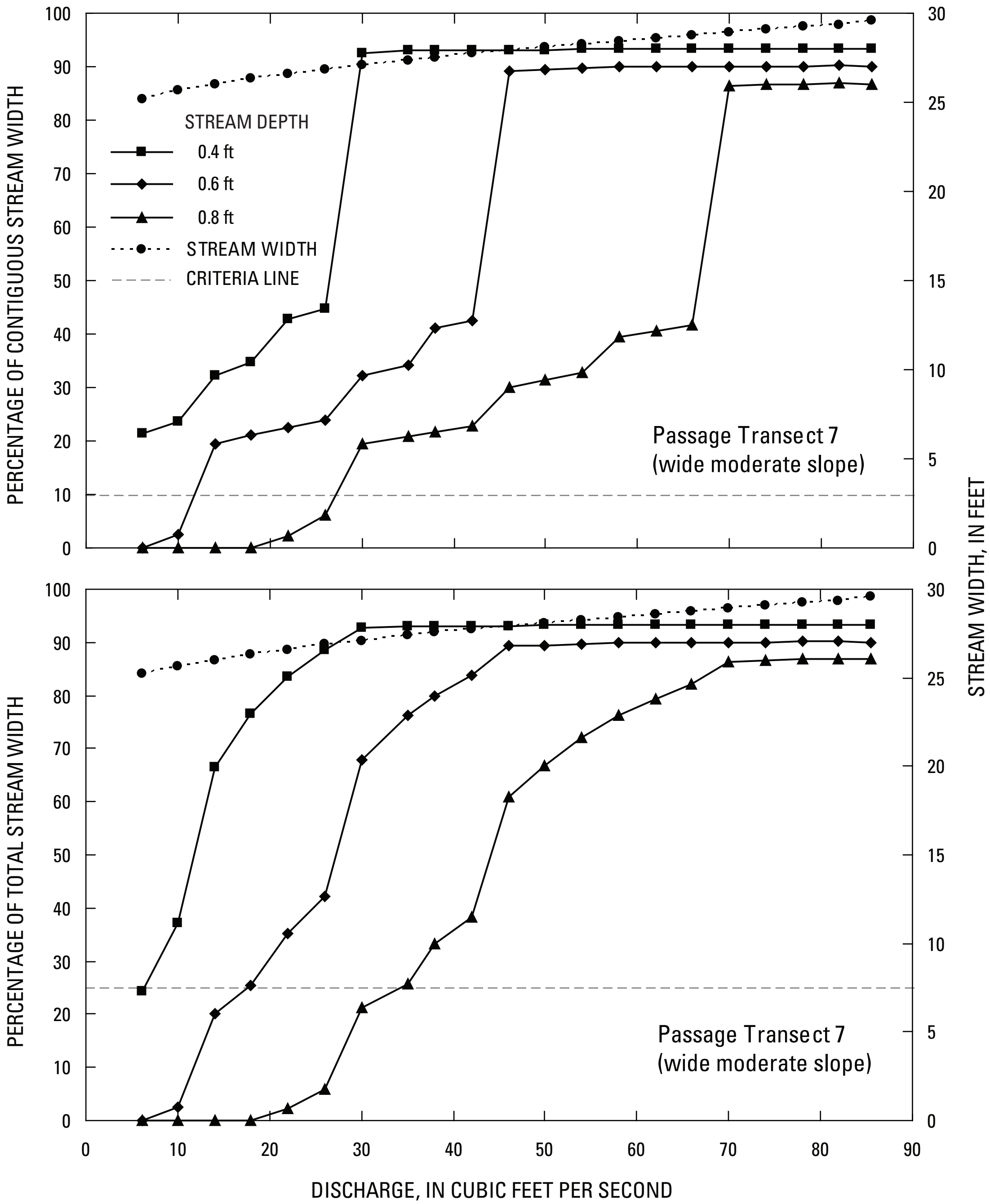


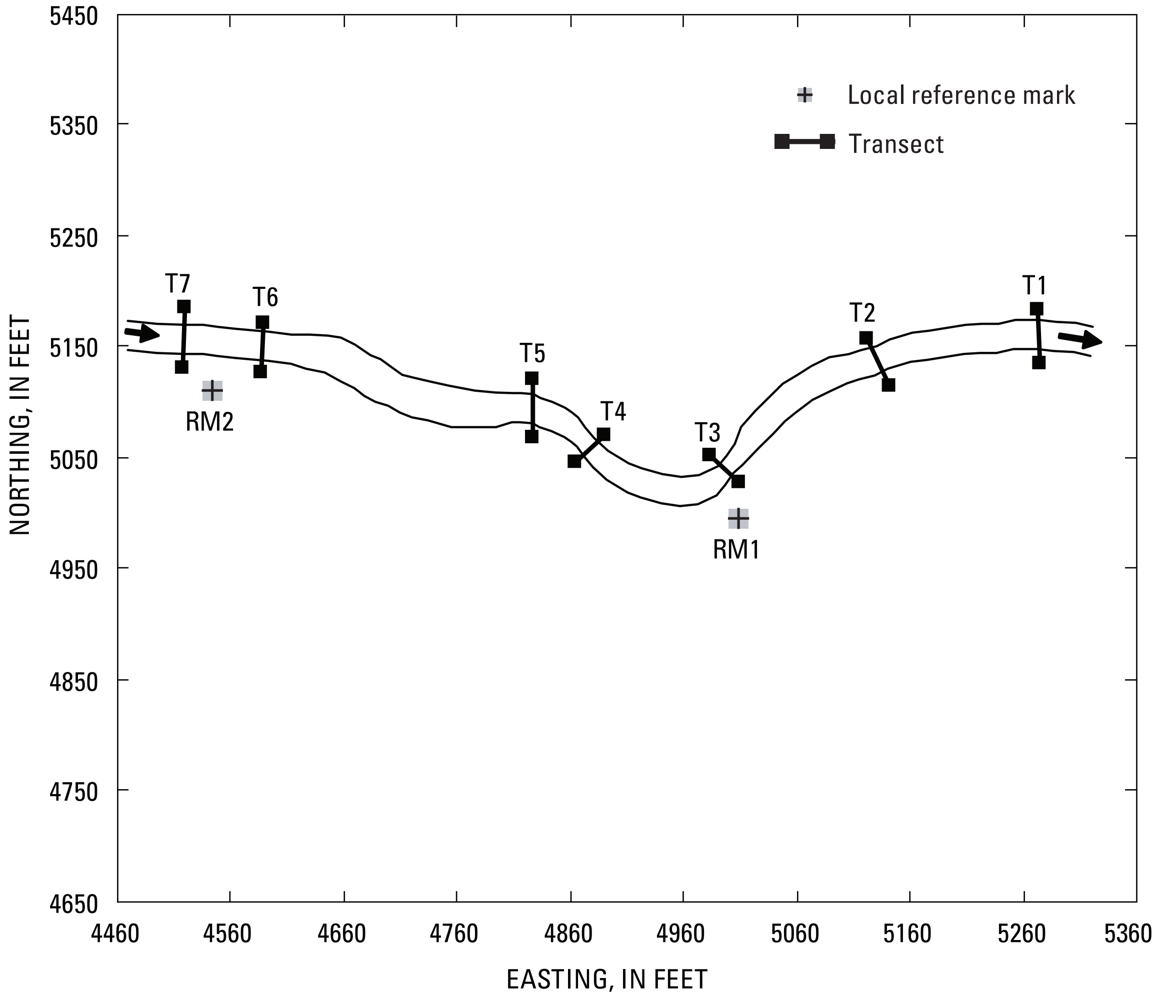

**Figure F5.** Percentages of contiguous and total stream width for passage transect 7, lower middle Challis Creek (CH2), upper Salmon River Basin, Idaho, 2005.

**Table F4.** Passage criteria assessment for transect 7 (wide moderate slope), site CH2, lower middle Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 6.2 | 25.2 | 6.1 | 24.3 | 5.4 | 21.4 |
| 10 | 25.7 | 9.5 | 37.1 | 6.0 | 23.6 |
| 14 | 26.0 | 17.3 | 66.4 | 8.4 | 32.3 |
| 18 | 26.3 | 20.1 | 76.4 | 9.2 | 34.9 |
| 22 | 26.6 | 22.2 | 83.5 | 11.4 | 42.9 |
| 26 | 26.9 | 23.8 | 88.5 | 12.0 | 44.8 |
| 30 | 27.1 | 25.1 | 92.6 | 25.1 | 92.6 |
| 35 | 27.4 | 25.4 | 92.9 | 25.4 | 92.9 |
| 38 | 27.5 | 25.6 | 93.0 | 25.6 | 93.0 |
| 42 | 27.7 | 25.8 | 93.1 | 25.8 | 93.1 |
| 46 | 27.9 | 26.0 | 93.1 | 26.0 | 93.1 |
| 50 | 28.1 | 26.2 | 93.2 | 26.2 | 93.2 |
| 54 | 28.3 | 26.4 | 93.2 | 26.4 | 93.2 |
| 58 | 28.4 | 26.5 | 93.2 | 26.5 | 93.2 |
| 62 | 28.6 | 26.7 | 93.3 | 26.7 | 93.3 |
| 66 | 28.8 | 26.8 | 93.3 | 26.8 | 93.3 |
| 70 | 28.9 | 27.0 | 93.4 | 27.0 | 93.4 |
| 74 | 29.1 | 27.1 | 93.4 | 27.1 | 93.4 |
| 78 | 29.2 | 27.3 | 93.4 | 27.3 | 93.4 |
| 82 | 29.4 | 27.4 | 93.4 | 27.4 | 93.4 |
| 85.5 | 29.5 | 27.6 | 93.3 | 27.6 | 93.3 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 6.2 | 25.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 25.7 | 0.7 | 2.6 | 0.7 | 2.6 |
| 14 | 26.0 | 5.2 | 20.0 | 5.1 | 19.5 |
| 18 | 26.3 | 6.7 | 25.3 | 5.6 | 21.1 |
| 22 | 26.6 | 9.4 | 35.2 | 6.0 | 22.6 |
| 26 | 26.9 | 11.3 | 42.1 | 6.4 | 23.9 |
| 30 | 27.1 | 18.4 | 67.9 | 8.7 | 32.2 |
| 35 | 27.4 | 20.9 | 76.4 | 9.4 | 34.3 |
| 38 | 27.5 | 22.0 | 79.9 | 11.3 | 41.1 |
| 42 | 27.7 | 23.2 | 83.7 | 11.8 | 42.6 |
| 46 | 27.9 | 24.9 | 89.3 | 24.9 | 89.3 |
| 50 | 28.1 | 25.2 | 89.5 | 25.2 | 89.5 |
| 54 | 28.3 | 25.4 | 89.7 | 25.4 | 89.7 |
| 58 | 28.4 | 25.6 | 89.9 | 25.6 | 89.9 |
| 62 | 28.6 | 25.7 | 89.9 | 25.7 | 89.9 |
| 66 | 28.8 | 25.9 | 90.0 | 25.9 | 90.0 |
| 70 | 28.9 | 26.0 | 90.0 | 26.0 | 90.0 |
| 74 | 29.1 | 26.2 | 90.1 | 26.2 | 90.1 |
| 78 | 29.2 | 26.3 | 90.1 | 26.3 | 90.1 |
| 82 | 29.4 | 26.5 | 90.2 | 26.5 | 90.2 |
| 85.5 | 29.5 | 26.6 | 90.0 | 26.6 | 90.0 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 6.2 | 25.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 25.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14 | 26.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 26.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 26.6 | 0.6 | 2.2 | 0.6 | 2.2 |
| 26 | 26.9 | 1.6 | 6.0 | 1.6 | 6.0 |
| 30 | 27.1 | 5.8 | 21.3 | 5.3 | 19.4 |
| 35 | 27.4 | 7.1 | 25.8 | 5.7 | 20.8 |
| 38 | 27.5 | 9.1 | 33.1 | 6.0 | 21.6 |
| 42 | 27.7 | 10.6 | 38.3 | 6.3 | 22.7 |
| 46 | 27.9 | 17.0 | 61.0 | 8.3 | 29.9 |
| 50 | 28.1 | 18.8 | 66.8 | 8.8 | 31.4 |
| 54 | 28.3 | 20.4 | 72.1 | 9.2 | 32.7 |
| 58 | 28.4 | 21.7 | 76.4 | 11.2 | 39.4 |
| 62 | 28.6 | 22.7 | 79.4 | 11.6 | 40.6 |
| 66 | 28.8 | 23.7 | 82.2 | 12.0 | 41.7 |
| 70 | 28.9 | 25.0 | 86.4 | 25.0 | 86.4 |
| 74 | 29.1 | 25.2 | 86.6 | 25.2 | 86.6 |
| 78 | 29.2 | 25.3 | 86.7 | 25.3 | 86.7 |
| 82 | 29.4 | 25.5 | 86.9 | 25.5 | 86.9 |
| 85.5 | 29.5 | 25.6 | 86.8 | 25.6 | 86.8 |

**Appendix G.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for lower Challis Creek (CH1), upper Salmon River Basin, Idaho, 2005.




| Point | Latitude | Longitude |
|---|---|---|
| RH1 | 44° 34' 10.97" N | 114° 11' 19.61" W |
| LH1 | 44° 34' 10.6" N | 114° 11' 19.61" W |
| RH2 | 44° 34' 10.72" N | 114° 11' 21.78" W |
| LH2 | 44° 34' 10.41" N | 114° 11' 21.51" W |
| RH3 | 44° 34' 9.85" N | 114° 11' 23.82" W |
| LH3 | 44° 34' 9.68" N | 114° 11' 23.43" W |
| RH4 | 44° 34' 9.97" N | 114° 11' 25.13" W |
| LH4 | 44° 34' 9.76" N | 114° 11' 25.49" W |
| RH5 | 44° 34' 10.32" N | 114° 11' 25.99" W |
| LH5 | 44° 34' 9.91" N | 114° 11' 26.01" W |
| RH6 | 44° 34' 10.63" N | 114° 11' 29.31" W |
| LH6 | 44° 34' 10.28" N | 114° 11' 29.39" W |
| RH7 | 44° 34' 10.71" N | 114° 11' 30.3" W |
| LH7 | 44° 34' 10.3" N | 114° 11' 30.38" W |

Transect Endpoint Coordinates (NAD 83)

For reference only; stream schematic not to scale.

**Figure G1.** Plan view of lower Challis Creek (CH1), upper Salmon River Basin, Idaho, 2005.

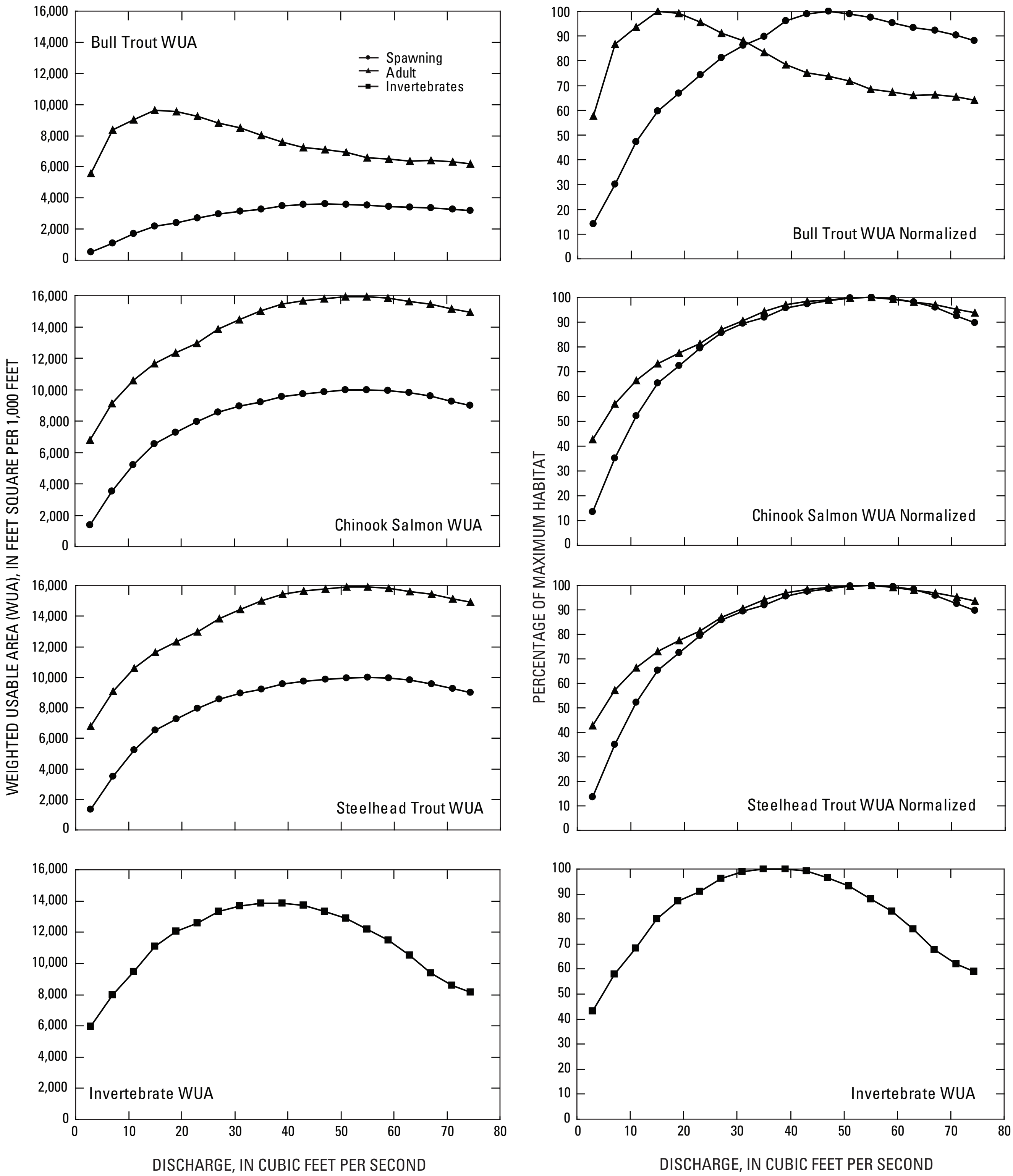



**Figure G2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, lower Challis Creek (CH1), upper Salmon River Basin, Idaho, 2005.

**Table G1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site CH1, lower Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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** | | | | | |
| 2.9 | 17,831 | 5,573 | 508 | 57.8 | 14.0 |
| 7 | 20,368 | 8,356 | 1,094 | 86.6 | 30.2 |
| 11 | 21,829 | 9,037 | 1,710 | 93.7 | 47.2 |
| 15 | 23,491 | 9,648 | 2,166 | 100.0 | 59.8 |
| 19 | 24,529 | 9,566 | 2,419 | 99.2 | 66.8 |
| 23 | 25,366 | 9,223 | 2,690 | 95.6 | 74.2 |
| 27 | 26,832 | 8,801 | 2,946 | 91.2 | 81.3 |
| 31 | 27,280 | 8,496 | 3,126 | 88.1 | 86.3 |
| 35 | 27,964 | 8,035 | 3,252 | 83.3 | 89.8 |
| 39 | 28,436 | 7,575 | 3,485 | 78.5 | 96.2 |
| 43 | 28,795 | 7,243 | 3,582 | 75.1 | 98.8 |
| 47 | 29,126 | 7,125 | 3,624 | 73.9 | 100.0 |
| 51 | 29,580 | 6,926 | 3,587 | 71.8 | 99.0 |
| 55 | 29,771 | 6,602 | 3,531 | 68.4 | 97.4 |
| 59 | 29,947 | 6,515 | 3,450 | 67.5 | 95.2 |
| 63 | 30,119 | 6,376 | 3,382 | 66.1 | 93.3 |
| 67 | 30,292 | 6,397 | 3,345 | 66.3 | 92.3 |
| 71 | 30,461 | 6,310 | 3,269 | 65.4 | 90.2 |
| 74.400 | 30,596 | 6,186 | 3,195 | 64.1 | 88.2 |
| **Chinook salmon** | | | | | |
| 2.9 | 17,831 | 6,798 | 1,359 | 42.7 | 13.6 |
| 7 | 20,368 | 9,101 | 3,512 | 57.2 | 35.1 |
| 11 | 21,829 | 10,589 | 5,225 | 66.5 | 52.3 |
| 15 | 23,491 | 11,653 | 6,535 | 73.2 | 65.4 |
| 19 | 24,529 | 12,340 | 7,254 | 77.5 | 72.6 |
| 23 | 25,366 | 12,966 | 7,945 | 81.4 | 79.5 |
| 27 | 26,832 | 13,851 | 8,577 | 87.0 | 85.8 |
| 31 | 27,280 | 14,432 | 8,938 | 90.6 | 89.4 |
| 35 | 27,964 | 15,014 | 9,193 | 94.3 | 92.0 |
| 39 | 28,436 | 15,447 | 9,554 | 97.0 | 95.6 |
| 43 | 28,795 | 15,659 | 9,736 | 98.3 | 97.4 |
| 47 | 29,126 | 15,774 | 9,869 | 99.1 | 98.7 |
| 51 | 29,580 | 15,898 | 9,963 | 99.8 | 99.7 |
| 55 | 29,771 | 15,925 | 9,996 | 100.0 | 100.0 |
| 59 | 29,947 | 15,806 | 9,934 | 99.3 | 99.4 |
| 63 | 30,119 | 15,615 | 9,817 | 98.1 | 98.2 |
| 67 | 30,292 | 15,431 | 9,578 | 96.9 | 95.8 |
| 71 | 30,461 | 15,154 | 9,247 | 95.2 | 92.5 |
| 74.400 | 30,596 | 14,928 | 8,976 | 93.7 | 89.8 |
| **Steelhead trout** | | | | | |
| 2.9 | 17,831 | 6,798 | 1,359 | 42.7 | 13.6 |
| 7 | 20,368 | 9,101 | 3,512 | 57.2 | 35.1 |
| 11 | 21,829 | 10,589 | 5,225 | 66.5 | 52.3 |
| 15 | 23,491 | 11,653 | 6,535 | 73.2 | 65.4 |
| 19 | 24,529 | 12,340 | 7,254 | 77.5 | 72.6 |
| 23 | 25,366 | 12,966 | 7,945 | 81.4 | 79.5 |
| 27 | 26,832 | 13,851 | 8,577 | 87.0 | 85.8 |
| 31 | 27,280 | 14,432 | 8,938 | 90.6 | 89.4 |
| 35 | 27,964 | 15,014 | 9,193 | 94.3 | 92.0 |
| 39 | 28,436 | 15,447 | 9,554 | 97.0 | 95.6 |
| 43 | 28,795 | 15,659 | 9,736 | 98.3 | 97.4 |
| 47 | 29,126 | 15,774 | 9,869 | 99.1 | 98.7 |
| 51 | 29,580 | 15,898 | 9,963 | 99.8 | 99.7 |
| 55 | 29,771 | 15,925 | 9,996 | 100.0 | 100.0 |
| 59 | 29,947 | 15,806 | 9,934 | 99.3 | 99.4 |
| 63 | 30,119 | 15,615 | 9,817 | 98.1 | 98.2 |
| 67 | 30,292 | 15,431 | 9,578 | 96.9 | 95.8 |
| 71 | 30,461 | 15,154 | 9,247 | 95.2 | 92.5 |
| 74.400 | 30,596 | 14,928 | 8,976 | 93.7 | 89.8 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2/1,000$ ft) | Percentage of maximum habitat |
|---|---|---|---|
| **EPT Invertebrates** | | | |
| 2.880 | 17,831 | 5,982 | 43 |
| 7 | 20,368 | 7,996 | 58 |
| 11 | 21,829 | 9,447 | 68 |
| 15 | 23,491 | 11,074 | 80 |
| 19 | 24,529 | 12,040 | 87 |
| 23 | 25,366 | 12,576 | 91 |
| 27 | 26,832 | 13,315 | 96 |
| 31 | 27,280 | 13,699 | 99 |
| 35 | 27,964 | 13,835 | 100 |
| 39 | 28,436 | 13,836 | 100 |
| 43 | 28,795 | 13,715 | 99 |
| 47 | 29,126 | 13,328 | 96 |
| 51 | 29,580 | 12,877 | 93 |
| 55 | 29,771 | 12,183 | 88 |
| 59 | 29,947 | 11,505 | 83 |
| 63 | 30,119 | 10,523 | 76 |
| 67 | 30,292 | 9,389 | 68 |
| 71 | 30,461 | 8,574 | 62 |
| 74.400 | 30,596 | 8,155 | 59 |

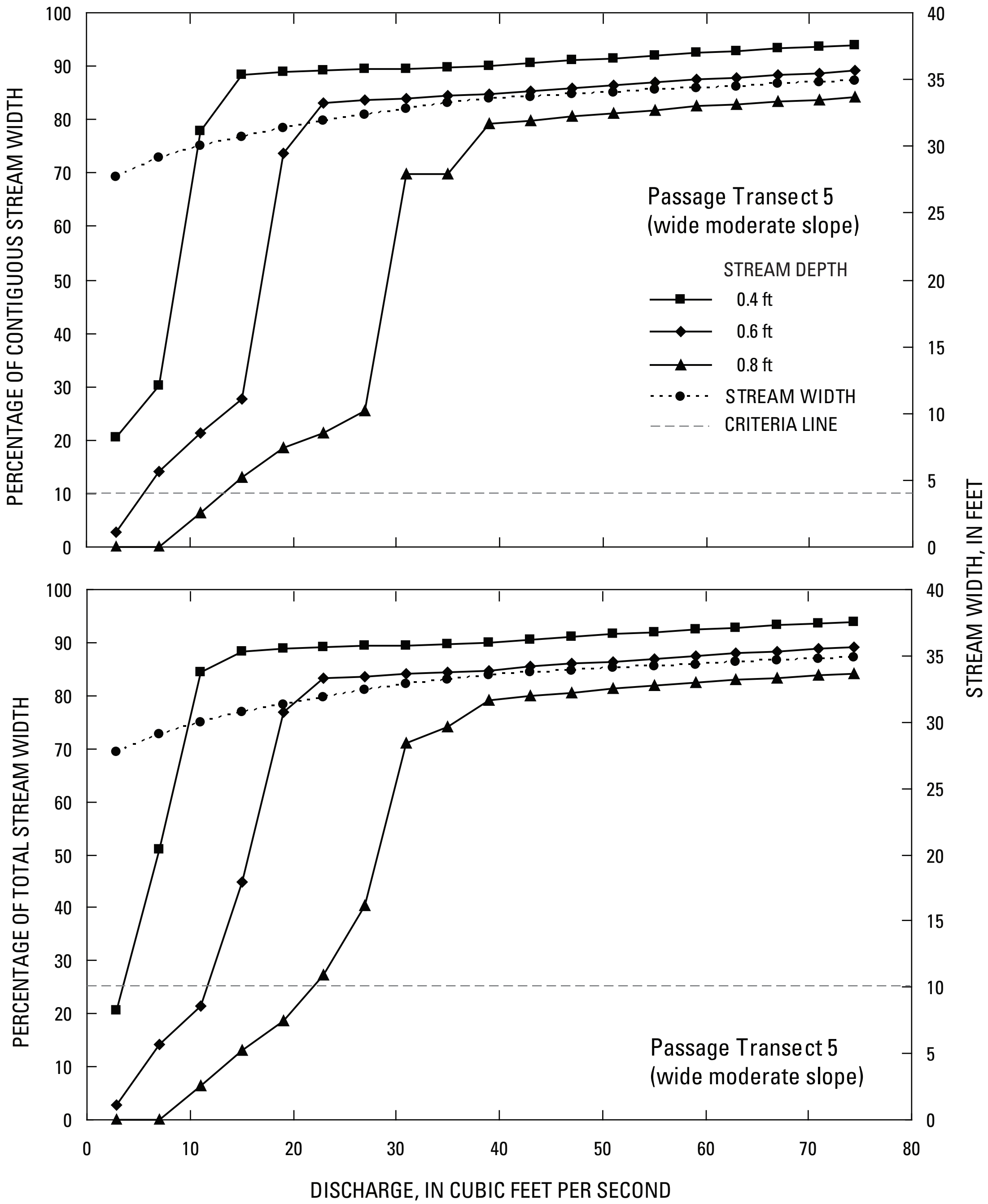



**Figure G3.** Percentages of contiguous and total stream width for passage transect 5, lower Challis Creek (CH1), upper Salmon River Basin, Idaho, 2005.

**Table G2.** Passage criteria assessment for transect 5 (wide moderate slope), site CH1, lower Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 2.9 | 27.7 | 5.7 | 20.6 | 5.7 | 20.6 |
| 7 | 29.1 | 14.8 | 50.9 | 8.8 | 30.3 |
| 11 | 30.0 | 25.3 | 84.3 | 23.4 | 77.9 |
| 15 | 30.7 | 27.2 | 88.4 | 27.2 | 88.4 |
| 19 | 31.3 | 27.8 | 88.9 | 27.8 | 88.9 |
| 23 | 31.9 | 28.4 | 89.2 | 28.4 | 89.2 |
| 27 | 32.4 | 28.9 | 89.4 | 28.9 | 89.4 |
| 31 | 32.8 | 29.4 | 89.5 | 29.4 | 89.5 |
| 35 | 33.2 | 29.8 | 89.6 | 29.8 | 89.6 |
| 39 | 33.5 | 30.2 | 89.9 | 30.2 | 89.9 |
| 43 | 33.7 | 30.5 | 90.5 | 30.5 | 90.5 |
| 47 | 33.9 | 30.9 | 91.0 | 30.9 | 91.0 |
| 51 | 34.1 | 31.2 | 91.5 | 31.2 | 91.5 |
| 55 | 34.2 | 31.5 | 92.0 | 31.5 | 92.0 |
| 59 | 34.4 | 31.8 | 92.4 | 31.8 | 92.4 |
| 63 | 34.5 | 32.0 | 92.9 | 32.0 | 92.9 |
| 67 | 34.6 | 32.3 | 93.3 | 32.3 | 93.3 |
| 71 | 34.8 | 32.6 | 93.7 | 32.6 | 93.7 |
| 74.4 | 34.9 | 32.8 | 94.0 | 32.8 | 94.0 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 2.9 | 27.7 | 0.8 | 2.9 | 0.8 | 2.9 |
| 7 | 29.1 | 4.1 | 14.2 | 4.1 | 14.2 |
| 11 | 30.0 | 6.4 | 21.3 | 6.4 | 21.3 |
| 15 | 30.7 | 13.8 | 44.9 | 8.5 | 27.6 |
| 19 | 31.3 | 24.1 | 76.8 | 23.1 | 73.6 |
| 23 | 31.9 | 26.5 | 83.2 | 26.5 | 83.2 |
| 27 | 32.4 | 27.1 | 83.7 | 27.1 | 83.7 |
| 31 | 32.8 | 27.6 | 84.0 | 27.6 | 84.0 |
| 35 | 33.2 | 28.0 | 84.4 | 28.0 | 84.4 |
| 39 | 33.5 | 28.5 | 84.8 | 28.5 | 84.8 |
| 43 | 33.7 | 28.8 | 85.4 | 28.8 | 85.4 |
| 47 | 33.9 | 29.1 | 86.0 | 29.1 | 86.0 |
| 51 | 34.1 | 29.5 | 86.5 | 29.5 | 86.5 |
| 55 | 34.2 | 29.8 | 87.0 | 29.8 | 87.0 |
| 59 | 34.4 | 30.0 | 87.4 | 30.0 | 87.4 |
| 63 | 34.5 | 30.3 | 87.9 | 30.3 | 87.9 |
| 67 | 34.6 | 30.6 | 88.3 | 30.6 | 88.3 |
| 71 | 34.8 | 30.9 | 88.7 | 30.9 | 88.7 |
| 74.4 | 34.9 | 31.1 | 89.1 | 31.1 | 89.1 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 2.9 | 27.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 29.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 30.0 | 1.9 | 6.4 | 1.9 | 6.4 |
| 15 | 30.7 | 4.0 | 13.0 | 4.0 | 13.0 |
| 19 | 31.3 | 5.8 | 18.6 | 5.8 | 18.6 |
| 23 | 31.9 | 8.7 | 27.3 | 6.8 | 21.3 |
| 27 | 32.4 | 13.1 | 40.5 | 8.2 | 25.5 |
| 31 | 32.8 | 23.3 | 71.1 | 22.9 | 69.7 |
| 35 | 33.2 | 24.6 | 74.1 | 23.2 | 69.8 |
| 39 | 33.5 | 26.5 | 79.1 | 26.5 | 79.1 |
| 43 | 33.7 | 26.9 | 79.9 | 26.9 | 79.9 |
| 47 | 33.9 | 27.3 | 80.6 | 27.3 | 80.6 |
| 51 | 34.1 | 27.7 | 81.2 | 27.7 | 81.2 |
| 55 | 34.2 | 28.0 | 81.9 | 28.0 | 81.9 |
| 59 | 34.4 | 28.3 | 82.4 | 28.3 | 82.4 |
| 63 | 34.5 | 28.6 | 82.9 | 28.6 | 82.9 |
| 67 | 34.6 | 28.9 | 83.4 | 28.9 | 83.4 |
| 71 | 34.8 | 29.1 | 83.8 | 29.1 | 83.8 |
| 74.4 | 34.9 | 29.4 | 84.1 | 29.4 | 84.1 |

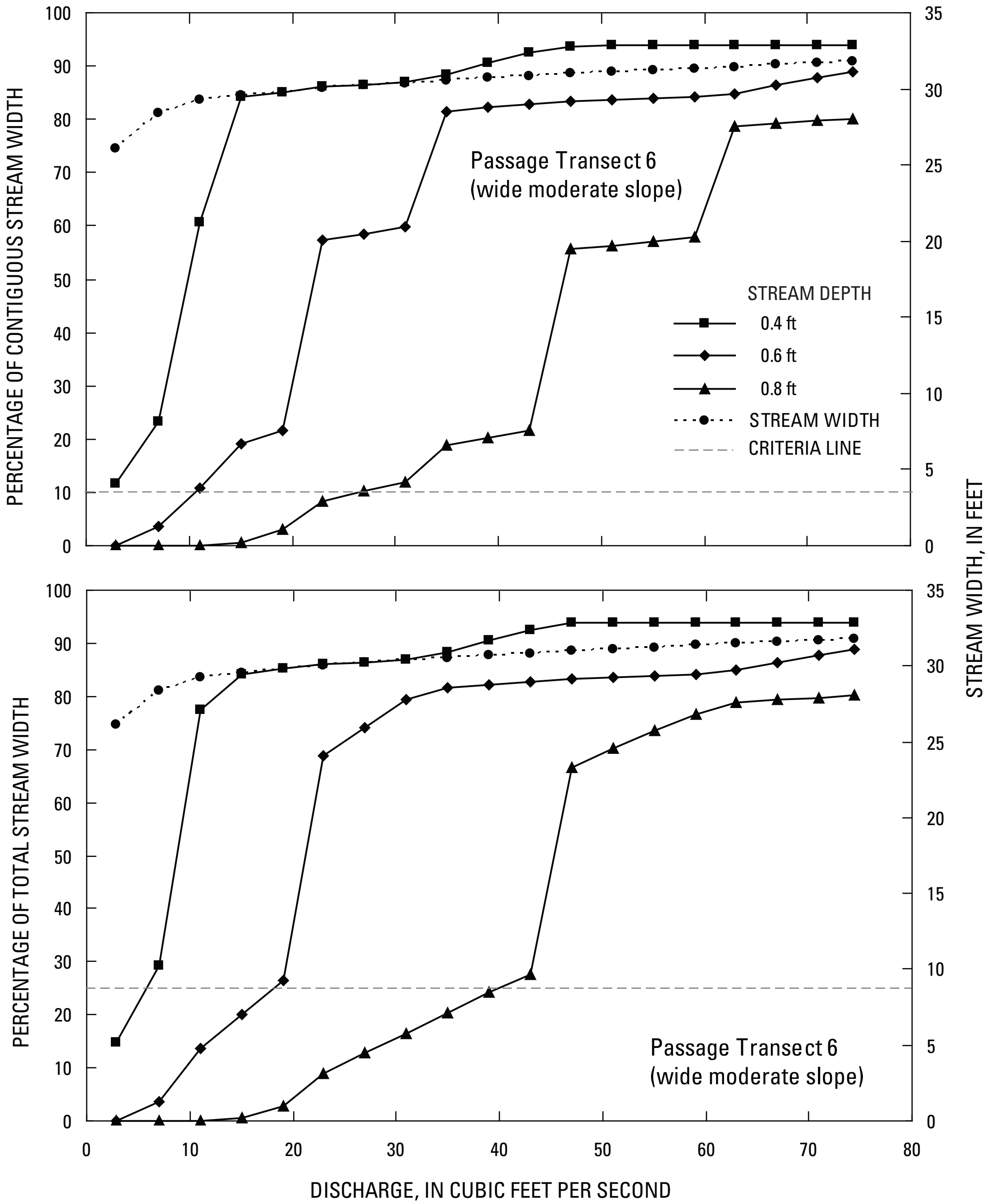



**Figure G4.** Percentages of contiguous and total stream width for passage transect 6, lower Challis Creek (CH1), upper Salmon River Basin, Idaho, 2005.

**Table G3.** Passage criteria assessment for transect 6 (wide moderate slope), site CH1, lower Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 2.9 | 26.1 | 3.9 | 14.8 | 3.1 | 11.7 |
| 7 | 28.4 | 8.3 | 29.2 | 6.6 | 23.3 |
| 11 | 29.3 | 22.6 | 77.4 | 17.7 | 60.7 |
| 15 | 29.5 | 24.8 | 84.1 | 24.8 | 84.1 |
| 19 | 29.8 | 25.4 | 85.2 | 25.4 | 85.2 |
| 23 | 30.0 | 25.8 | 86.0 | 25.8 | 86.0 |
| 27 | 30.2 | 26.1 | 86.5 | 26.1 | 86.5 |
| 31 | 30.4 | 26.4 | 86.9 | 26.4 | 86.9 |
| 35 | 30.6 | 27.0 | 88.4 | 27.0 | 88.4 |
| 39 | 30.7 | 27.8 | 90.6 | 27.8 | 90.6 |
| 43 | 30.8 | 28.5 | 92.5 | 28.5 | 92.5 |
| 47 | 31.0 | 29.0 | 93.8 | 29.0 | 93.8 |
| 51 | 31.1 | 29.2 | 93.8 | 29.2 | 93.8 |
| 55 | 31.2 | 29.3 | 93.8 | 29.3 | 93.8 |
| 59 | 31.3 | 29.4 | 93.8 | 29.4 | 93.8 |
| 63 | 31.5 | 29.5 | 93.9 | 29.5 | 93.9 |
| 67 | 31.6 | 29.6 | 93.9 | 29.6 | 93.9 |
| 71 | 31.7 | 29.7 | 93.9 | 29.7 | 93.9 |
| 74.4 | 31.8 | 29.8 | 93.9 | 29.8 | 93.9 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 2.9 | 26.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 28.4 | 1.0 | 3.6 | 1.0 | 3.6 |
| 11 | 29.3 | 4.0 | 13.7 | 3.1 | 10.7 |
| 15 | 29.5 | 5.9 | 20.0 | 5.6 | 19.0 |
| 19 | 29.8 | 7.9 | 26.4 | 6.4 | 21.6 |
| 23 | 30.0 | 20.6 | 68.8 | 17.2 | 57.4 |
| 27 | 30.2 | 22.4 | 74.2 | 17.7 | 58.6 |
| 31 | 30.4 | 24.1 | 79.3 | 18.1 | 59.7 |
| 35 | 30.6 | 24.9 | 81.6 | 24.9 | 81.6 |
| 39 | 30.7 | 25.3 | 82.2 | 25.3 | 82.2 |
| 43 | 30.8 | 25.6 | 82.9 | 25.6 | 82.9 |
| 47 | 31.0 | 25.8 | 83.3 | 25.8 | 83.3 |
| 51 | 31.1 | 26.0 | 83.6 | 26.0 | 83.6 |
| 55 | 31.2 | 26.2 | 83.9 | 26.2 | 83.9 |
| 59 | 31.3 | 26.4 | 84.2 | 26.4 | 84.2 |
| 63 | 31.5 | 26.7 | 84.9 | 26.7 | 84.9 |
| 67 | 31.6 | 27.3 | 86.4 | 27.3 | 86.4 |
| 71 | 31.7 | 27.8 | 87.8 | 27.8 | 87.8 |
| 74.4 | 31.8 | 28.3 | 89.0 | 28.3 | 89.0 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 2.9 | 26.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 28.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 29.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 29.5 | 0.2 | 0.6 | 0.2 | 0.6 |
| 19 | 29.8 | 0.9 | 2.9 | 0.9 | 2.9 |
| 23 | 30.0 | 2.6 | 8.8 | 2.5 | 8.3 |
| 27 | 30.2 | 3.9 | 12.8 | 3.1 | 10.1 |
| 31 | 30.4 | 5.0 | 16.4 | 3.6 | 11.9 |
| 35 | 30.6 | 6.2 | 20.3 | 5.7 | 18.8 |
| 39 | 30.7 | 7.4 | 24.1 | 6.2 | 20.3 |
| 43 | 30.8 | 8.5 | 27.6 | 6.7 | 21.7 |
| 47 | 31.0 | 20.6 | 66.5 | 17.2 | 55.6 |
| 51 | 31.1 | 21.8 | 70.2 | 17.5 | 56.4 |
| 55 | 31.2 | 23.0 | 73.6 | 17.8 | 57.1 |
| 59 | 31.3 | 24.0 | 76.7 | 18.1 | 57.8 |
| 63 | 31.5 | 24.8 | 78.8 | 24.8 | 78.8 |
| 67 | 31.6 | 25.0 | 79.3 | 25.0 | 79.3 |
| 71 | 31.7 | 25.3 | 79.7 | 25.3 | 79.7 |
| 74.4 | 31.8 | 25.4 | 80.1 | 25.4 | 80.1 |

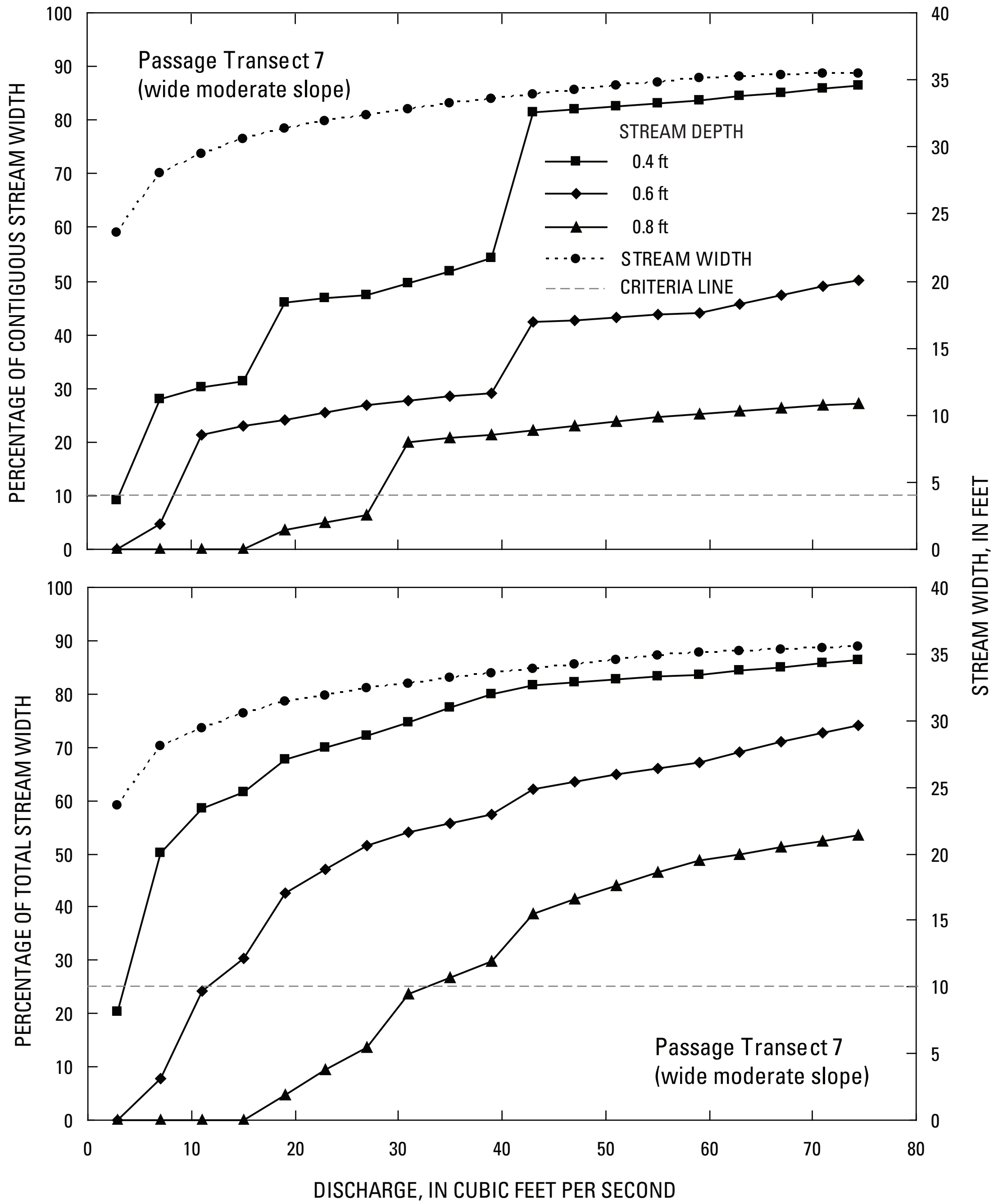


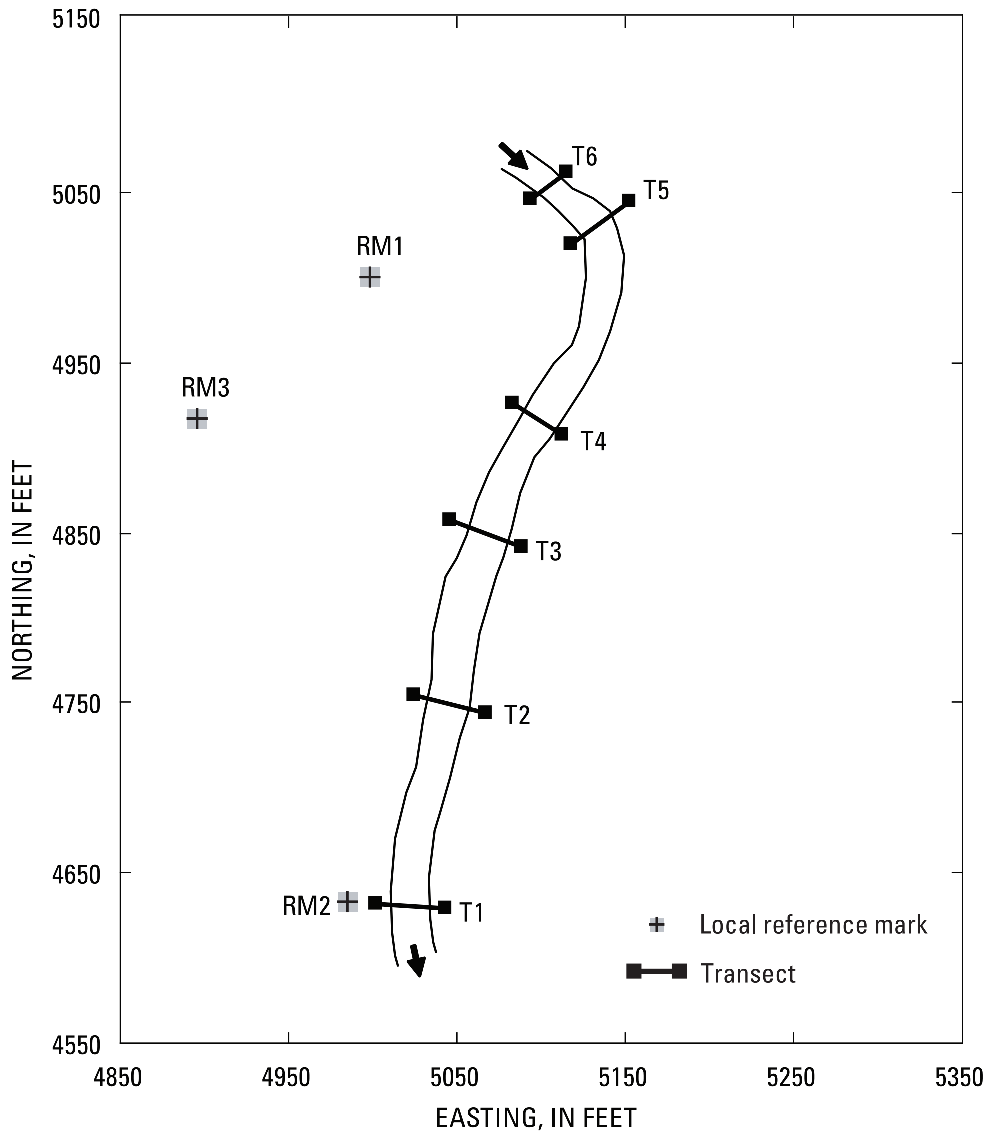

**Figure G5.** Percentages of contiguous and total stream width for passage transect 7, lower Challis Creek (CH1), upper Salmon River Basin, Idaho, 2005.

**Table G4.** Passage criteria assessment for transect 7 (wide moderate slope), site CH1, lower Challis Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 8. **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 | | | |
| 2.9 | 23.6 | 4.8 | 20.3 | 2.1 | 9.1 |
| 7 | 28.1 | 14.1 | 50.2 | 7.8 | 27.9 |
| 11 | 29.5 | 17.2 | 58.5 | 8.9 | 30.3 |
| 15 | 30.5 | 18.8 | 61.6 | 9.6 | 31.4 |
| 19 | 31.4 | 21.2 | 67.7 | 14.4 | 45.9 |
| 23 | 31.9 | 22.3 | 70.0 | 14.9 | 46.7 |
| 27 | 32.4 | 23.3 | 72.0 | 15.3 | 47.4 |
| 31 | 32.8 | 24.5 | 74.7 | 16.3 | 49.6 |
| 35 | 33.2 | 25.7 | 77.3 | 17.2 | 51.9 |
| 39 | 33.6 | 26.8 | 79.9 | 18.2 | 54.2 |
| 43 | 33.9 | 27.7 | 81.6 | 27.7 | 81.6 |
| 47 | 34.2 | 28.1 | 82.1 | 28.1 | 82.1 |
| 51 | 34.5 | 28.5 | 82.6 | 28.5 | 82.6 |
| 55 | 34.8 | 29.0 | 83.2 | 29.0 | 83.2 |
| 59 | 35.1 | 29.3 | 83.6 | 29.3 | 83.6 |
| 63 | 35.2 | 29.7 | 84.4 | 29.7 | 84.4 |
| 67 | 35.3 | 30.1 | 85.1 | 30.1 | 85.1 |
| 71 | 35.4 | 30.4 | 85.8 | 30.4 | 85.8 |
| 74.4 | 35.5 | 30.6 | 86.3 | 30.6 | 86.3 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 2.9 | 23.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 28.1 | 2.2 | 7.7 | 1.4 | 4.8 |
| 11 | 29.5 | 7.1 | 24.1 | 6.3 | 21.4 |
| 15 | 30.5 | 9.3 | 30.5 | 7.0 | 22.9 |
| 19 | 31.4 | 13.3 | 42.5 | 7.6 | 24.2 |
| 23 | 31.9 | 15.0 | 47.2 | 8.2 | 25.6 |
| 27 | 32.4 | 16.6 | 51.4 | 8.7 | 26.9 |
| 31 | 32.8 | 17.7 | 54.0 | 9.1 | 27.8 |
| 35 | 33.2 | 18.5 | 55.8 | 9.5 | 28.5 |
| 39 | 33.6 | 19.3 | 57.5 | 9.8 | 29.2 |
| 43 | 33.9 | 21.1 | 62.2 | 14.3 | 42.3 |
| 47 | 34.2 | 21.8 | 63.6 | 14.6 | 42.8 |
| 51 | 34.5 | 22.4 | 64.9 | 14.9 | 43.2 |
| 55 | 34.8 | 23.0 | 66.1 | 15.2 | 43.7 |
| 59 | 35.1 | 23.6 | 67.2 | 15.5 | 44.1 |
| 63 | 35.2 | 24.4 | 69.2 | 16.1 | 45.8 |
| 67 | 35.3 | 25.1 | 71.0 | 16.7 | 47.4 |
| 71 | 35.4 | 25.8 | 72.8 | 17.3 | 48.9 |
| 74.4 | 35.5 | 26.3 | 74.1 | 17.8 | 50.1 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 2.9 | 23.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 28.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 29.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 30.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19 | 31.4 | 1.5 | 4.8 | 1.1 | 3.7 |
| 23 | 31.9 | 3.0 | 9.4 | 1.6 | 5.0 |
| 27 | 32.4 | 4.4 | 13.6 | 2.0 | 6.3 |
| 31 | 32.8 | 7.8 | 23.7 | 6.5 | 19.9 |
| 35 | 33.2 | 8.9 | 26.8 | 6.9 | 20.7 |
| 39 | 33.6 | 10.0 | 29.8 | 7.2 | 21.4 |
| 43 | 33.9 | 13.1 | 38.7 | 7.5 | 22.2 |
| 47 | 34.2 | 14.2 | 41.4 | 7.9 | 23.0 |
| 51 | 34.5 | 15.2 | 44.0 | 8.2 | 23.8 |
| 55 | 34.8 | 16.2 | 46.5 | 8.6 | 24.6 |
| 59 | 35.1 | 17.1 | 48.6 | 8.8 | 25.2 |
| 63 | 35.2 | 17.6 | 50.0 | 9.1 | 25.8 |
| 67 | 35.3 | 18.1 | 51.3 | 9.3 | 26.3 |
| 71 | 35.4 | 18.6 | 52.5 | 9.5 | 26.8 |
| 74.4 | 35.5 | 19.0 | 53.4 | 9.7 | 27.2 |

**Appendix H.** Plan view, weighted usable areas, and passage criteria assessments for bull trout, Chinook salmon, steelhead trout, and invertebrates for lower Morgan Creek (MC1), upper Salmon River Basin, Idaho, 2005.




Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH1 | 44° 34' 4.73" N | 114° 10' 53.22" W |
| LH1 | 44° 34' 4.73" N | 114° 10' 53.77" W |
| RH2 | 44° 34' 5.86" N | 114° 10' 52.94" W |
| LH2 | 44° 34' 5.95" N | 114° 10' 53.58" W |
| RH3 | 44° 34' 6.85" N | 114° 10' 52.75" W |
| LH3 | 44° 34' 6.98" N | 114° 10' 53.33" W |

Transect Endpoint Coordinates (NAD 83)

| Point | Latitude | Longitude |
|---|---|---|
| RH4 | 44° 34' 7.49" N | 114° 10' 52.45" W |
| LH4 | 44° 34' 7.67" N | 114° 10' 52.86" W |
| RH5 | 44° 34' 8.88" N | 114° 10' 52.01" W |
| LH5 | 44° 34' 8.62" N | 114° 10' 52.45" W |
| RH6 | 44° 34' 9.03" N | 114° 10' 52.53 W |
| LH6 | 44° 34' 8.87" N | 114° 10' 52.81" W |

For reference only; stream schematic not to scale.

**Figure H1.** Plan view of lower Morgan Creek (MC1), upper Salmon River Basin, Idaho, 2005.

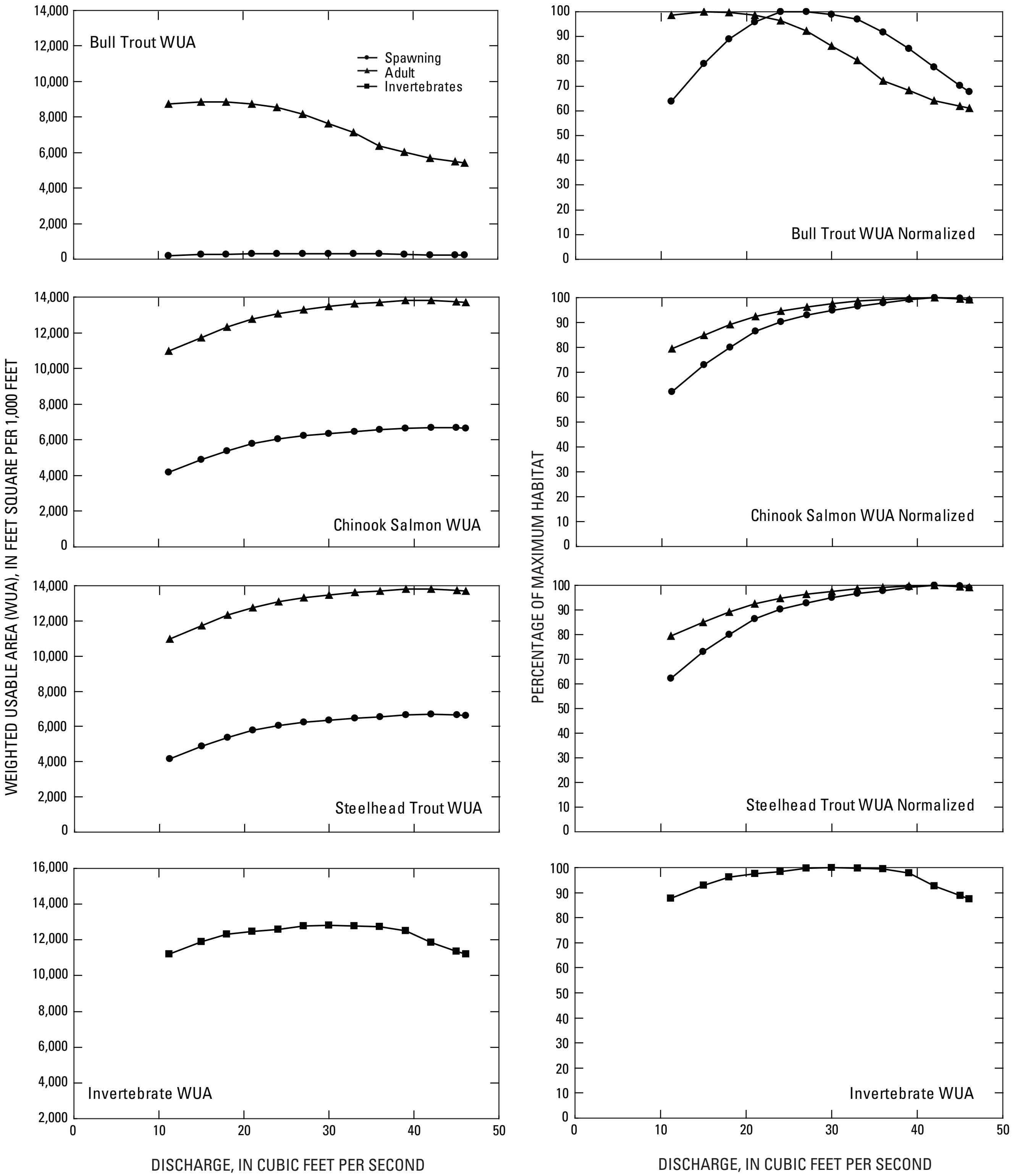



**Figure H2.** Weighted usable area and percentage of maximum habitat for bull trout, Chinook salmon, steelhead trout, and invertebrates, lower Morgan Creek (MC1), upper Salmon River Basin, Idaho, 2005.

**Table H1.** Weighted usable area for bull trout, Chinook salmon, steelhead trout life stages, and Ephemeroptera, Plecoptera, and Trichoptera (EPT) invertebrates, site MC1, lower Morgan Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 12. **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** | | | | | |
| 11.2 | 22,018 | 8,724 | 200 | 98.6 | 63.8 |
| 15 | 22,462 | 8,851 | 248 | 100.0 | 79.0 |
| 18 | 22,762 | 8,835 | 279 | 99.8 | 88.9 |
| 21 | 23,024 | 8,727 | 301 | 98.6 | 95.8 |
| 24 | 23,261 | 8,527 | 314 | 96.3 | 100.0 |
| 27 | 23,478 | 8,164 | 314 | 92.2 | 100.0 |
| 30 | 23,680 | 7,638 | 311 | 86.3 | 99.0 |
| 33 | 23,865 | 7,115 | 305 | 80.4 | 97.1 |
| 36 | 24,039 | 6,373 | 288 | 72.0 | 91.7 |
| 39 | 24,195 | 6,034 | 267 | 68.2 | 85.1 |
| 42 | 24,314 | 5,683 | 244 | 64.2 | 77.6 |
| 45 | 24,429 | 5,483 | 220 | 61.9 | 70.1 |
| 46.100 | 24,471 | 5,412 | 213 | 61.1 | 67.8 |
| **Chinook salmon** | | | | | |
| 11.2 | 22,018 | 10,984 | 4,170 | 79.5 | 62.2 |
| 15 | 22,462 | 11,740 | 4,895 | 84.9 | 73.1 |
| 18 | 22,762 | 12,317 | 5,367 | 89.1 | 80.1 |
| 21 | 23,024 | 12,770 | 5,789 | 92.4 | 86.4 |
| 24 | 23,261 | 13,079 | 6,044 | 94.6 | 90.2 |
| 27 | 23,478 | 13,306 | 6,225 | 96.3 | 92.9 |
| 30 | 23,680 | 13,479 | 6,363 | 97.5 | 95.0 |
| 33 | 23,865 | 13,635 | 6,470 | 98.6 | 96.6 |
| 36 | 24,039 | 13,706 | 6,554 | 99.2 | 97.8 |
| 39 | 24,195 | 13,802 | 6,650 | 99.9 | 99.3 |
| 42 | 24,314 | 13,821 | 6,700 | 100.0 | 100.0 |
| 45 | 24,429 | 13,754 | 6,674 | 99.5 | 99.6 |
| 46.100 | 24,471 | 13,705 | 6,628 | 99.2 | 98.9 |

| 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** | | | | | |
| 11.2 | 22,018 | 10,984 | 4,170 | 79.5 | 62.2 |
| 15 | 22,462 | 11,740 | 4,895 | 84.9 | 73.1 |
| 18 | 22,762 | 12,317 | 5,367 | 89.1 | 80.1 |
| 21 | 23,024 | 12,770 | 5,789 | 92.4 | 86.4 |
| 24 | 23,261 | 13,079 | 6,044 | 94.6 | 90.2 |
| 27 | 23,478 | 13,306 | 6,225 | 96.3 | 92.9 |
| 30 | 23,680 | 13,479 | 6,363 | 97.5 | 95.0 |
| 33 | 23,865 | 13,635 | 6,470 | 98.6 | 96.6 |
| 36 | 24,039 | 13,706 | 6,554 | 99.2 | 97.8 |
| 39 | 24,195 | 13,802 | 6,650 | 99.9 | 99.3 |
| 42 | 24,314 | 13,821 | 6,700 | 100.0 | 100.0 |
| 45 | 24,429 | 13,754 | 6,674 | 99.5 | 99.6 |
| 46.100 | 24,471 | 13,705 | 6,628 | 99.2 | 98.9 |

| Discharge ($ft^3/s$) | Total area ($ft^2$) | Summary of WUA ($ft^2/1,000$ ft) | Percentage of maximum habitat |
|---|---|---|---|
| **EPT Invertebrates** | | | |
| 11.2 | 22,018 | 11,220 | 87.6 |
| 15 | 22,462 | 11,894 | 92.9 |
| 18 | 22,762 | 12,313 | 96.2 |
| 21 | 23,024 | 12,482 | 97.5 |
| 24 | 23,261 | 12,586 | 98.3 |
| 27 | 23,478 | 12,768 | 99.7 |
| 30 | 23,680 | 12,802 | 100.0 |
| 33 | 23,865 | 12,775 | 99.8 |
| 36 | 24,039 | 12,723 | 99.4 |
| 39 | 24,195 | 12,506 | 97.7 |
| 42 | 24,314 | 11,846 | 92.5 |
| 45 | 24,429 | 11,370 | 88.8 |
| 46.100 | 24,471 | 11,209 | 87.6 |

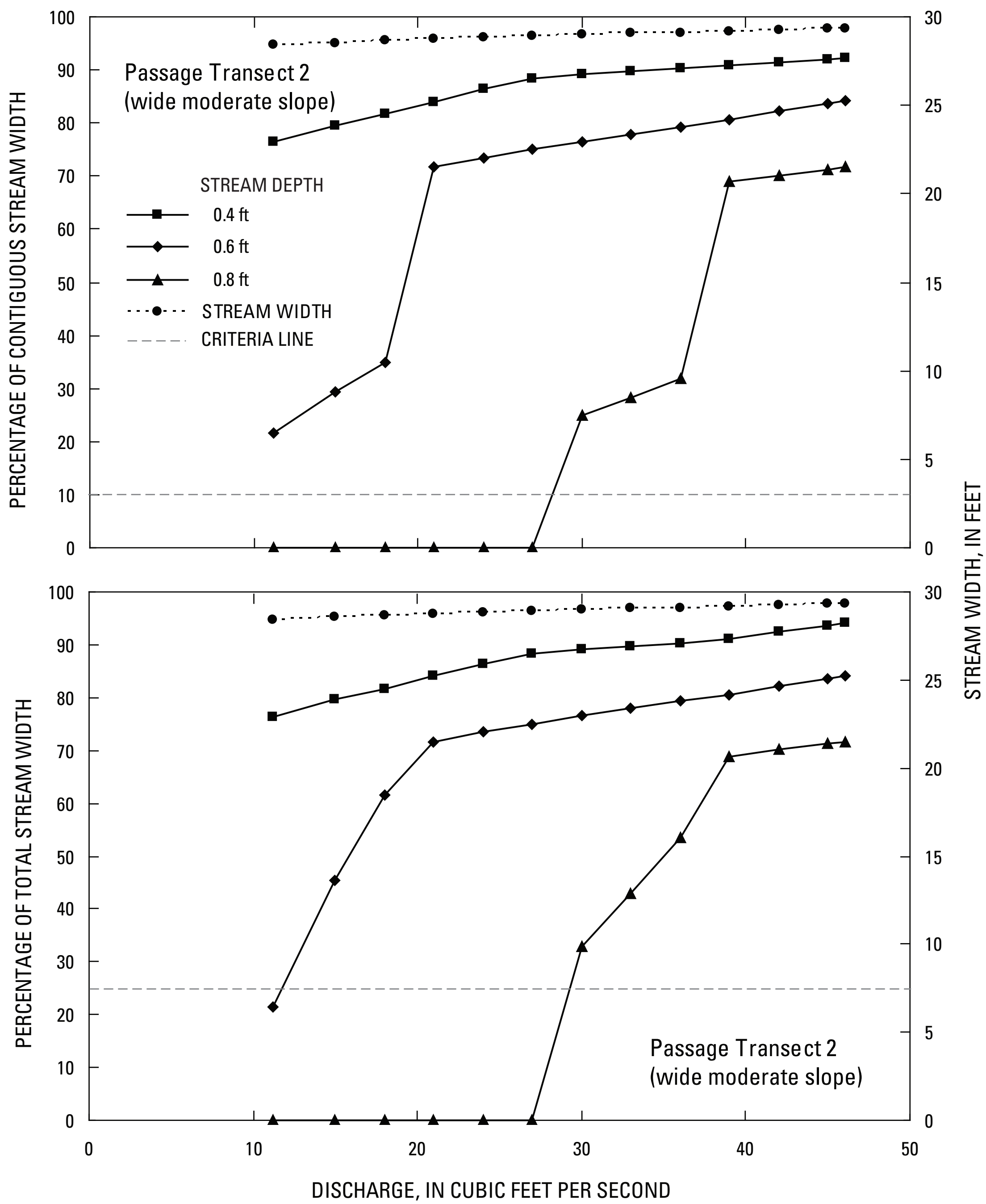



**Figure H3.** Percentages of contiguous and total stream width for passage transect 2, lower Morgan Creek (MC1), upper Salmon River Basin, Idaho, 2005.

**Table H2.** Passage criteria assessment for transect 2 (wide moderate slope), site MC1, lower Morgan Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 12. **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 | | | |
| 11.2 | 28.4 | 21.7 | 76.4 | 21.7 | 76.4 | 11.2 | 28.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 28.5 | 22.7 | 79.5 | 22.7 | 79.5 | 15 | 28.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 28.6 | 23.4 | 81.6 | 23.4 | 81.6 | 18 | 28.6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 28.7 | 24.2 | 84.1 | 24.2 | 84.1 | 21 | 28.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | 28.8 | 24.9 | 86.3 | 24.9 | 86.3 | 24 | 28.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 27 | 28.9 | 25.5 | 88.4 | 25.5 | 88.4 | 27 | 28.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 30 | 29.0 | 25.8 | 89.1 | 25.8 | 89.1 | 30 | 29.0 | 9.5 | 32.8 | 7.2 | 25.0 |
| 33 | 29.1 | 26.1 | 89.7 | 26.1 | 89.7 | 33 | 29.1 | 12.5 | 43.0 | 8.2 | 28.4 |
| 36 | 29.1 | 26.3 | 90.3 | 26.3 | 90.3 | 36 | 29.1 | 15.6 | 53.5 | 9.3 | 31.9 |
| 39 | 29.2 | 26.6 | 91.1 | 26.5 | 90.9 | 39 | 29.2 | 20.1 | 68.8 | 20.1 | 68.8 |
| 42 | 29.2 | 27.0 | 92.4 | 26.7 | 91.4 | 42 | 29.2 | 20.5 | 70.1 | 20.5 | 70.1 |
| 45 | 29.3 | 27.5 | 93.7 | 26.9 | 92.0 | 45 | 29.3 | 20.9 | 71.3 | 20.9 | 71.3 |
| 46 | 29.3 | 27.6 | 94.2 | 27.0 | 92.1 | 46 | 29.3 | 21.0 | 71.7 | 21.0 | 71.7 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 11.2 | 28.4 | 6.1 | 21.5 | 6.1 | 21.5 | | | | | | |
| 15 | 28.5 | 12.9 | 45.3 | 8.4 | 29.4 | | | | | | |
| 18 | 28.6 | 17.6 | 61.5 | 10.0 | 34.8 | | | | | | |
| 21 | 28.7 | 20.6 | 71.7 | 20.6 | 71.7 | | | | | | |
| 24 | 28.8 | 21.2 | 73.4 | 21.2 | 73.4 | | | | | | |
| 27 | 28.9 | 21.7 | 75.0 | 21.7 | 75.0 | | | | | | |
| 30 | 29.0 | 22.2 | 76.6 | 22.2 | 76.6 | | | | | | |
| 33 | 29.1 | 22.6 | 77.9 | 22.6 | 77.9 | | | | | | |
| 36 | 29.1 | 23.1 | 79.3 | 23.1 | 79.3 | | | | | | |
| 39 | 29.2 | 23.5 | 80.6 | 23.5 | 80.6 | | | | | | |
| 42 | 29.2 | 24.0 | 82.2 | 24.0 | 82.2 | | | | | | |
| 45 | 29.3 | 24.5 | 83.7 | 24.5 | 83.7 | | | | | | |
| 46 | 29.3 | 24.7 | 84.2 | 24.7 | 84.2 | | | | | | |

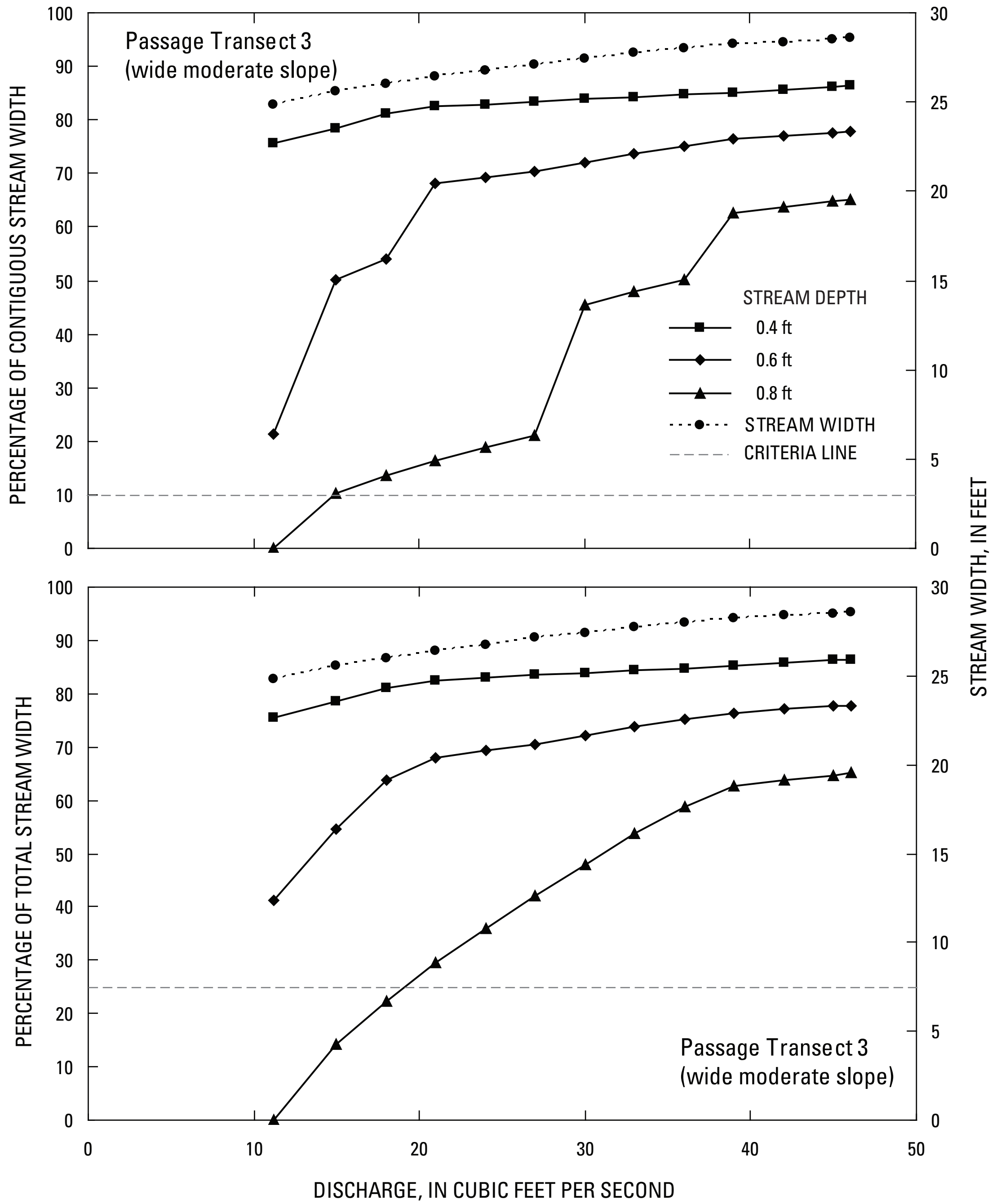



**Figure H4.** Percentages of contiguous and total stream width for passage transect 3, lower Morgan Creek (MC1), upper Salmon River Basin, Idaho, 2005.

**Table H3.** Passage criteria assessment for transect 3 (wide moderate slope), site MC1, lower Morgan Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 12. **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 | | | |
| 11.2 | 24.8 | 18.7 | 75.5 | 18.7 | 75.5 |
| 15 | 25.6 | 20.1 | 78.5 | 20.1 | 78.5 |
| 18 | 26.0 | 21.1 | 81.1 | 21.1 | 81.1 |
| 21 | 26.4 | 21.8 | 82.4 | 21.8 | 82.4 |
| 24 | 26.8 | 22.2 | 83.0 | 22.2 | 83.0 |
| 27 | 27.1 | 22.6 | 83.5 | 22.6 | 83.5 |
| 30 | 27.4 | 23.0 | 83.9 | 23.0 | 83.9 |
| 33 | 27.7 | 23.4 | 84.3 | 23.4 | 84.3 |
| 36 | 28.0 | 23.7 | 84.7 | 23.7 | 84.7 |
| 39 | 28.2 | 24.0 | 85.1 | 24.0 | 85.1 |
| 42 | 28.4 | 24.3 | 85.7 | 24.3 | 85.7 |
| 45 | 28.5 | 24.6 | 86.3 | 24.6 | 86.3 |
| 46 | 28.6 | 24.7 | 86.5 | 24.7 | 86.5 |
| | | Stream widths greater than 0.6-ft depth | | | |
| 11.2 | 24.8 | 10.3 | 41.3 | 5.3 | 21.3 |
| 15 | 25.6 | 14.0 | 54.6 | 12.8 | 50.2 |
| 18 | 26.0 | 16.6 | 63.8 | 14.1 | 54.1 |
| 21 | 26.4 | 18.0 | 68.0 | 18.0 | 68.0 |
| 24 | 26.8 | 18.6 | 69.3 | 18.6 | 69.3 |
| 27 | 27.1 | 19.1 | 70.4 | 19.1 | 70.4 |
| 30 | 27.4 | 19.8 | 72.0 | 19.8 | 72.0 |
| 33 | 27.7 | 20.4 | 73.7 | 20.4 | 73.7 |
| 36 | 28.0 | 21.0 | 75.1 | 21.0 | 75.1 |
| 39 | 28.2 | 21.6 | 76.4 | 21.6 | 76.4 |
| 42 | 28.4 | 21.9 | 77.0 | 21.9 | 77.0 |
| 45 | 28.5 | 22.1 | 77.6 | 22.1 | 77.6 |
| 46 | 28.6 | 22.2 | 77.8 | 22.2 | 77.8 |
| | | Stream widths greater than 0.8-ft depth | | | |
| 11.2 | 24.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 25.6 | 3.7 | 14.3 | 2.6 | 10.3 |
| 18 | 26.0 | 5.8 | 22.4 | 3.6 | 13.6 |
| 21 | 26.4 | 7.8 | 29.6 | 4.4 | 16.5 |
| 24 | 26.8 | 9.6 | 36.0 | 5.1 | 18.9 |
| 27 | 27.1 | 11.4 | 42.0 | 5.7 | 21.2 |
| 30 | 27.4 | 13.2 | 48.0 | 12.5 | 45.4 |
| 33 | 27.7 | 14.9 | 53.6 | 13.3 | 47.8 |
| 36 | 28.0 | 16.4 | 58.7 | 14.0 | 50.0 |
| 39 | 28.2 | 17.7 | 62.7 | 17.7 | 62.7 |
| 42 | 28.4 | 18.1 | 63.7 | 18.1 | 63.7 |
| 45 | 28.5 | 18.5 | 64.7 | 18.5 | 64.7 |
| 46 | 28.6 | 18.6 | 65.0 | 18.6 | 65.0 |

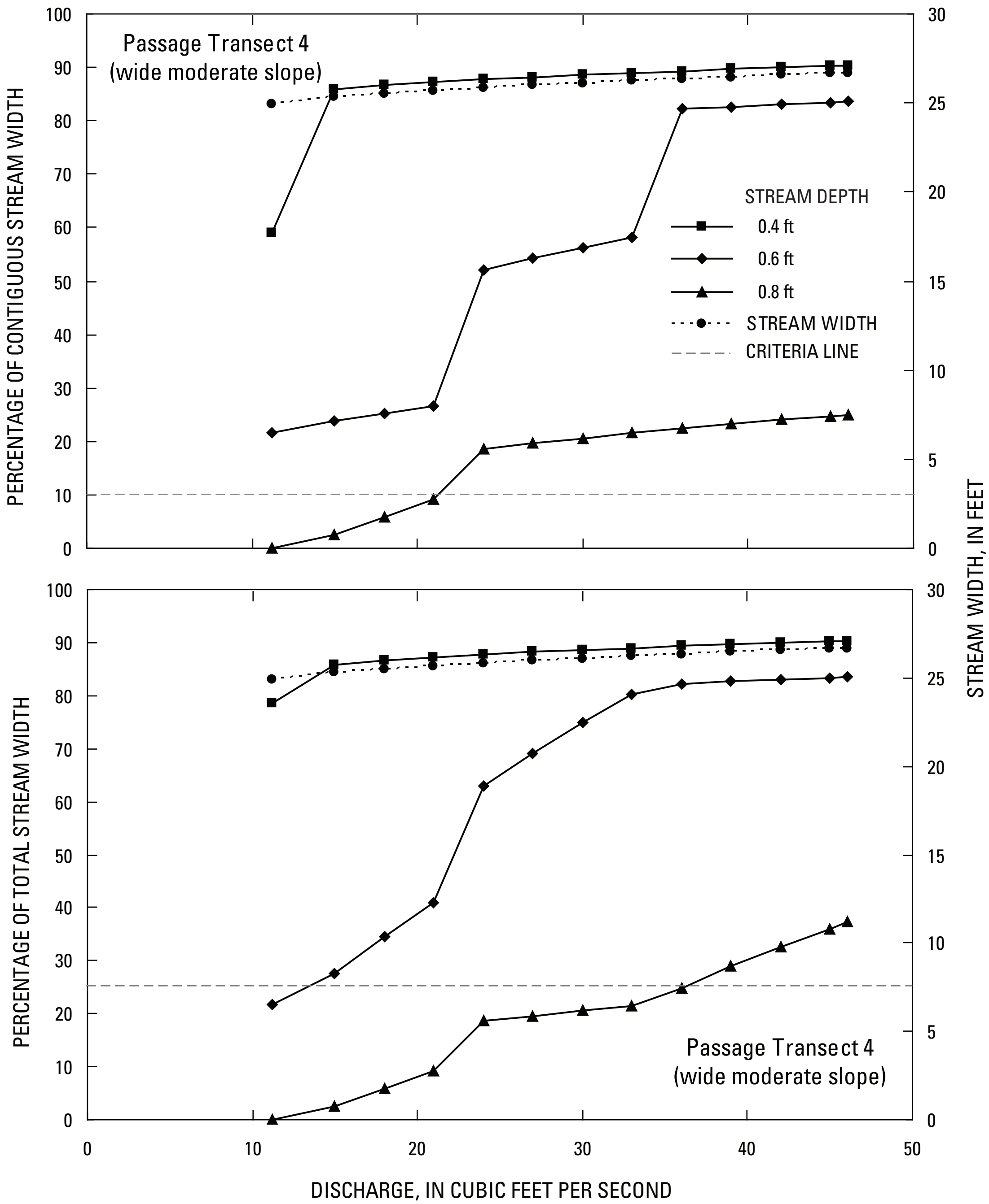



**Figure H5.** Percentages of contiguous and total stream width for passage transect 4, lower Morgan Creek (MC1), upper Salmon River Basin, Idaho, 2005.

**Table H4.** Passage criteria assessment for transect 4 (wide moderate slope), site MC1, lower Morgan Creek, upper Salmon River Basin, Idaho, 2005.

[Site location shown in figure 12. **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 | | | |
| 11.2 | 24.9 | 19.6 | 78.4 | 14.7 | 58.9 | 11.2 | 24.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 25.3 | 21.7 | 85.8 | 21.7 | 85.8 | 15 | 25.3 | 0.6 | 2.4 | 0.6 | 2.4 |
| 18 | 25.5 | 22.1 | 86.6 | 22.1 | 86.6 | 18 | 25.5 | 1.5 | 5.9 | 1.5 | 5.9 |
| 21 | 25.7 | 22.4 | 87.2 | 22.4 | 87.2 | 21 | 25.7 | 2.3 | 9.1 | 2.3 | 9.1 |
| 24 | 25.8 | 22.7 | 87.8 | 22.7 | 87.8 | 24 | 25.8 | 4.8 | 18.5 | 4.8 | 18.5 |
| 27 | 26.0 | 22.9 | 88.2 | 22.9 | 88.2 | 27 | 26.0 | 5.1 | 19.6 | 5.1 | 19.6 |
| 30 | 26.1 | 23.1 | 88.6 | 23.1 | 88.6 | 30 | 26.1 | 5.4 | 20.6 | 5.4 | 20.6 |
| 33 | 26.2 | 23.3 | 89.0 | 23.3 | 89.0 | 33 | 26.2 | 5.7 | 21.6 | 5.7 | 21.6 |
| 36 | 26.3 | 23.5 | 89.3 | 23.5 | 89.3 | 36 | 26.3 | 6.5 | 24.8 | 5.9 | 22.4 |
| 39 | 26.5 | 23.7 | 89.7 | 23.7 | 89.7 | 39 | 26.5 | 7.6 | 28.9 | 6.2 | 23.3 |
| 42 | 26.6 | 23.9 | 90.0 | 23.9 | 90.0 | 42 | 26.6 | 8.7 | 32.6 | 6.4 | 24.0 |
| 45 | 26.7 | 24.1 | 90.3 | 24.1 | 90.3 | 45 | 26.7 | 9.6 | 36.0 | 6.6 | 24.7 |
| 46 | 26.7 | 24.1 | 90.4 | 24.1 | 90.4 | 46 | 26.7 | 9.9 | 37.2 | 6.7 | 25.0 |
| | | Stream widths greater than 0.6-ft depth | | | | | | | | | |
| 11.2 | 24.9 | 5.4 | 21.6 | 5.4 | 21.6 | | | | | | |
| 15 | 25.3 | 7.0 | 27.5 | 6.0 | 23.7 | | | | | | |
| 18 | 25.5 | 8.8 | 34.7 | 6.4 | 25.2 | | | | | | |
| 21 | 25.7 | 10.5 | 41.0 | 6.8 | 26.5 | | | | | | |
| 24 | 25.8 | 16.2 | 62.9 | 13.5 | 52.1 | | | | | | |
| 27 | 26.0 | 18.0 | 69.1 | 14.1 | 54.3 | | | | | | |
| 30 | 26.1 | 19.6 | 74.9 | 14.7 | 56.2 | | | | | | |
| 33 | 26.2 | 21.1 | 80.3 | 15.2 | 58.1 | | | | | | |
| 36 | 26.3 | 21.7 | 82.2 | 21.7 | 82.2 | | | | | | |
| 39 | 26.5 | 21.9 | 82.6 | 21.9 | 82.6 | | | | | | |
| 42 | 26.6 | 22.1 | 83.0 | 22.1 | 83.0 | | | | | | |
| 45 | 26.7 | 22.2 | 83.4 | 22.2 | 83.4 | | | | | | |
| 46 | 26.7 | 22.3 | 83.5 | 22.3 | 83.5 | | | | | | |

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Maret and others

Instream Flow Characterization of Upper Salmon River Basin Streams, Central Idaho, 2005

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